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USER MANUAL:

DPFlex Sensorless Brushless Motor Drive

Contents

This manual describes the installation and operation of the generation 1 and generation 2 DPFlex sensorless brushless DC motor drives manufactured by Allied Motion Technologies.

Every effort has been made to ensure the accuracy of the information in this manual. However, Allied Motion assumes no responsibility for any errors or omissions. The information contained in this document is subject to change without prior notice. We welcome your critical evaluation and suggestions for improvements to be made in future revisions.

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	Read all provided documentation before assembly and commissioning. Failure or incorrect or improper use of this equipment can cause death, personal injury and consequential damage.

	Allied Motion disclaims any responsibility for such occurrence whereby unskilled and/or untrained personnel have incorrectly installed the equipment.
	Do not apply power to the motor without checking for proper wiring.

The final responsibility for the safe use of this motor is solely that of the user.

Allied Motion has used its best effort in the preparation of this manual. We reserve the right to make modifications, and alterations to improve the content and amend errors may be made to it without notice. Check the appendices for errata and revisions.

IV. Inspection upon Receipt

All Allied Motion products are thoroughly inspected and tested before leaving the factory. Although our products are packaged with extreme care, it is important that the user complete a thorough inspection of the product upon arrival.

Examine the condition of the shipping container and materials. If damage is found, notify the commercial carrier involved. It is the user's responsibility to file any necessary damage claims with the carrier. Our products are shipped EXW (ex works), unless other arrangements have been made. Allied Motion is not responsible for carrier mishandling.

1 Introducing DPFlex

This chapter provides an overview of the DPFlex: its features, functions, and specifications.

1.1 What is DPFlex?

The DPFlex™ provides sensorless control of rotary brushless DC motors at performance levels that exceed those of conventional Hall commutated drives. DPFlex detects motor rotor position at motor stand still through an innovative algorithm based on motor phase-inductance measurement. You can integrate the DPFlex into a motor, e.g. into the bell end, or mount it separately from the motor.

DPFlex features include:

- Enables a brushless DC motor to provide controlled torque or speed without the need for motor commutation sensors
- One non-isolated analog input to adjust torque or speed
- One non-isolated digital input to select the direction of motor rotation
- One non-isolated digital input to enable or disable the drive and motor
- One non-isolated digital output
- Over-temperature and over-current protection
- Auto-start programming function
- Models for motors requiring up to 30 A peak
- Allied Motion's DP.D software for Microsoft® Windows® 2000/XP/Vista/7/8 enables you to tune, configure, and program the drive. It provides the following features:
  - Motor set-up and configuration tools
  - Inputs set-up and configuration tools
  - Motor verification and performance analysis tools
  - Integrated online help

DPFlex is suitable for a wide range of applications, including control of fans, pumps, compressors, centrifuges, drills and mills, conveyors, office and medical equipment, automotive subsystems, and many others.

1.2 DPFlex Components

The DPFlex product family includes the following components:

- The DPFlex drive

- The DP.D software for Microsoft Windows 2000/XP./Vista/7/8
- Cables and connectors for connecting a DPFlex drive to power, motor, and
- A personal computer
- This user manual

1.3 DPFlex Evaluation Kits

Allied Motion offers DPFlex evaluation kits that contain all the components you need to design and test the DPFlex in your application. Contact us for more information.

Voltage/Current	Part Number
16 V / 30 A	11-F0012-30
16 V / 15 A	11-F0012-15
16 V / 10 A	11-F0012-10
30 V / 30 A	11-F0024-30
30 V / 15 A	11-F0024-15
30 V / 10 A	11-F0024-10

Table 1: DPFlex Evaluation Kits-generation 1

Component	Part Number
DPFlex Drive 16 V Maximum	30A: 10-F0012-30 15A: 10-F0012-15 10A: 10-F0012-10
DPFlex Drive 30 V Maximum	30A: 10-F0024-30 15A: 10-F0024-15 10A: 10-F0024-10
USB to UART Communication Cable	10-0099
USB A to B Communication Cable	40-0089
Motor Cable	40-0106
Power Cable	40-0105
Kit Connection Instruction	07-0044
DP.D CD	35-0028
DPFlex User Manual	34-2109

Table 2: DPFlex Evaluation Kit Contents-generation 1

Voltage/Current	Part Number
16 V / 30 A	
16 V / 15 A	
16 V / 5 A	
30 V / 30 A	
30 V / 15 A	
30 V / 5 A	
60 V / 30 A	
60 V / 15 A	
60 V / 5 A	

Table 3: DPFlex Evaluation Kits-generation 2

Component	Part Number
DPFlex Drive 16 V Maximum	30A: 10-F0012-30 15A: 10-F0012-15 6A: 10-F0012-10
DPFlex Drive 30 V Maximum	30A: 10-F0024-30 15A: 10-F0024-15 6A: 10-F0024-10
DPFlex Drive 60 V Maximum	30A: 10-F0024-30 15A: 10-F0024-15 6A: 10-F0024-10
USB to UART Communication Cable	10-0099
USB A to B Communication Cable	40-0089
Motor Cable	40-0106
Power Cable	40-0105
Kit Connection Instruction	07-0044
DP.D CD	35-0028
DPFlex User Manual	34-2109

Table 4: DPFlex Evaluation Kit Contents-generation 2

2 Sensorless Drive Technology

2.1 Understanding Commutation and DPFlex

Controlling current in a motor to produce torque is called commutation. Torque in an electric motor is the interaction between two magnetic fields, one from a rotor and the other one from a stator. These two magnetic fields must move relative to each other to maintain torque.

There are two ways to produce a moving magnetic field. One way is to apply AC current to stationary windings. The other is to change the physical path of DC current in a stator. A DC motor uses the latter approach to commutation.

DPFlex changes the path of current in motor coils in the following manner. Electrical commutation is done using an external controller to change the current path. Current is directed through various wires in the stator creating a moving magnetic field. To control the paths for current, DPFlex uses a six-step sensorless method that relies on back electromotive force sensing.

2.2 Six-Step or Trapezoidal Commutation

In this method, there are only two phases of the stator coils energized by the DC source. To complete one electrical cycle (360 degrees) for magnetic field rotation, every phase would be energized four times (two times in the positive polarity and the other two in the negative polarity). Because the transition from one step to the next is discrete, the waveform of the field is like a trapezoid. This method is simple and can be used for different types of BLDC motors. The simplicity and effectiveness of this method makes it an attractive choice for commutation even at high speed. BLDC motors are commutated in six 60°steps during each full 360° electrical cycle. Only two of the three motor coils are energized during each step.

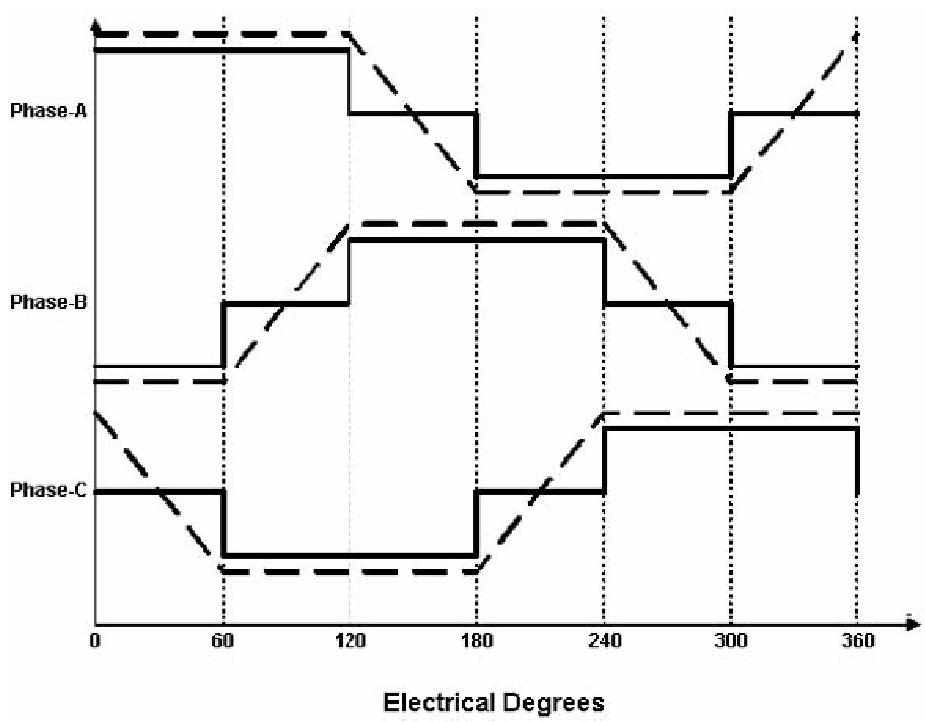


Figure 1: Six-Step Commutation Phase Current & Back-EMF Diagram

2.3 Sensorless Six-step Commutation

Once the shaft of the motor is spinning sufficiently fast, the induced back-emf (speed) voltage caused by the time varying magnetic flux linking the stator windings can be measured by the drive. The magnetic flux is produced from the permanent magnets contained in the rotor. It is possible to use this information to commutate the motor without any other position feedback information. This is what is meant by the term *sensorless*: it is the absence of any physical position feedback devices in the motor.

For trapezoidal commutation, only two coils of the three motor coils are energized at any one time. The coils that are energized are the two that yield the maximum developed electromagnetic torque. For a Y (WYE) connected motor, the third coil is off and the speed voltage can be sensed at its phase terminal. Each of the three coils is energized (ON) for 120 electrical degrees and is then de-energized (OFF) for 60 electrical degrees. This pattern is repeated again and again every 180 electrical degrees and the current is switched in direction each 180 degree segment.

The speed voltage induced in the OFF phase undergoes a polarity reversal during the time the phase is OFF. The bias voltage is the voltage of the neutral point of the WYE connection. Ideally, the drive should shut OFF a coil as the induced speed voltage across that coil is undergoing a polarity reversal. The coil should then be re-energized once the voltage has changed polarity and that coil can contribute to torque production. In order to do this, the controller samples the voltage of the OFF phase once the current in that phase has dropped to zero. Once it detects that the rotor flux is generating a speed voltage of the proper polarity, it shuts OFF the coil that is just beginning to go through this voltage reversal process and energizes the one that just finished this process.

The drive uses a physical constant of the motor in order to assess when the time is appropriate. The motor constant related to the volts per rpm (Ke) of the motor is used to calculate how much flux there is per pole. By integrating the induced speed voltage in the OFF phase and waiting for the proper amount of flux to accumulate, the drive can commutate at the appropriate time.

Since this is a motor constant, it is speed independent and it is applicable at all speeds at which the back-emf of the motor can be detected by the drive.

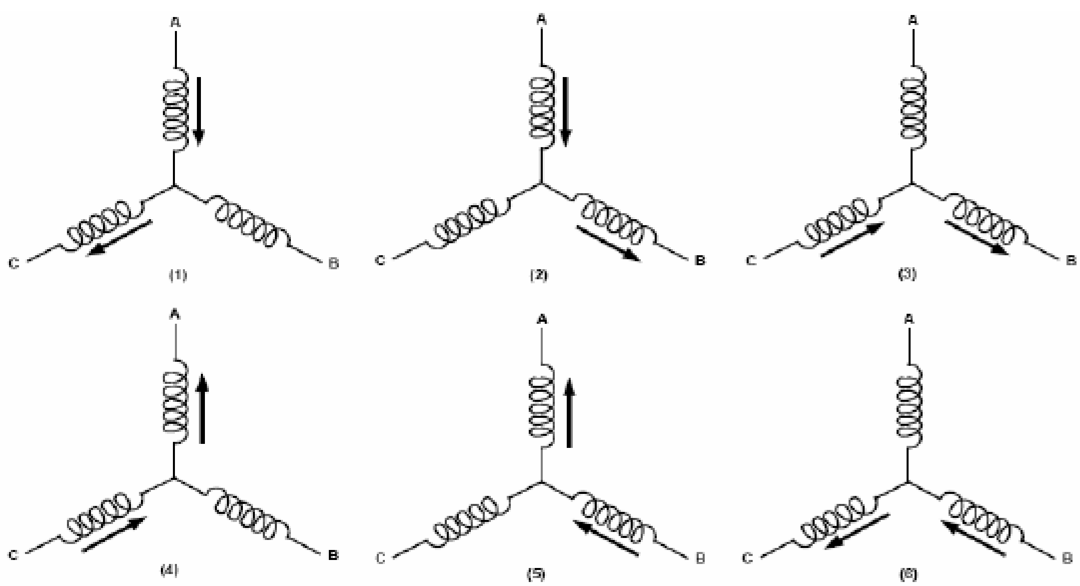


Figure 2: Six-Step Commutation Sequence

2.4 Special Considerations for Sensorless Commutation

During the process of commutation, current in one phase must drop to zero and be transferred to the phase that is just coming ON. Because of the fact that the coils are not mutually coupled 100% and that each coil has its own leakage reactance, there will be a portion of time, albeit brief, where all three coils have current in them. During this period of time, an accurate back- EMF or speed voltage cannot be obtained from the voltage sense circuit on the controller.

Immediately after commutation, the drive will shut OFF the phase voltage and wait until it determines that an accurate back EMF signal can be obtained from the analog input dedicated to BEMF sensing in the OFF phase.

It is only after this has been successfully detected that the drive will begin to use the measured speed voltage for commutation purposes. Since DPFlex itself monitors the speed voltage feedback and activates the back EMF sensing itself, there is no parameter associated with the coil-coil current transfer.

2.5 Sensorless Startup

As the back-EMF is proportional to speed a sensorless controller needs a means of finding the initial rotor position, in order to start the motor and accelerate it to sufficient speed to be able to detect the back-EMF voltage. Startup is undoubtedly the biggest hurdle any sensorless-control algorithm must overcome. Conventional methods drive a current through the motor windings, in order to force the motor rotor into a known position to ensure proper motor start. This can cause up to 180° of (2-pole) motor rotation opposite to the desired direction, adding to acceleration and startup time. The current required to orient the rotor depends on the inertial and frictional load of the motor. If the initial current to orient the motor is too high, there may be overshoot and ringing in the system. If the current is too low, the motor may not start at all. Such a system is not robust with respect to system load conditions.

More advanced methods determine motor rotor position based on the motor-phase saturation inductance change. The drive generates 6 short, opposing current pulses that drive the motor phases into saturation. The drive calculates the motor rotor position based on the saturation inductance change in each phase. We refer to this procedure as the *ping* method. The motor rotor remains stationary during the initial ping period, because the current pulses are short and in opposing sequence. In most cases, the motor reaches sufficient speed before the next commutation-sector change for the back-EMF commutation algorithm to take over. In a few cases, usually if the load on the motor is extremely heavy, the ping process repeats while the motor rotates at low speeds below the back-EMF commutation threshold. This is possible, because the ping period time is negligible with respect to the time between sector transitions at low motor speeds. The ping method guarantees unidirectional motor start, which is independent of motor loading conditions. The system is robust with respect to system load conditions.

3 DPFlex Specifications

3.1 DPFlex Specifications Generation 1

Specification	Value
DC Supply Voltage	15 V (min), 24 V (typ), 30 V(max)
	8 V (min), 12 V (typ), 16 V (max)
Acceptable Motor Type	Brushless AC/DC, WYE/DELTA connected
Output Phase Current	10 / 15 / 30 A peak
Motor phase-to-phase inductance	100 µH (min)
Motor time constant	150 µsec
Trip temperature[1]	90 °C
Digital Input[2]: motor direction, enable/disable	0 V (min), 30 V (max)
Digital output[3]	0 V (min), 30 V (max)
Analog input[4]	5 V, single-ended
Analog Input Sampling Frequency	100 Hz
Input Sampling Frequency	20 kHz
Commutation Type	Six-step back-emf
Commutation Period	250 µsec (min)
Diagnostics	400-point data logger
Protection	Over voltage, over current, over temperature
USB-UART communications	Digital TX, 115 kbps

(1) Refer to the power dissipation curve shown in Figure 13 to properly heat-sink the drive.

(2) Digital inputs require isolation if connected to active circuitry. Refer to schematic shown in Figure 3 and

Figure 4.

(3) Refer to schematic shown in Figure 5.

(4) Refer to schematic shown in Figure 6.

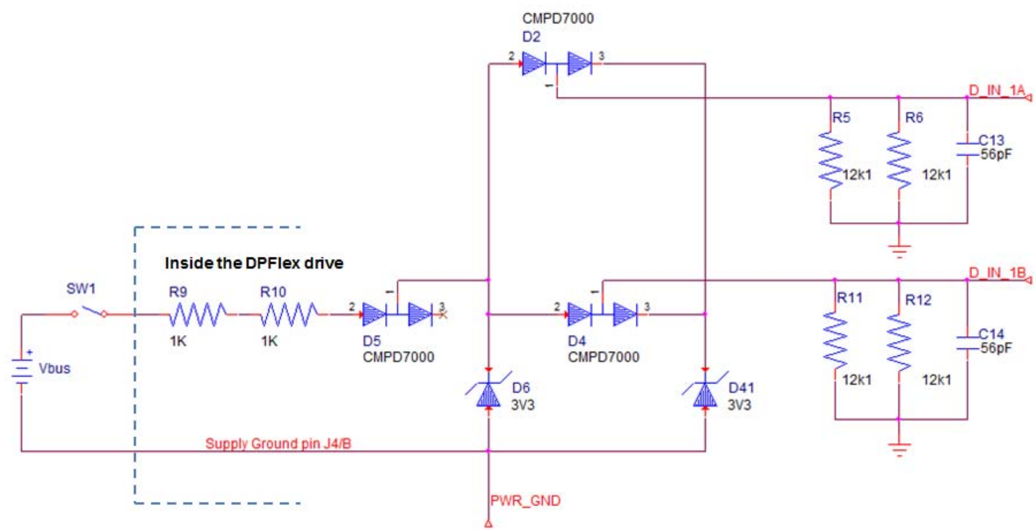


Figure 3: Digital input 1 (motor enable) circuitry (DI 1) generation 1

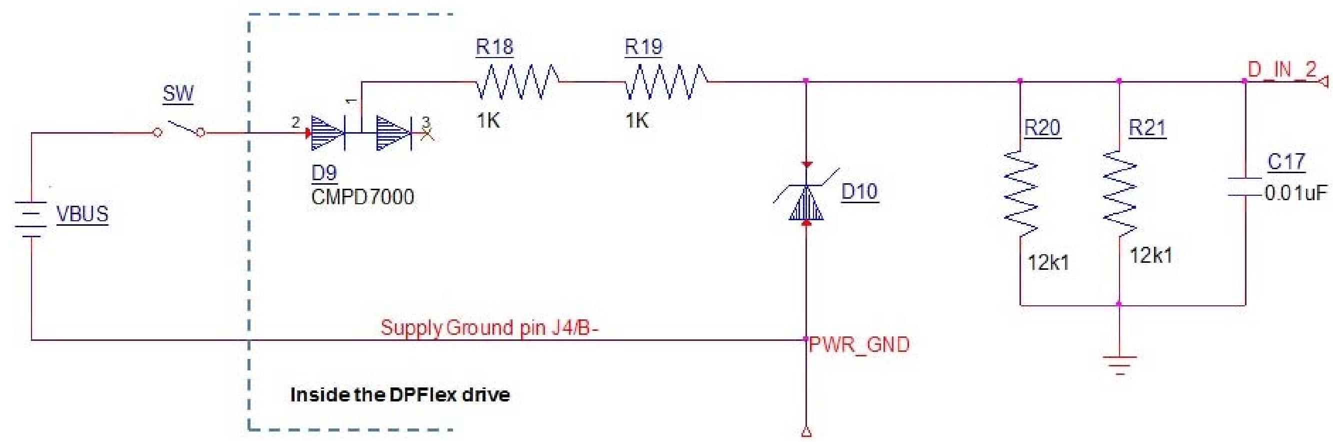


Figure 4: Digital input 2 (motor direction) circuitry (DI 2) generation 1

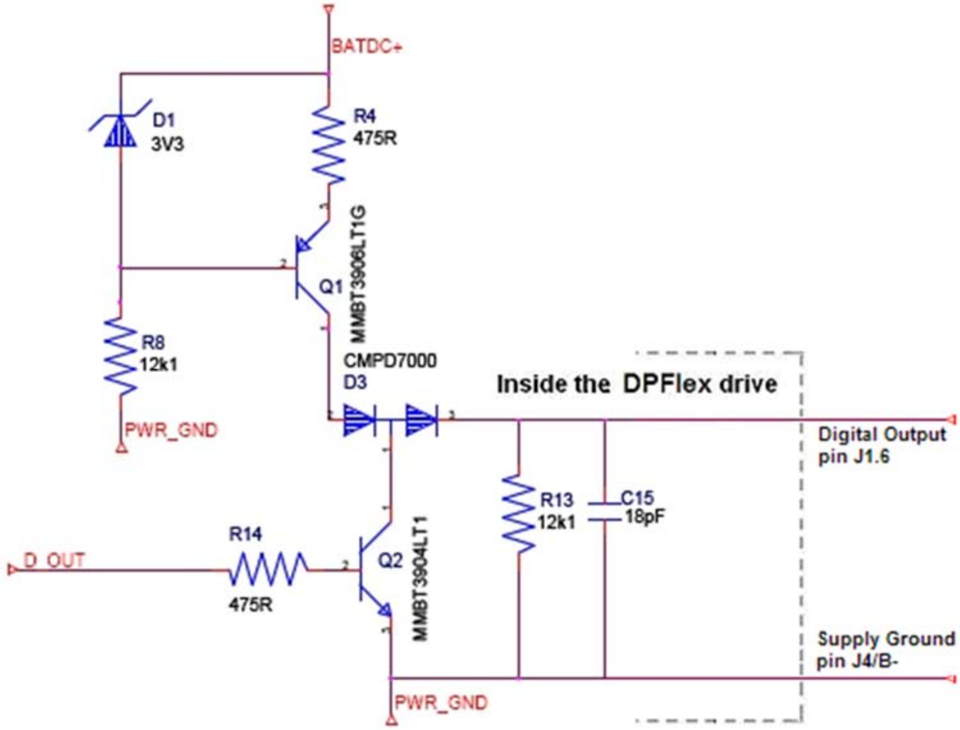


Figure 5: Digital output circuitry generation 1

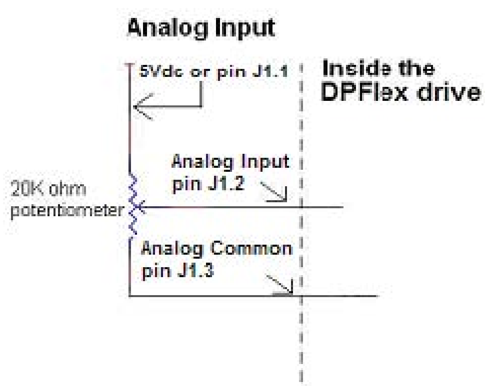


Figure 6: Example of connecting passive circuitry to DPFlex's analog input generation 1

3.2 DPFlex Specifications Generation 2

Specification	Value
DC Supply Voltage	36 V (min), 48 V (typ), 55 V(max)
	18 V (min), 24 V (typ), 34 V (max)
	9 V (min), 12 V (typ), 18 V (max)
Acceptable Motor Type	Brushless AC/DC, WYE/DELTA connected
Output Phase Current	5 / 15 / 30 A peak
Motor phase-to-phase inductance	10 µH (min)
Motor time constant	150 µsec
Trip temperature[1]	90 °C
Digital Input[2]: motor direction, enable/disable	Active High: 8 V (min), 60 V (max)
	Active Low :0.5V active low
Digital output[3]	0 V (min), 24 V (internally clamped)
Analog input[4]	5 V, single-ended
Analog Input Sampling Frequency	100 Hz
Input Sampling Frequency	20 kHz
Commutation Type	Six-step back-emf
Commutation Period	75 µsec (min)
Diagnostics	400-point data logger
Protection	Over/under voltage, over current, over temperature
USB-UART communications	Digital TX, 115 kbps

(1) Refer to the power dissipation curve shown in Figure 13 to properly heat-sink the drive.
(2) Digital inputs require isolation if connected to active circuitry. Refer to schematic shown in Figure 7 and Figure 8.
(3) Refer to schematic shown in Figure 9.
(4) Refer to schematic shown in Figure 10.

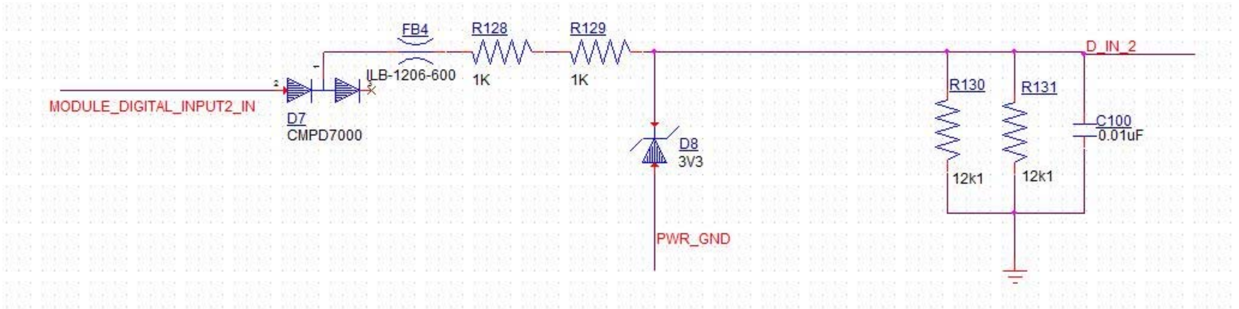


Figure 7: Digital input (active high) circuitry generation 2

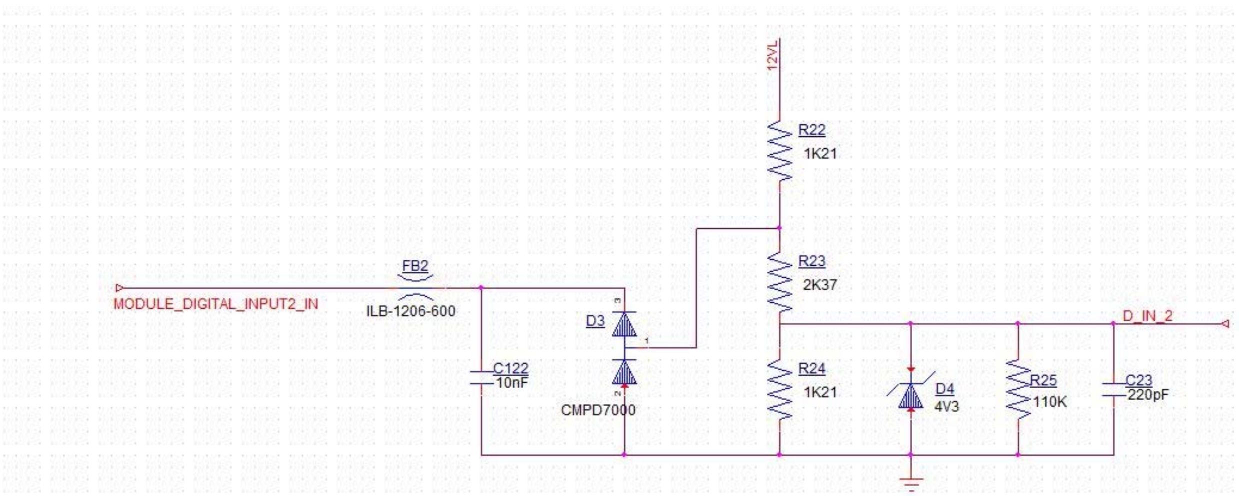


Figure 8: Digital input (active low) circuitry generation 2

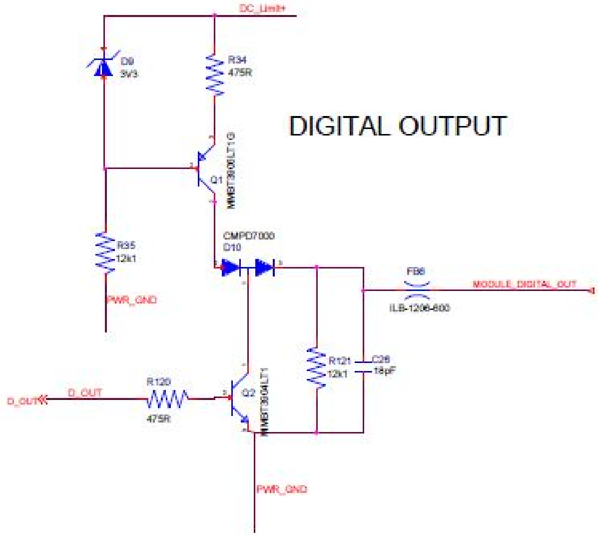


Figure 9: Digital output circuitry generation 1

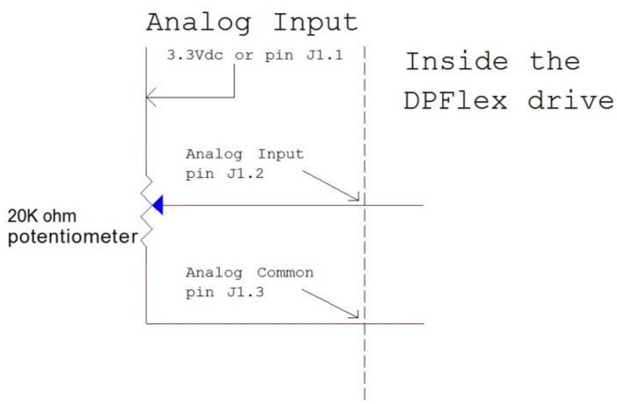


Figure 10: Example of connecting passive circuitry to DPFlex's analog input generation 2

3.3 DPFlex Connectors

Connector	Type	Pins
Power	Keystone Horizontal Quick-Fit Terminals (P/N #: 4907, Tab Size : 187" [4,75])	2
Motor	Keystone Horizontal Quick-Fit Terminals (P/N #: 4907, Tab Size : 187" [4,75])	3
Enable	Horizontal Quick-Fit Terminals (P/N #: 4907, Tab Size : 187" [4,75])	1
Analog & Digital I/O	JST (P/N #: SM06B-GHS-TB)	6
USB-UART Communication	JST (P/N #: SM04B-GHS-TB)	4

Table 5: DPFlex connectors

For connector pinouts for DPFlex, see Making Cables for DPFlex Drives.

3.4 DPFlex Dimensions

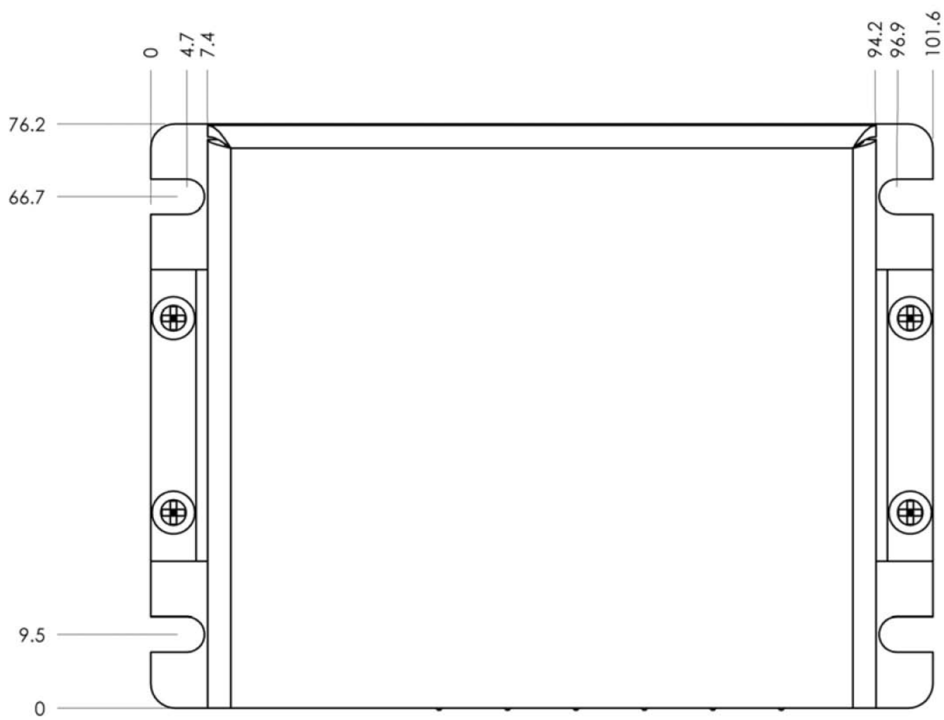


Figure 11: DPFlex dimensions (top view)

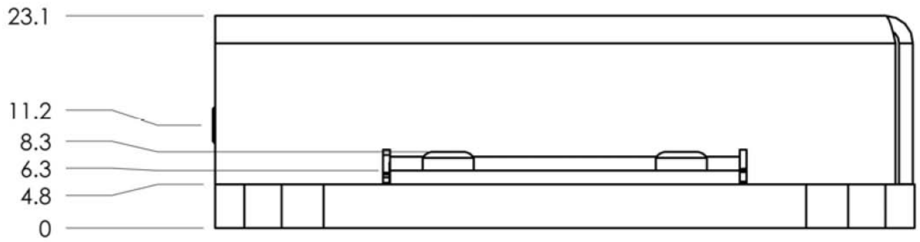


Figure 12: DPFlex dimensions (side view)

3.5 DPFlex Safety

To ensure safe operation of DPFlex, your application must meet the following requirements:

>  *CAUTION Failure to comply with the requirements listed below may create an electrical hazard in your application.*

- Use two AWG 16 twisted (with one twist per cm) cables 3 ft [1 m] long to connect the DC power supply to DPFlex.
- Use three AWG 16 twisted (with one twist per cm) cables 1 ft [.3 m] long to connect the motor to DPFlex.
- Connect a fuse between the positive voltage from the DC power supply and pin J3 (B+) on DPFlex's power terminal. Size the fuse to 150% of DPFlex's rated current.
- Spot ground the DPFlex drive itself.
- Use a USB cable to connect the PC to the USB-UART adapter.
- Heat sink the DPFlex drive, using the power dissipation curve shown in Figure 3-8 to guide the heat sink’s design.

3.6 DPFlex Power Dissipation

DPFlex generates heat as its consumption of power increases. Use the graphs in Figure 13 and Figure 14 below to determine safe operating conditions.

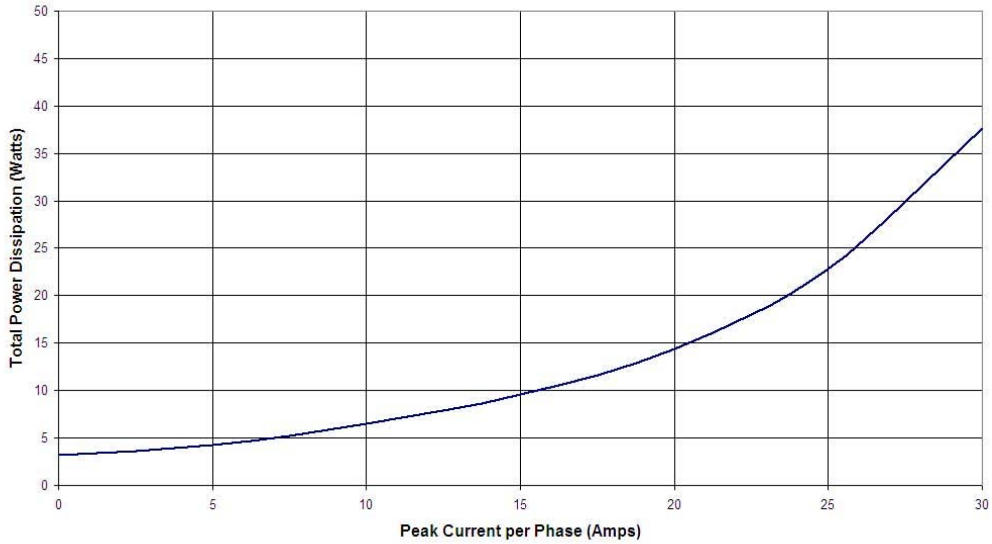


Figure 13: DPFlex power dissipation 30A variant

> ***Note:*** *The power dissipation curve was generated with balanced, 3-phase sinusoidal current at a 100 Hz fundamental and a 20 KHz switching frequency.*

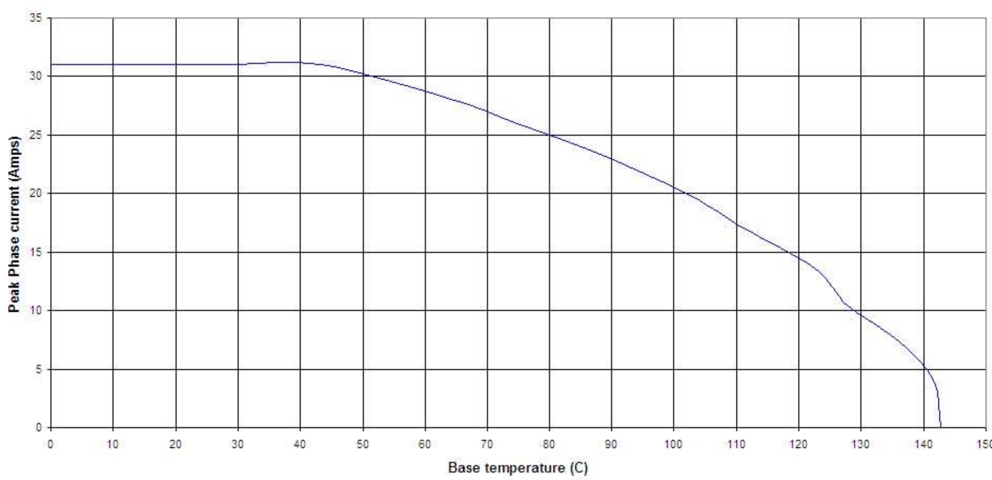


Figure 14: DPFlex safe operating area 30A variant

4 Setting Up DPFlex

This chapter describes how to set up DPFlex and configure it for a motor.

4.1 Installing the Software

The software provided with the DPFlex drive includes DP.D, an application for Microsoft Windows that enables you to configure and monitor the drive, and a USB-to-serial driver that enables a PC to communicate with the drive over a USB port.

For details about installing the DP.D software see the upcoming topics:

4.2 Installation Requirements

To install and run the DPFlex software, you need a personal computer that meets the following minimum requirements:

- Windows 2000 with SP4 or Windows XP with SP2
- A USB port or an RS-232 serial communication port capable of 115200 bps
- 133 MHz or higher Pentium-compatible microprocessor
- At least 64 megabytes (MB) RAM
- 50 MB available storage
- SVGA or higher resolution monitor.

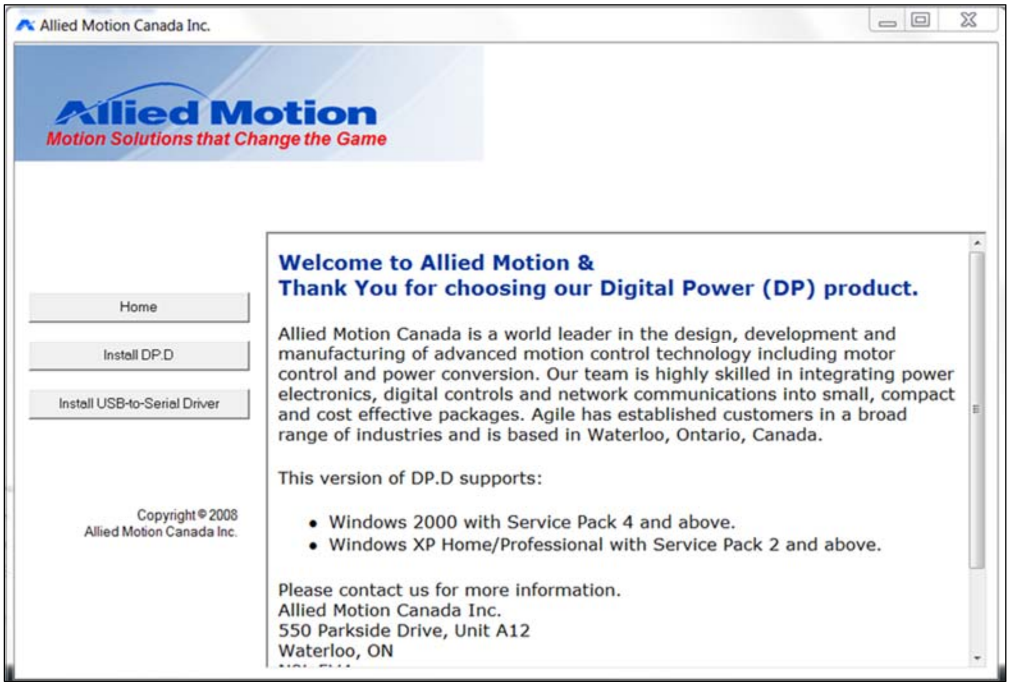
> ***Note:*** *A personal computer equipped with more RAM or a faster microprocessor will provide significantly better performance.*

4.3 Using the Installation CD

The DPFlex software is packaged on a CD-ROM (part number 35-0028) containing the DP.D software.

To run the installation utility:

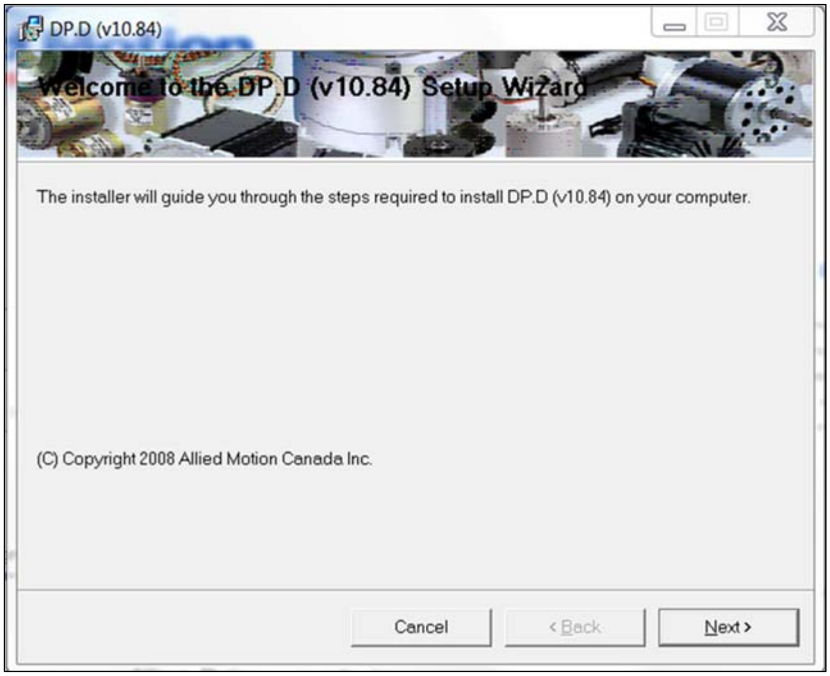
- Insert the CD in your CDROM drive.
- Wait for the Install Application to run.



If the installation utility does not automatically run, run the Setup.exe program found in the root of the CD.

<u>To install DP.D:</u>

- In the installation utility, choose Install DP.D. The installation utility launches the DP.D installation wizard:

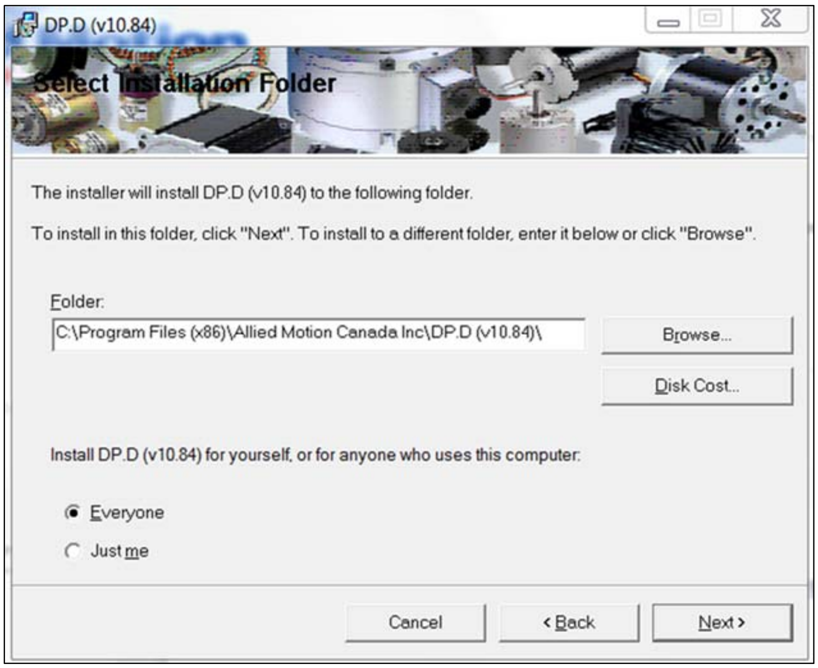


- Follow the instructions in the wizard to install DP.D.

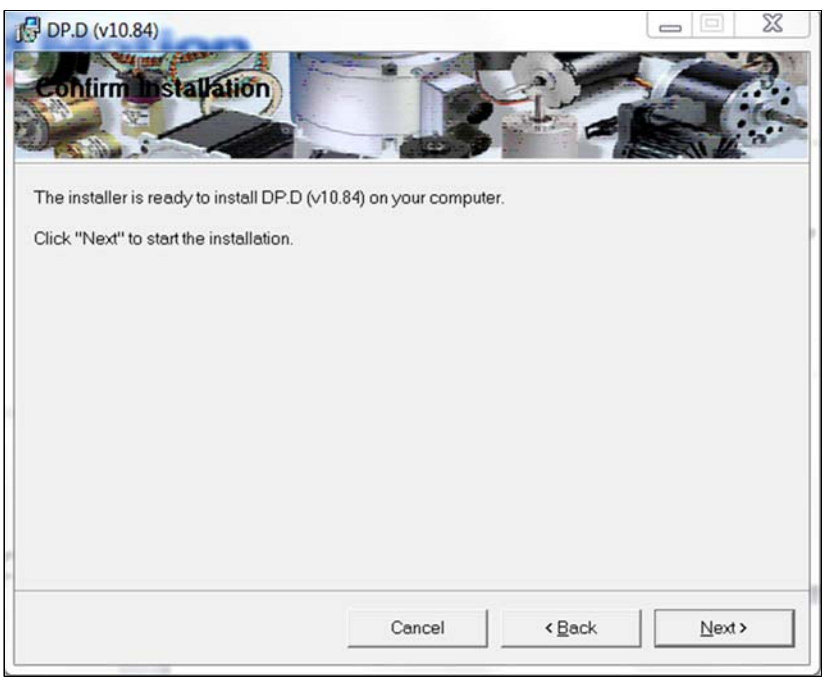
> ***Note:*** *DP.D requires an Open Database Connectivity driver to be installed on the PC. If you do not have one, you can install one by running the MDAC_TYP.EXE program in the MDAC2_8 directory found on the CD.*

To install the USB-to-serial driver:

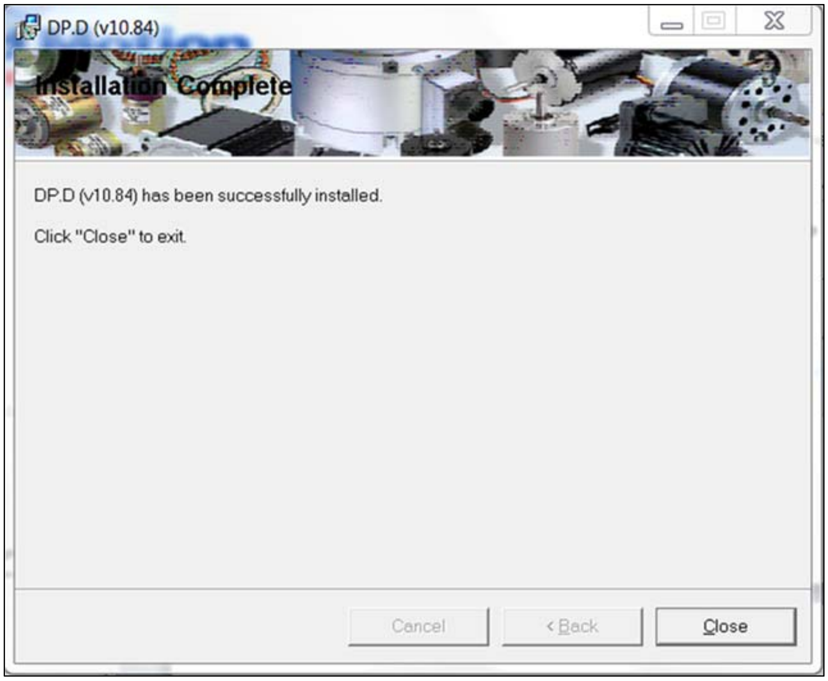
- In the installation utility, choose Install USB-to-serial Driver. The installation utility launches the driver installation wizard:



- If you want to change where the driver is installed, choose **Browse** to select another location.



- Choose **Next** to install the driver or **Cancel** to abort the operation.



4.4 Connecting the DPFlex Drive

To use the DPFlex drive in an application, you must connect it to power and to a motor. To configure DPFlex and to monitor its performance, you must also connect it to a PC.

4.4.1 DPFlex safety

To ensure safe operation of DPFlex, your application must meet the following requirements:


CAUTION Failure to comply with the requirements listed below may create an electrical hazard in your application.

- Use two AWG 16 twisted (with one twist per cm) cables 3 ft [1 m] long to connect the DC power supply to DPFlex.
- Use three AWG 16 twisted (with one twist per cm) cables 1 ft [.3 m] long to connect the motor to DPFlex.
- Connect a fuse between the positive voltage from the DC power supply and pin J3 (B+) on DPFlex's power terminal. Size the fuse to 150% of DPFlex's rated current.
- Spot ground the DPFlex drive itself.
- Use a USB cable to connect the PC to the USB-UART adapter.
- Heat sink the DPFlex drive, using the power dissipation curve shown in Figure 3-8 to guide the heat sink's design.

4.4.2 Connecting DPFlex with the Cable Kit

The easiest way to connect a DPFlex drive is to use cables offered by Allied Motion:

– The DPFlex Power Cable (part number 40-0105) connects the drive to power. One end (fitted with Amp 8-520182-1) of the red wire in the cable connects to J3/B+ (the positive pin). One end (also fitted with Amp 8-520182-1) of the white wire in the cable connects to J4/B- (the ground pin). The other ends connect to the power supply.

– The DPFlex Motor Cable (40-0106) connects the drive to a motor. One end (fitted with Amp 8-520182-1) of each of the red, white, and black wires in the cable connects to the motor pins (Motor Phase A: pin J5; Motor Phase B: pin J6; Motor Phase C: pin J7). The other ends connect to the corresponding motor phases.

– The DPFlex USB to UART Communication Cable Kit (part number 10-0099) connects the drive to a USB port on a PC. It includes the following cables:

  - A 6-foot USB A to B Cable (part number 40-0098)
  - A USB-UART adapter cable (part number 40-0094)

Note: You can make your own cables. For details, see Making Cables for DPFlex Drives.

4.4.3 Connecting DPFlex to a PC

1. Plug one end of the USB A to B cable into the USB port of the USB-UART adapter cable.
2. Plug the free end of the USB A to B cable into a USB port on the PC.

   Note: If you did not install the USB-to-serial driver when you installed DP.D, the PC will launch a device driver install wizard when it detects the adapter cable. Use the wizard to install the driver from the driver directory on the DP.D CD.
3. Plug the free end of the adapter cable into the serial communications connector on the DPFlex drive.

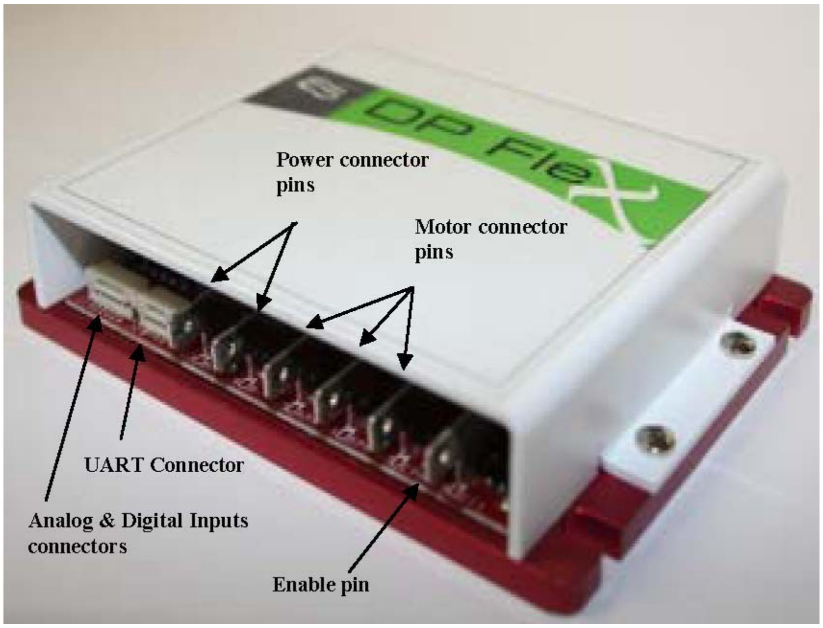


Figure 15: DPFlex connector locations

4.4.4 Connecting DPFlex to power

1. Plug the power cable into DPFlex's power connector.
2. Wire the other end of the power cable to your power supply, referring to their labels for pin number and signal name.

 ***CAUTION*** *Failure to connect a properly-rated fuse between DPFlex's high voltage input (pin J5 on the power connector) and the power supply may create an electrical hazard. Size the fuse to 150% of DPFlex's rated current.*

4.4.5 Connecting DPFlex to a motor

1. Plug the motor cable into DPFlex's motor connector.
2. Wire the other end of the motor cable to the motor.

4.5 Making Cables for DPFlex Drives

You can make your own cables for DPFlex as long as the following points are adhered to:

- The signal cables for J1 must be less than 1m in length.
- Drive dc power supply cables connected to J3/J4 should be made as short as possible and should be twisted together using 1 twist or more per cm.
- Motor cables connected to J5/J6/J7 should be as short as possible and should be twisted together using 1 twist or more per cm.

- An additional electrolytic capacitor placed as close as possible to the J3/J4 power connectors is recommended. Rule of thumb sizing for this capacitor is 30uF per amp. Cables running to and from the added capacitor should follow the above cabling practices.
- If extra capacitance is used, it is highly recommended that a pre-charge circuit be used to limit the inrush current required to charge this capacitance. The limiting resistor should then be shorted out using a relay or some other appropriate means.

The following tables list the pinouts and connector type for each connector on the drive. Figure 16 below shows how external devices are connected to DPFlex.

> ***Note:*** *The serial communications connector on the drive uses TTL signals. If you want to communicate with the drive from a device using standard RS-232 signals, you must provide a means to convert the signal levels between the two devices.*

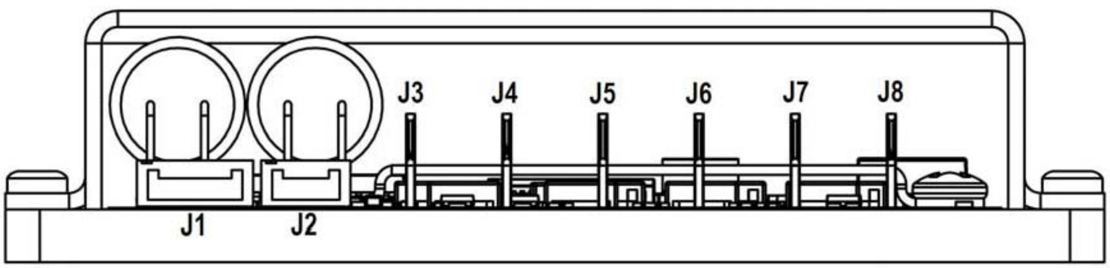


Figure 16: DPFlex connection points

Pin (Name)	Purpose
J1.1 (ASupply)	Analog Supply (5V Gen1) (3.3V Gen2)
J1.2 (AIN)	Analog Input (0-5V DC)
J1.3 (ACH)	Analog Common
J1.4 (DI1) or J8 (DI1)	Digital Input 1 [motor enable/disable] (Referenced to J4/B-)
J1.5 (DI2)	Digital Input 2 [motor direction] (Referenced to J4/B-)
J1.6 (D0)	Digital Output (Referenced to J4/B-)

Table 6: Analog & digital I/O connector pinout [J1]

Pin (Pin Name)	Purpose
J2.1 (GND)	Communication Ground
J2.2 (TX)	Host Transmit
J2.3 (LogicV)	Communication Logic supply (5V Gen1) (3.3V Gen2)
J2.4 (RX)	Host Receive

Table 7: Serial communication connector pinout [J2]

Pin (Pin Name)	Purpose
J3 (B+)	(+) DC Voltage
J4 (B-)	(-) DC Voltage

Table 8: Power connector pins (Keystone Terminals P/N #: 4907)

Pin (Pin Name)	Purpose
J5 (APH)	A Motor Phase
J6 (BPH)	B Motor Phase
J7 (CPH)	C Motor Phase

Table 9: Motor connector pins (Keystone Terminals P/N #: 4907)

5 Creating DPFlex Applications

This chapter describes how to develop and deploy the DPFlex in your application: How to configure it for a motor; how to check the analog and digital inputs; how to set motor performance parameters; and how to check application performance.

5.1 Developing DPFlex Applications

Once you have installed the DP.D software and connected a motor and power to DPFlex, you can start developing your application.

5.1.1 Steps To Develop a DPFlex Application

1. Create a configuration. A configuration stores controller and motor settings, and other application parameters. DP.D enables you to create and store multiple configurations. For details, see Creating and Managing Configurations.
2. Configure DPFlex for the motor you want to use in the application. For details, see Configuring DPFlex.
3. Tune the current loop for the application. For details, see Tuning the Current Loop.
4. Tune the velocity loop for the application. For details, see Tuning the Velocity Loop.
5. Check DPFlex's inputs. For details, see Viewing DPFlex Inputs.
6. Configure thresholds and check for faults. For details, see Viewing and Configuring Faults.
7. Save the application parameters and deploy them to other DPFlex controllers. For details, see Deploying DPFlex Applications.

5.2 Using DP.D

You use the DP.D application software for Microsoft Windows 2000/XP/Vista/7 to develop and deploy DPFlex applications.

For details about installing DP.D, see Installing the Software.

- To start DP.D: On your Windows Desktop, choose Start > Programs > Allied Motion > DP.D.
- To exit DP.D: In DP.D, choose File > Exit.

5.3 About DP.D

DP.D enables you to perform the following tasks:

- Configure DPFlex for a motor.
- Tune the current and velocity loops for your application.
- Configure thresholds and view faults: over temperature, over current, and over voltage.
- Monitor DPFlex inputs.
- Save configuration parameters to a file on the PC and to DPFlex's non-volatile memory.
- Create, save, and open sets of DPFlex configurations.

5.4 Using the DP.D Navigation Tree

When you start DP.D, it opens a navigation tree that you use to create and manage multiple DPFlex configurations.

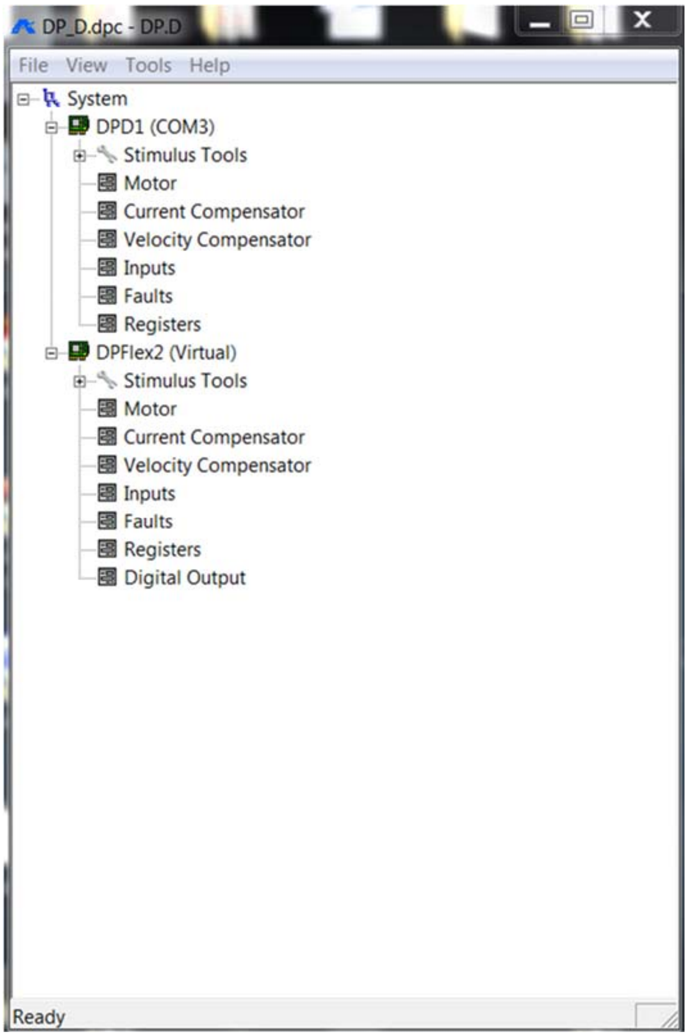


Figure 17: DP.D navigation tree with two configurations

DP.D displays each DPFlex configuration as a branch in the navigation tree. It displays the parameters for each configuration as leaves on the branch.

Each DPFlex configuration shows which port the controller is connected to, and provides access to the following configuration parameters:

- The **Stimulus Tools** forms enable you to vary motor current or velocity.
- The **Motor Parameters** form enables you to set motor ratings and command DPFlex to configure itself for that motor.
- The **Current Compensator** form enables you to define the gains for the application's current loop, and provides access to DPFlex current loop tuning tools.

- The **Velocity Compensator** form enables you to define the gains for the application's velocity loop, and provides access to DPFlex velocity loop tuning tools.
- The **Inputs** form enables you to view the current values of DPFlex digital and analog inputs.
- The **Faults** form enables you to configure and view fault settings, states, warnings, and error messages.
- The **Registers** form enables you to store and retrieve DPFlex settings in files, and to save those settings to DPFlex's non-volatile memory. It also enables you to configure the drive autostart mode.

<u>To open a parameters form, take one of the following steps:</u>

- Right-click the desired parameters leaf in the navigation tree and choose Interact, or
- Double-click the leaf. DP.D displays the form.

<u>To view system configuration properties, take one of the following steps:</u>

- Right-click the DPFlex (*Port*) leaf in the navigation tree and choose Interact.
- Double-click the leaf. DP.D displays the system properties form.

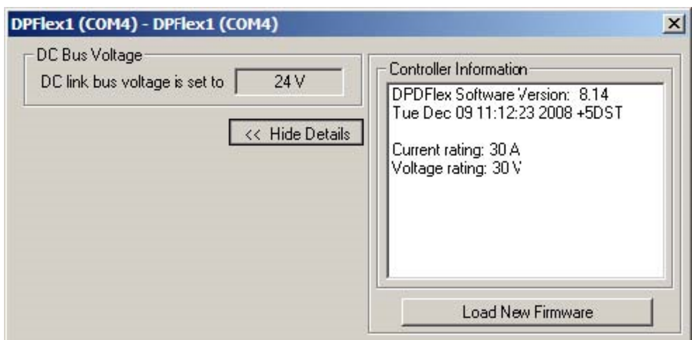


Figure 18: System properties form

The system properties form displays the following controller information:

- The current supply voltage
- The firmware version, and its date and time of compilation
- The drive's current and voltage ratings

<u>To display or hide a configuration's system properties:</u>

- Click Show Details or Hide Details.

<u>To rename a configuration:</u>

- Right-click the DPFlex (*Port*) branch in the navigation tree and choose Rename.

To add, delete, or change the properties of configurations, take one of the following steps:

- Right-click the System branch in the navigation tree and choose Connection.
- Double-click the System branch. DP.D displays the Interact form, which lists defined connections.

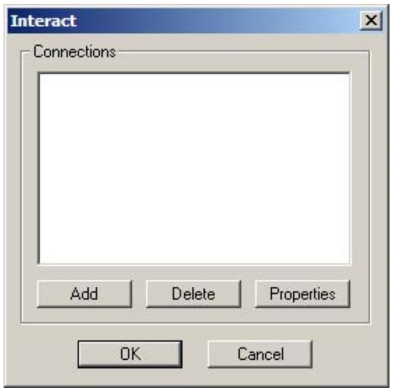


Figure 19: DP.D Interact form

For details about using the Interact form, see "Creating and Managing Configurations"

5.5 Using DPFlex's Digital Oscilloscope

DPFlex features a four-channel digital oscilloscope that enables you to view your application's set points and the motor's actual performance.

To display the digital oscilloscope, take one of the following actions:

- In the Tools menu, choose Oscilloscope.
- In the Current Compensator form or Velocity Compensator form, choose Tuning Tools.

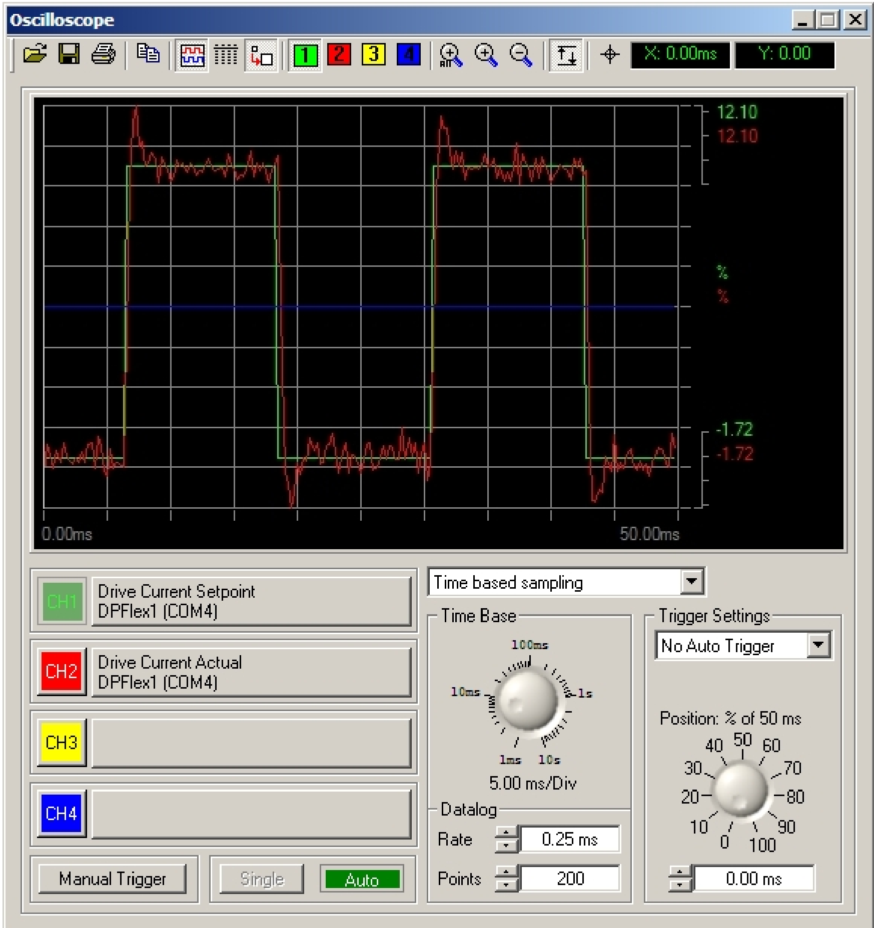


Figure 20: DP.D digital oscilloscope

The digital oscilloscope features the following controls:

- The tool bar enables you to manage oscilloscope settings, examine captured signals, and control the display
- The signal display traces the signal on each channel after the trigger occurs and for the selected time base.
- The channel controls enable you to assign a signal to a channel.
- The trigger type controls enable you to select the type of triggering to use.
- The time base control enable you to specify the time base used in the display
- The datalog controls enable you to specify the rate at which inputs are logged and the number of data points to plot.
- The trigger settings enable you to specify the timing and type of trigger.
- The cursor position indicators show the coordinates of the current cursor position.

To use the tool bar:

- Clicking on buttons in the tool bar performs the actions listed in the table below.

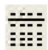
Choose button...	...to perform this action
	Zoom in on the selected segment of the graph.
	Zoom out of the selected segment of the graph.
	Rescale the display to the input signals' range.
	Show or hide the cursor.
	Open an oscilloscope configuration.
	Save the current oscilloscope configuration.
	Print the captured data points.
	Copy all captured data points to the clipboard.
	Display inputs as graphs.
	Display inputs in a table.
	Display scaled data.
	Position the cursor on the selected input.
	Zoom out on the graph to show all captured data points.

Table 10: DP.D oscilloscope tool bar buttons

To view or change a channel's settings:

- Click the channel's settings button:

- DP.D displays the channel settings form:

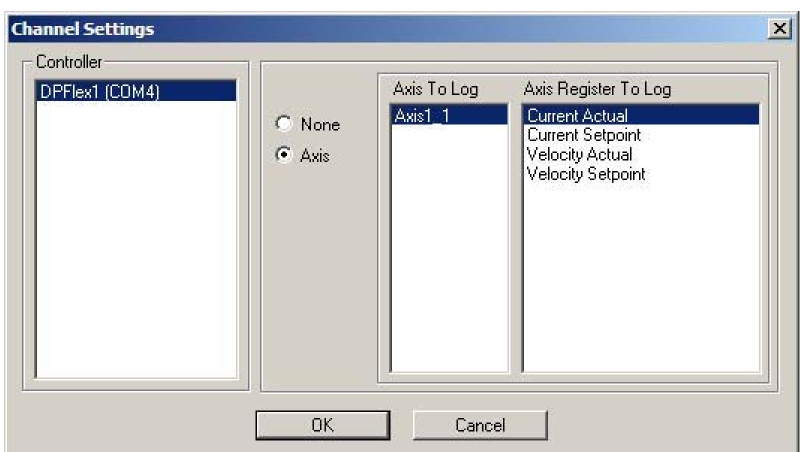


Figure 21: Channel settings form

- Choose Axis to log data or None to disable logging.

- Choose the data to log from the list in the Axis Register To Log panel.
- Choose OK to save the settings or Cancel to abort the operation.

To change the oscilloscope display, take the following actions:

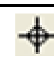
To take this action...	...choose this button
Display inputs as graphs.	
Display inputs in a table.	
Display scaled data.	
Position the cursor on the select the input channel.	
Zoom out to show all captured data points.	
Zoom in on the selected segment of the graph.	
Zoom out of the selected segment of the graph.	
Rescale the display to the input signals' range.	
Show or hide the cursor.	

Table 11: Change oscilloscope display

To manage captured data, take the following actions:

To take this action...	...choose this button
Open an oscilloscope configuration.	
Save the current oscilloscope configuration.	
Print the captured data points.	
Copy all captured data points to the clipboard.	

Table 12: Manager captured data

To select the trigger type, choose one of the following commands:

- Choose Manual to trigger input logging once immediately.
- Choose Single to trigger input logging once at the point set with the trigger settings controls.
- Choose Auto to enable the oscilloscope to trigger continuously and display captured data.

To set the time base:

- Using the mouse, rotate the time base control to the desired period.

To set the data logging frequency:

- In the Datalog Rate field, enter the sampling period in seconds.
- In the Datalog Points field, enter the number of points to log during the time base period.

To change the trigger settings:

- In the Trigger Settings area, choose one of the following triggers from the drop-down list:

Choose this setting...	...to set this trigger
No Auto Trigger...	None.
On Stimulus Edge...	On the edge of the current or velocity stimulus
On +ve Stimulus Edge...	On the positive edge of the current or velocity stimulus
On -ve Stimulus Edge...	On the negative edge of the current or velocity stimulus
On Enable...	When the motor is enabled

Figure 22: Setting the trigger type

- In the Trigger Settings area, set the point in time to trigger by rotating the Position at % of 50 ms control or entering a value in milliseconds in the field below.

5.6 Managing Views

DP.D provides several options for managing its display:

- You can set DP.D to always display DP.D forms on top of other application windows and forms.
- If you have multiple parameter forms open, you can save their current display positions and restore them to those positions after closing the forms or re-starting DP.D.
- You can set whether DP.D displays a status bar.

<u>To toggle displaying DP.D forms on top:</u>

- Choose View > Always on Top.

<u>To save the currently displayed forms' positions:</u>

- Choose View > Save Windows.

<u>To restore forms to their displayed positions:</u>

- Choose View > Restore Windows.

<u>To toggle display of the status bar</u>

- Choose View > Status Bar.

5.7 Getting Help

DP.D provides online help for all procedures and forms.

<u>To display online help, take one of the following actions:</u>

- Right-click a node in the navigation tree and choose Help.
- Choose Help > DP.D Help Topics.
- Press the F1 key.

<u>To view information about DP.D:</u>

- Choose Help > About DP.D. DP.D displays the About DP.D form:

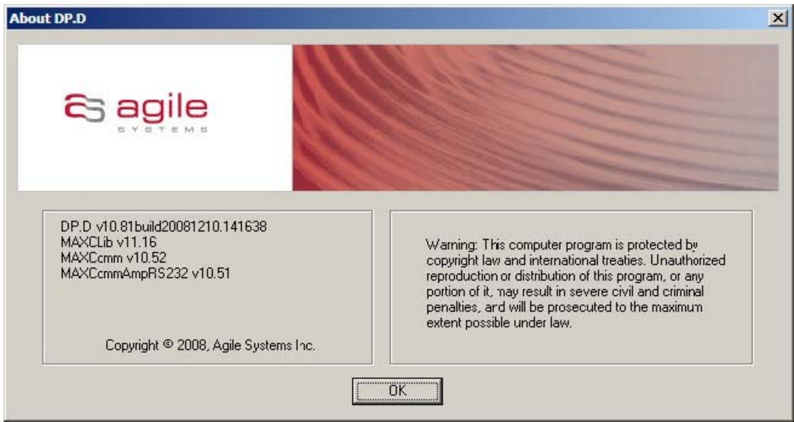
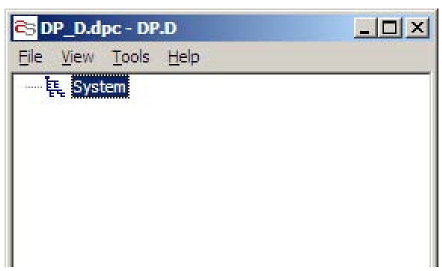


Figure 23: DP.D About screen

5.8 Creating and Managing Configurations

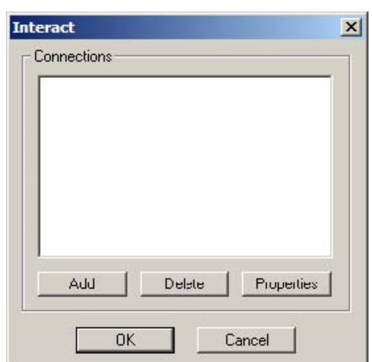
A configuration stores controller and motor settings, and other application parameters. DP.D enables you to create and store multiple configurations.

<u>To create a configuration: Click Start > Programs > Allied Motion > DP.D DP.D opens the navigation tree:</u>



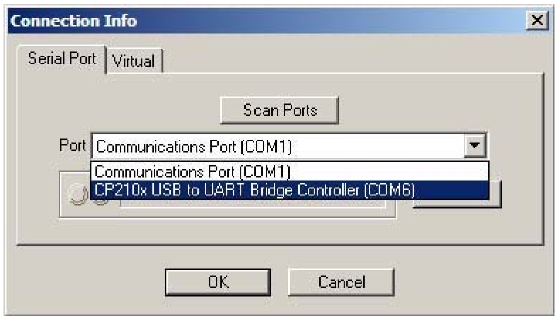
<u>To create a new configuration:</u>

- In the navigation tree, double-click System. DP.D displays the Interact form, which lists defined connections:

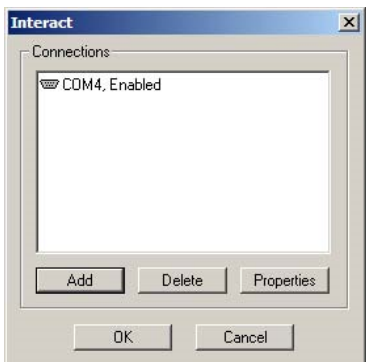


- Choose Add. DP.D displays the Connection Info form.
- If the port to which the DPFlex controller is connected is not displayed in the Port drop-down list, choose Scan Ports. DP.D scans the PC for serial ports or the USB-to-serial adapter.
- If the USB port does not appear in the list, check the following items and re-scan:

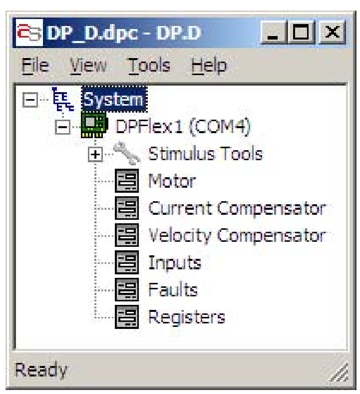
  - That the USB-to-serial driver is installed
  - That the USB-to-serial cables are properly connected
- In the Port drop-down list, choose the port to which the DPFlex controller is connected.



- Choose Test to confirm the connection to the controller is working.
- If the test fails, check the following items and re-test:
  - That the communication cables are properly connected
  - That the DPFlex controller is powered
- Choose OK to accept the connection or Cancel to abort the operation. The Interact form now lists the connection to the controller:



- Choose OK to accept the controller connection configuration or Cancel to abort the operation. DP.D updates the navigation tree for the new configuration:



To save the current configurations:

- Choose File > Save. If you have not previously saved the configurations, DP.D displays a browser.
- Select a path and file name for the configurations and choose Save.

To save the current configurations to a different file:

- Choose File > Save As. DP.D displays a browser.
- Select a path and file name for the configurations and choose Save.

To create a new set of configurations:

- Choose File > New. If you have not previously saved the current configurations, DP.D prompts you to save or discard them.
- If you want to save the current configurations:
  - Choose Yes. DP.D displays a browser.
  - Select a path and file name for the configurations and choose Save.
- If you want to discard the current configurations, choose No.
- If you want to cancel the creation of the new configurations, choose Cancel.

To open a set of configurations:

- Choose File > Open. DP.D displays a browser.
- Select a path and file name for the configurations and choose Open.

5.9 Configuring DPFlex

You configure DPFlex by setting motor parameters and running the configuration tool. After the tool has finished, you can save the configuration parameters to the controller's non-volatile memory so that they are not lost if the controller loses power.

To set motor parameters:

- In the DP.D navigation tree, double-click System > DPFlex (*Port*) > Motor . DP.D displays the Motor parameters form:

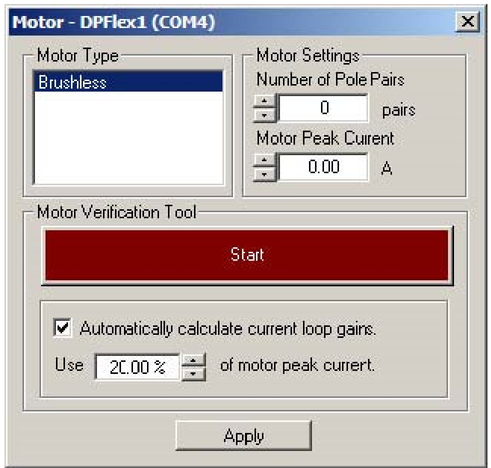


Figure 24: Motor parameters form

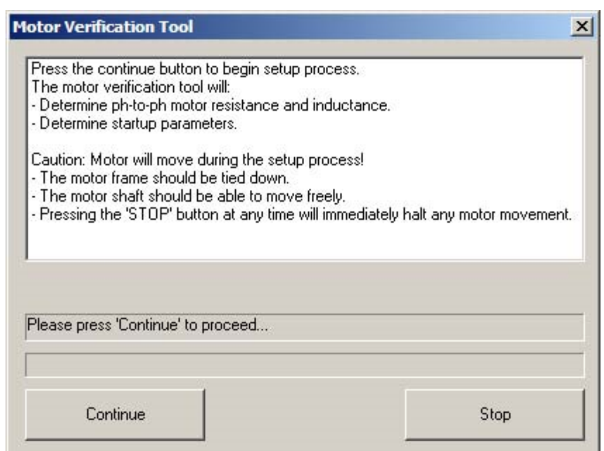
- From the motor's data sheet, set the following parameters:

To set this parameter...	...take this action
Number of Pole Pairs	Enter the number of pairs.
Motor Peak Current	Enter the number of Amperes.

- Choose Apply to update the motor parameters.

To run the configuration tool:

- In the Motor parameters form, choose Start. The DP.D configuration tool displays the configuration instructions:



***CAUTION** Failure to ensure that the motor is fixed in place, not connected to a load, and that the shaft can turn freely may result in improper configuration and damage to equipment or personnel.*

- Choose Continue to start the configuration operation. Choose Stop at any time to immediately halt the configuration operation.
- Follow the instructions in the configuration tool to complete the configuration. Note that the configuration operation can take several minutes to complete.
- Click to close the configuration tool.

To save configuration parameters to DPFlex's non-volatile memory:

- In the DP.D navigation tree, double-click System > DPFlex (*Port*) > Registers. DP.D displays the Registers form:

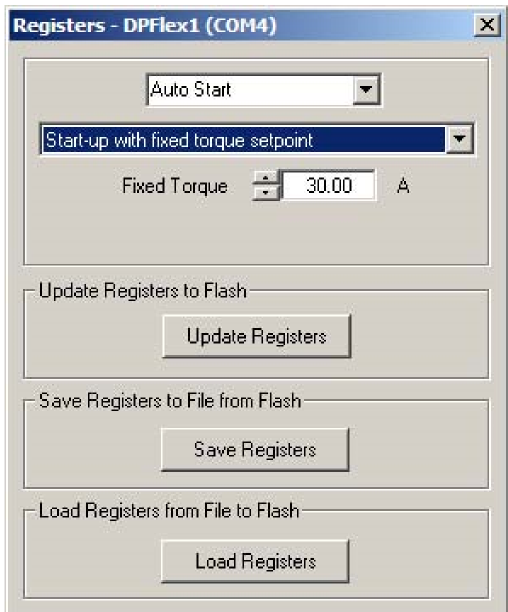


Figure 25: DP.D Registers form

- Choose Update Registers. DP.D saves the current configuration parameters into the drive's non-volatile memory.
- Click to close the Registers form.

5.10 Tuning the Current Loop

Once you have configured DPFlex for the target motor, you can tune the current loop for the application.

A well-tuned current loop is the first step to acceptable velocity and torque control. Without proper current tuning, satisfactory velocity and torque control cannot be achieved.

5.10.1 Current Compensator Loop

The current loop is a control loop inside the velocity loop, which ensures the desired current setpoint is achieved and maintained. Refer to the block diagram shown in Figure 26 below. Except for the plant (the motor and its load), all of the blocks are parts of the drive. For the sake of simplicity, the plant is just an R-L transfer function of a BLDC motor.

In the control loops, two main tasks must be achieved:

- Keeping the output (in this case, current in the motor coil) as close as possible to the input (in this case, a current setpoint). This is called *steady state response* .
- Proper response to the change in the setpoint. This is called *dynamic response* .

To achieve these two goals, a second order infinite impulse response filter (biquad compensator) is used to approximate a classic PID control loop.

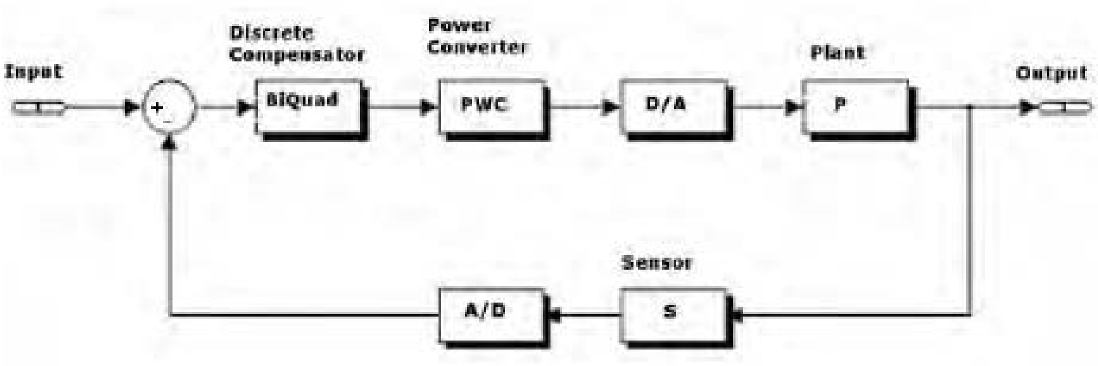


Figure 26: Current loop block diagram

5.10.2 Biquad Compensator

A classic PID control loop can be approximated in the discrete time domain by a 2nd order IIR filter with the following (z) domain transfer function.

$$D(z) = \frac{Y(z)}{X(z)} = \frac{B_0 + B_1 Z^{-1} + B_2 z^{-2}}{1 + A_1 z^{-1} + A_2 Z^{-2}} \quad (1)$$

Which has the following block diagram:

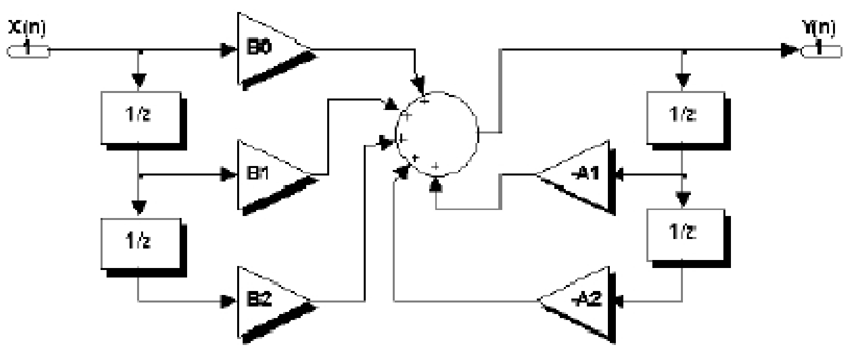


Figure 27: Biquad filter structure

5.10.3 Calculating Filter Coefficients

DP.D automatically calculates the biquad filter coefficients (B*n* and A*n*) from the on screen representation (gains Kp, Ki, and Kd). Biquad coefficients are values described in Q1.15 format with exponent value. (Most good digital signal-processing texts contain a description of the Q1.15 numerical format.)

The transfer function of the PID compensator in the (s) domain is:

$$PID(s) = \frac{Y(s)}{X(s)} = k_p + \frac{k_i}{s} + k_d s \qquad (2)$$

To find out how PID gains are related to Biquad gains, let's assume that $s = \frac{z}{z-1}$, which is an approximation of the bilinear transformation. Then, by substituting (z) in (2):

$$PID(z) = \frac{Y(z)}{X(z)} = \frac{(k_p + k_i + k_d) + (-k_p - 2k_d)z^{-1} + (k_d)z^{-2}}{1 - z^{-1}} \qquad (3)$$

and by comparing (1) and (3):

$$A_1 = 1 \qquad (4)$$

$$A_2 = 0 \qquad (5)$$

$$B_0 = (k_p + k_i + k_d) \qquad (6)$$

$$B_1 = -(k_p + 2k_d) \qquad (7)$$

$$B_2 = k_d \qquad (8)$$

Equations 4 through 8 show how each of the 5-biquad filter coefficients are calculated from the screen PID representation in DP.D.

To tune the current loop:

- Make sure the motor shaft is connected to the required load, that the load is free to move and can move safely, and that the motor itself will not move when turning.

> *CAUTION You risk damaging equipment or personnel during tuning if you do not ensure that the load can move safely and that the motor will not move when rotating!*

- In DP.D's navigation tree, double-click System > DPFlex (*Port*) > Current Compensator. DP.D displays the Current Compensator form:

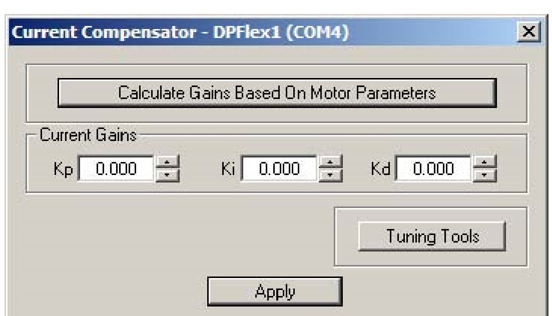


Figure 28: Current Compensator form

The Current Compensator form displays the current gains set for the target motor. It also enables you to re-calculate the gains based on the motor parameters and to open DP.D's tuning tools.

- Choose Tuning Tools. DP.D displays the Oscilloscope and the Current stimulus forms:

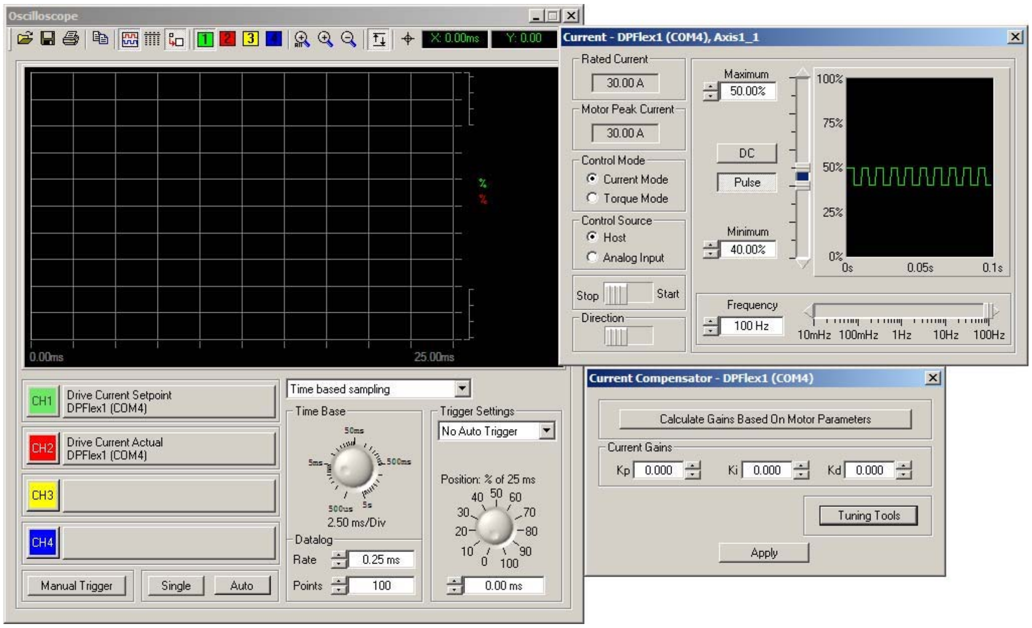


Figure 29: DP.D Oscilloscope and Current stimulus forms

> *Tip You can arrange the forms as you like and save their positions using the View > Save Windows command. You can restore the forms to their saved positions at any time (including the next time you run DP.D) with the View > Restore Windows command.*

DP.D automatically sets the controls and fields in the Oscilloscope and Current stimulus forms to default values appropriate for tuning the current loop, based on the values you set in the Motor parameters form.

The Current stimulus form enables you to vary the current available to the motor:

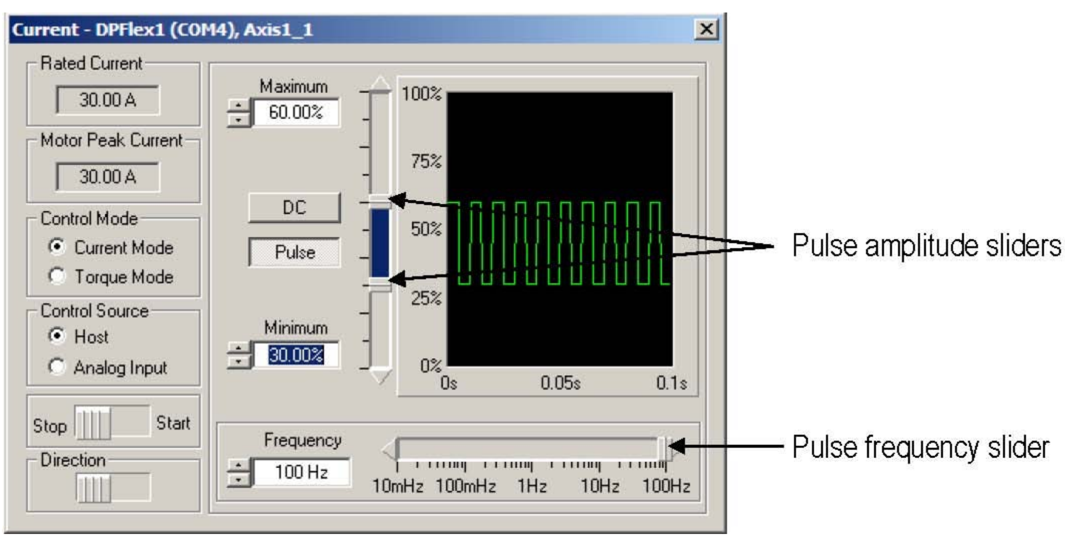
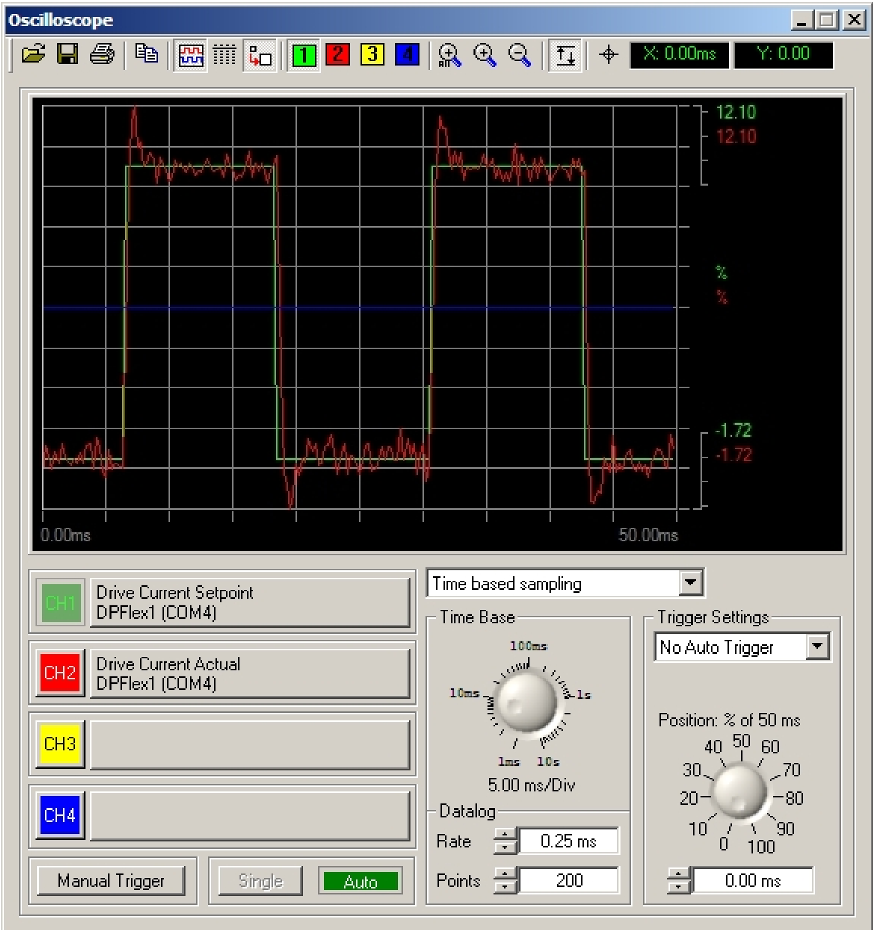


Figure 30 Current stimulus form

- The Rated Current field shows the maximum current available from the DPFlex drive.
- The Motor Peak Current field shows the value previously set for the motor's peak current rating. (To change this value, see "To set motor parameters.")
- The Control Mode section enables you to set Current or Torque as the control mode.
- The Stop/Start control enables you to turn the current to the motor on or off.
- The current controls enable you to set the following characteristics:
  - The DC command sets the current to direct.
  - The Pulse command sets the current to a square wave.
  - The Frequency field and slider sets the frequency of the square wave.
  - The Maximum and Minimum fields and sliders set the maximum and minimum values of the current pulse as percentages of the motor peak current. These values can be negative, zero, or positive.
- In the Current stimulus form:
  - Choose Current Mode.
  - Choose Pulse.
  - Set the desired values for current pulse frequency and amplitude.
- In the Current stimulus form, choose Start to apply current to the motor.
- In the Oscilloscope form, choose Auto to start triggering.

After a few seconds, the Oscilloscope form will display the current stimulus in green and the actual current drawn by the motor in red:



You can vary the settings in the Current stimulus form, including the slider controls for the frequency and amplitude of the current stimulus, to see how it affects the current the motor draws.

- In the Oscilloscope form, choose Auto to stop triggering.
- In the Current stimulus form, choose Stop to cut current to the motor.

5.11 Tuning the Velocity Loop

Once you have configured DPFlex for the target motor, you can tune the velocity loop for the application.

5.11.1 Velocity Compensator Loop

The velocity loop ensures the desired velocity setpoint is achieved and maintained. Refer to the block diagram in Figure 31 below. Except for the plant (a motor and its load), all of the blocks are parts of the drive. For the sake of simplicity, the plant is just an R-L transfer function of a DC motor. In the control loops, two main tasks must be achieved:

- Keeping the output (in this case, velocity of the motor) as close as possible to the input (in this case, a velocity setpoint). This is called *steady state response*.

– Proper response to the change in the setpoint. This is called *dynamic response*.

To achieve these two goals, a second order infinite impulse response filter (biquad compensator) is used to approximate a classic PID control loop.

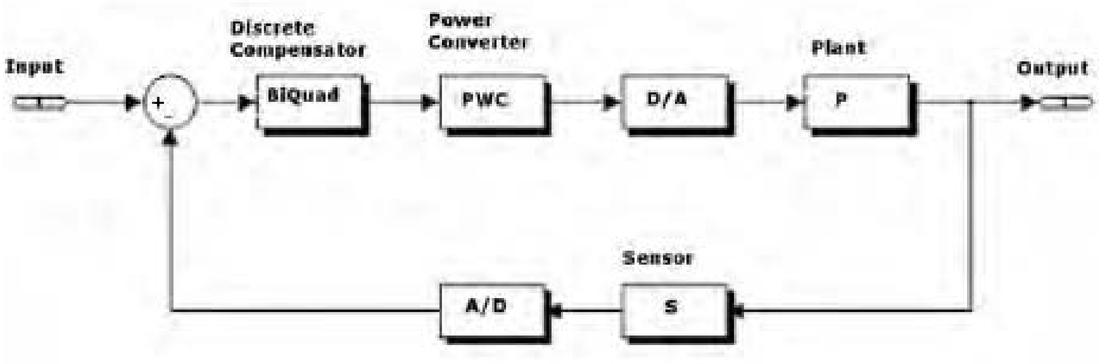


Figure 31: Velocity loop block diagram

5.11.2 Biquad Compensator

A classic PID control loop can be approximated in the discrete time domain by a 2nd order IIR filter with the following (z) domain transfer function.

$$D(z) = \frac{Y(z)}{X(z)} = \frac{B_0 + B_1 Z^{-1} + B_2 z^{-2}}{1 + A_1 z^{-1} + A_2 Z^{-2}} \quad (1)$$

Which has the block diagram:

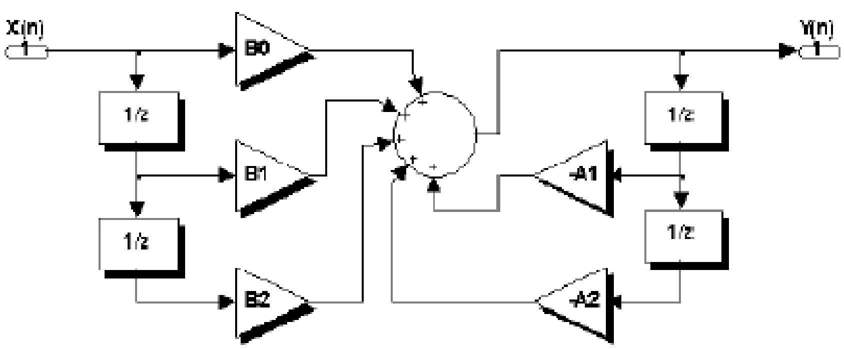


Figure 32: Biquad filter structure

5.11.3 Calculating Filter Coefficients

DP.D automatically calculates the biquad filter coefficients (B*n* and A*n*) from the on screen representation (gains Kp, Ki, and Kd). Biquad coefficients are values described in Q1.15 format with exponent value. (Most good digital signal-processing texts contain a description of the Q1.15 numerical format.)

The transfer function of the PID compensator in the (s) domain is:

$$PID(s) = \frac{Y(s)}{X(s)} = k_p + \frac{k_i}{s} + k_d s \quad (2)$$

To find out how PID gains are related to Biquad gains, let's assume that $s = \frac{z}{z-1}$, which is an approximation of the bilinear transformation. Then, by substituting (z) in (2):

$$PID(z) = \frac{Y(z)}{X(z)} = \frac{(k_p + k_i + k_d) + (-k_p - 2k_d)z^{-1} + (k_d)z^{-2}}{1 - z^{-1}} \quad (3)$$

and by comparing (1) and (3):

$$A_1 = 1 \quad (4)$$

$$A_2 = 0 \quad (5)$$

$$B_0 = (k_p + k_i + k_d) \quad (6)$$

$$B_1 = -(k_p + 2k_d) \quad (7)$$

$$B_2 = k_d \quad (8)$$

Equations 4 through 8 show how each of the 5-biquad filter coefficients are calculated from the screen PID representation in DP.D.

To tune the velocity loop

- Make sure the motor shaft is connected to the required load, that the load is free to move and can move safely, and that the motor itself will not move when turning.

CAUTION You risk damaging equipment or personnel during tuning if you do not ensure that the load can move safely and that the motor will not move when rotating!

- In DP.D's navigation tree, double-click System > DPFlex (*Port*) > Velocity Compensator. DP.D displays the Velocity Compensator form:

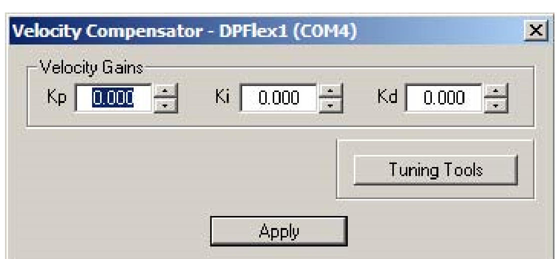


Figure 33: Velocity Compensator form

The Velocity Compensator form displays the current gains set for the target motor. It also enables you to re-calculate the gains based on the motor parameters and to open DP.D's tuning tools.

- Choose Tuning Tools. DP.D displays the Oscilloscope and the Velocity stimulus forms:

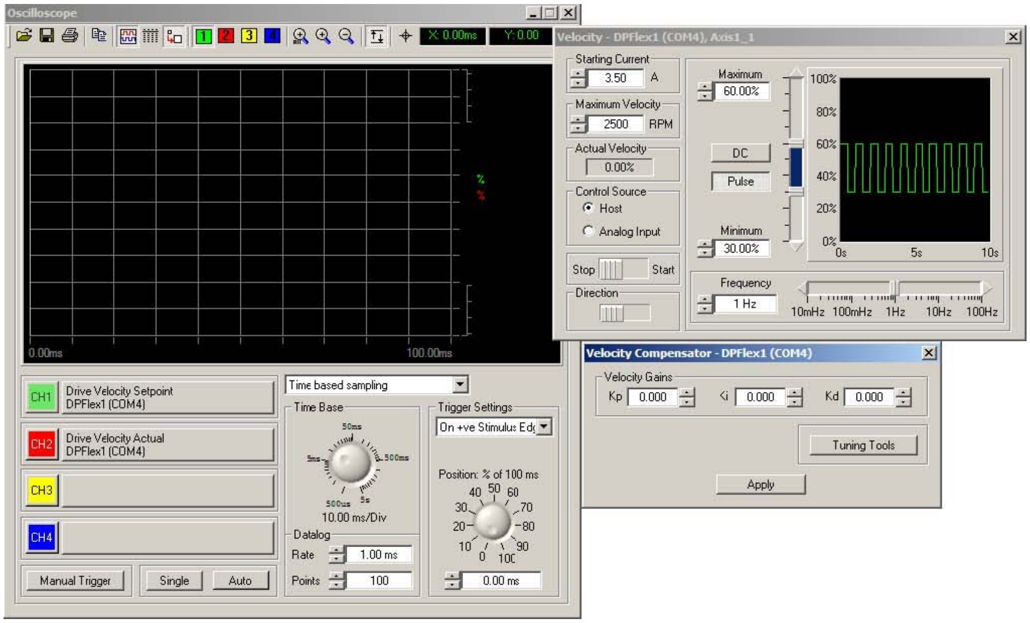


Figure 34: DP.D Oscilloscope and Velocity stimulus forms

> ***Tip*** *You can arrange the forms as you like and save their positions using the View > Save Windows command. You can restore the forms to their saved positions at any time (including the next time you run DP.D) with the View > Restore Windows command.*

Note that DP.D automatically sets the controls and fields in the Oscilloscope and Velocity stimulus forms to default values appropriate for tuning the velocity loop.

The Velocity stimulus form enables you to vary the velocity stimulus to the motor:

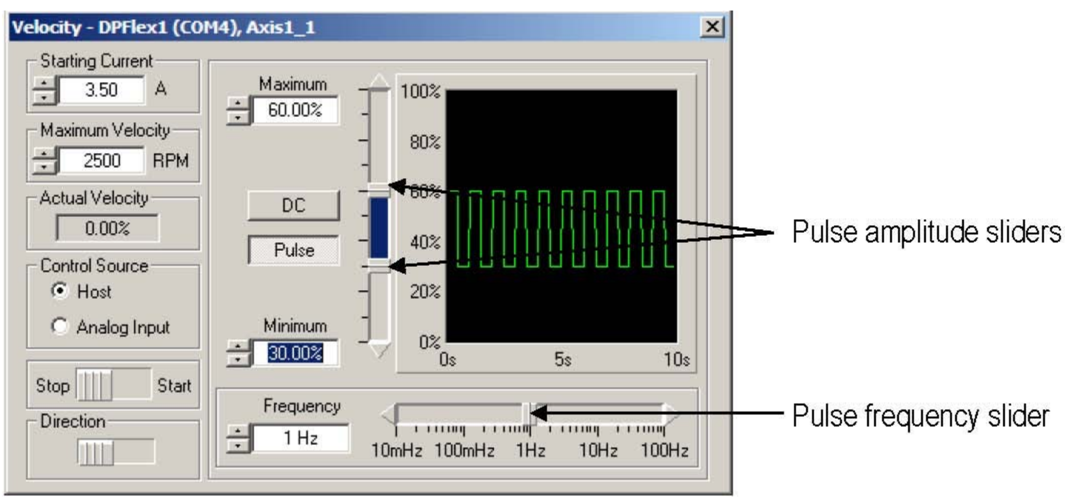


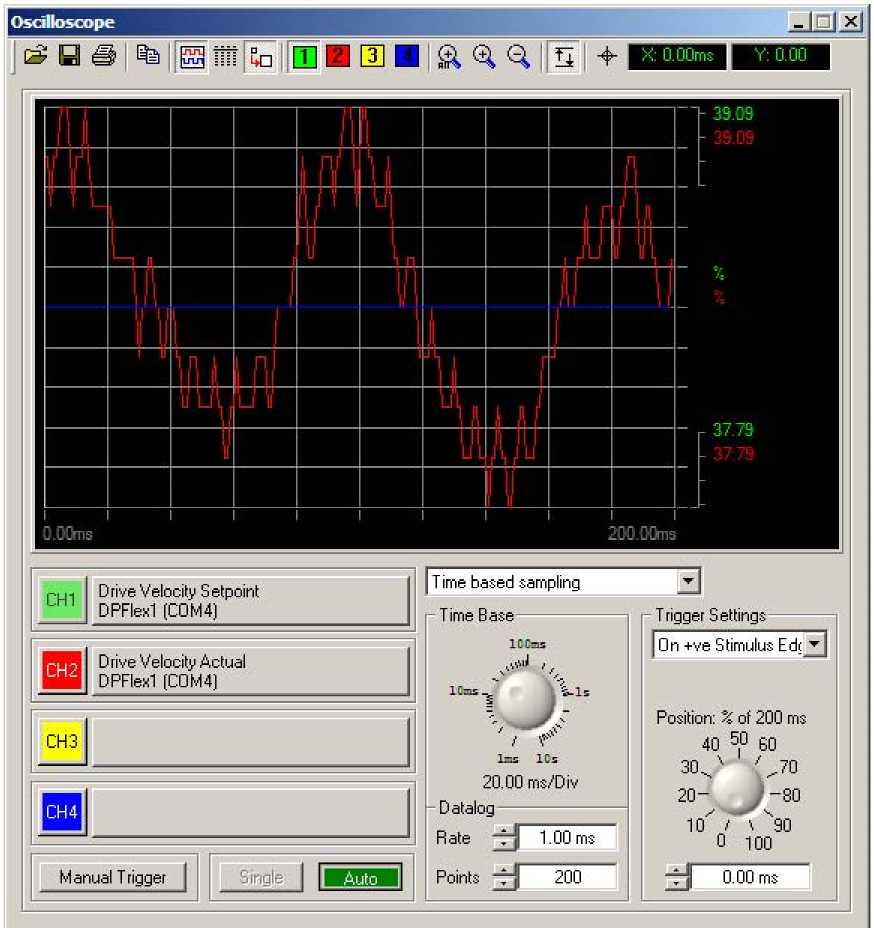
Figure 35: Velocity stimulus form

- In the Velocity stimulus form:
  - Choose Pulse.
  - Set the desired values for starting current, maximum velocity, maximum and minimum velocity setpoints, and velocity pulse stimulus frequency:

To do this...	...take this action
Set the starting current.	In Starting Current, enter the starting current in Amps. The starting current is the current needed to move the motor from an a standing still position. This current has to be sufficient to generate enough torque to overcome the static inertia of the motor plus the load.
Set the maximum velocity.	In Maximum Velocity, enter the maximum permitted velocity in revolutions/minute.
Control the velocity from DP.D.	In Control Mode, choose Host.
Control the velocity from an external analog input.	In Control Mode, choose Analog Input.
Set the type of stimulus.	Choose DC for a constant velocity stimulus or Pulse for a varying velocity stimulus.
Set the range of the velocity pulse stimulus.	In the Maximum and Minimum fields or using their matching sliders, enter the maximum and minimum velocity pulse stimulus to percentages of the value you set in Maximum Velocity.
Set the frequency of the velocity pulse stimulus.	In the Frequency field or using the matching slider, enter the frequency of the velocity pulse stimulus.
Start or stop the motor.	Choose Start or Stop.

- In the Velocity stimulus form, choose Start to apply the velocity setpoints to the motor.
- In the Oscilloscope form, choose Auto to start triggering.

After a few seconds, the Oscilloscope form will display the velocity stimulus setpoints and the actual velocity of the motor.



You can vary the settings in the Velocity stimulus form to see how it affects the actual velocity achieved by the motor.

- In the Oscilloscope form, choose Auto to stop triggering.
- In the Velocity stimulus form, choose Stop to stop the motor.

5.12 Viewing DPFlex Inputs

When DPFlex is connected to a PC, you can use DP.D to check the signals at the input pins.

Note that while you are checking the inputs with DP.D, the drive is disabled.

To monitor DPFlex inputs

- In DP.D's navigation tree, double-click Inputs. DP.D displays the Inputs form:

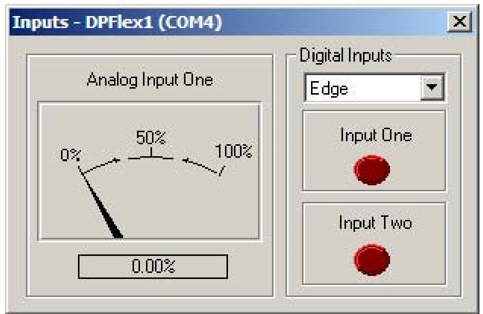


Figure 36: DP.D Inputs form

The Digital Input One and Digital Input Two indicators turns ON when signal voltage is applied across the corresponding inputs. The Analog Input One indicator shows the percentage of input voltage across the analog input.

- Click  to close the Inputs form.

5.13 Controlling the Digital Output (Gen2 only)

In the generation 2 DPFlex, the output can be configured through DP.D as either a speed indicator or a fault indicator. When configured as a speed indicator, the output will change state every sixty (60) electrical degrees. When configured as a fault indicator, the digital output will remain low when no faults are present. It is asserted high when there is a fault.

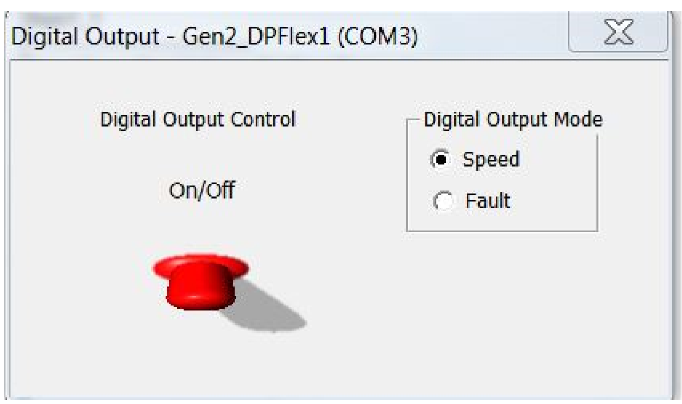


Figure 37

5.14 Viewing and Configuring Faults

DP.D enables you to view and configure faults while the DPFlex drive is running.

To view and configure fault thresholds

- In DP.D's navigation tree, double-click Faults. DP.D displays the Faults form:

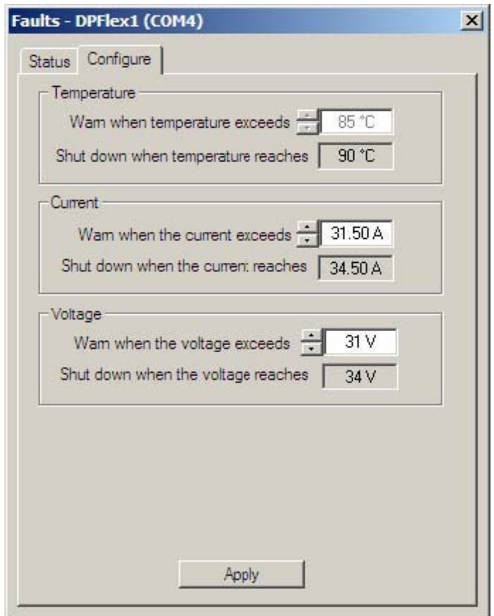
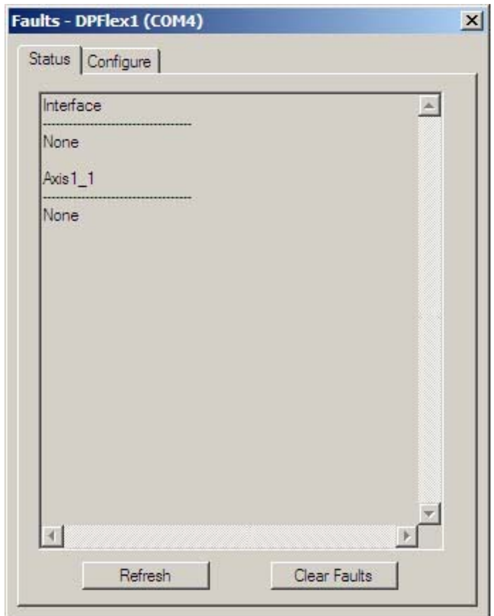


Figure 38: DP.D Faults form

- Set the thresholds by entering values for temperature, current, and voltage in degrees Celsius, amperes, and volts, respectively.
- Choose Apply.
- Click  to close the Faults form.

To view the operational status of the drive and motor

- In the Faults form, choose the Status tab:



- Check the current status:
  - Choose Refresh to update the display with the current status.
  - Choose Clear Faults to clear the display and update the status.
- Click  to close the Faults form.

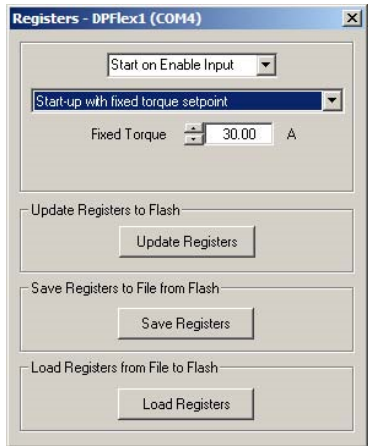
5.15 Deploying DPFlex Applications

At any time during application development, you can update a connected DPFlex drive's non-volatile memory with the current configuration parameters. You can also save DPFlex configuration parameters to a file and load these parameters into a connected DPFlex drive's non-volatile memory.

You can also define in which mode to run the motor when the drive powers up.

To update DPFlex with the current configuration parameters

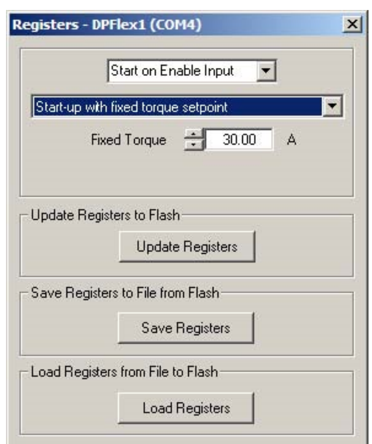
- In the DP.D navigation tree, choose System > DPFlex (*Port*) > Registers. DP.D displays the Registers form:



- Choose Update Registers. DP.D saves the current configuration parameters into the drive's non-volatile memory.
- Click  to close the Registers form.

To save configuration parameters to a file

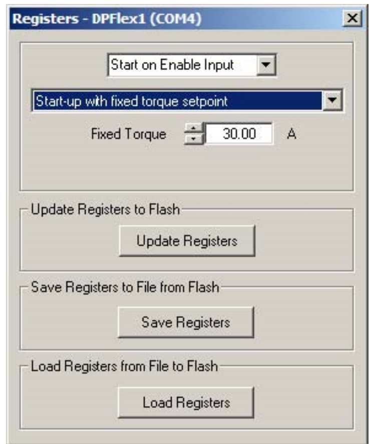
- In the DP.D navigation tree, choose System > DPFlex (*Port*) > Registers. DP.D displays the Registers form:



- Choose Save Registers. DP.D opens a browser.
- Select the path and file name and choose Save.
- Click  to close the Registers form.

To load configuration parameters from a file into DPFlex's non-volatile memory

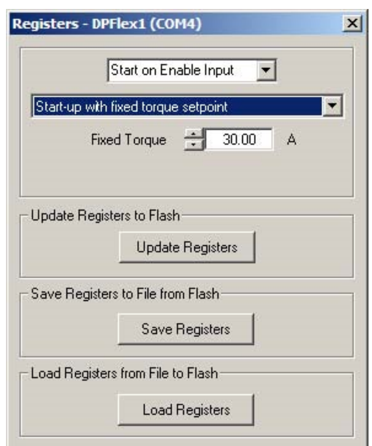
- In the DP.D navigation tree, choose System > DPFlex (*Port*) > Registers. DP.D displays the Registers form:



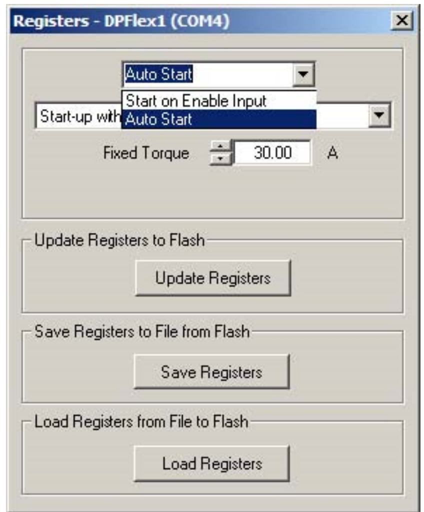
- Choose Load Registers. DP.D opens a browser.
- Select the path and file name and choose Open. DP.D loads the parameters into the drive's non-volatile memory.
- Click  to close the Registers form.

To set the drive to Auto-Start or Start on Enable Input

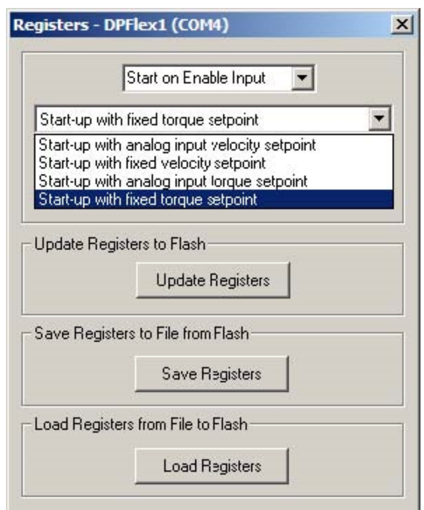
- In the DP.D navigation tree, choose System > DPFlex (*Port*) > Registers. DP.D displays the Registers form:



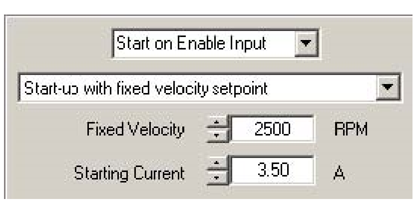
- Select Auto Start or Start on Enable Input from the first drop-down list box.

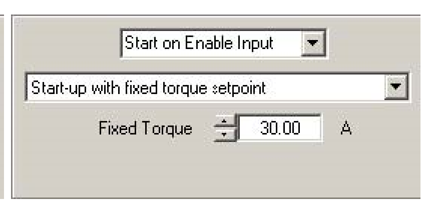


- Select from one of four motor start-up parameter from the second drop-down list box. DP·D displays the motor start-up parameters drop-down list box.

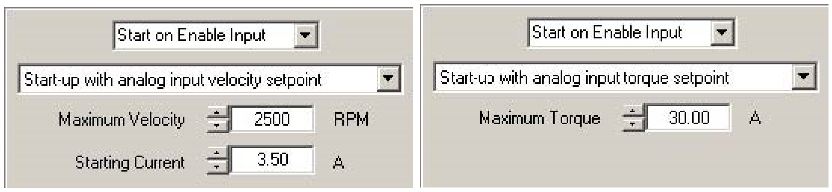


- You can choose to start the motor using a torque or velocity set point. You can also choose a fixed set point or one set by the analog input.
- If you chose to use a fixed set point, enter the required set point value in the Fixed Velocity or Fixed Torque field.





- If you chose to use a set point set by the analog input, enter the maximum permitted set point value in the Maximum Velocity or Maximum Torque field.



- Enter the Starting Current in amperes.
- Choose Update Registers. DP.D saves the current configuration parameters into the drive's non-volatile memory.
- Click  to close the Registers form.

Note that you must cut power to the drive, disconnect it from the computer, and restore power to the drive to start using the auto-start function.

Appendix A

Mounting Guidelines for Stand-Alone DPFlex Controller PCB Assembly

A.1 Introduction

DPFlex is a fully operational sensorless BLDC motor controller that requires a functional heatsink to realize the full product power rating. This document has been written to provide guidance to OEM designers who desire to incorporate the DPFlex controller within packaging of their own design so that the product will achieve maximum mechanical robustness and greatest electrical performance.

The section is organized into two sections that focus on the mechanical clearances and the electrically insulated thermally conductive interface.

A.1.1 Mechanical Integration

The DPFlex BLDC sensorless controller assembly has been designed to allow OEM installation of the controller with minimum skilled technical involvement. There are three items to be aware of during the design of the mounting surface for the PCB assembly:

- Mechanical clearance between the printed circuit board (PCB) and surrounding areas must be checked to ensure that interferences do not occur at maximum PCB tolerances as this might induce unexpected stresses on the PCB that could affect component reliability.
- Mechanical clearances between the mounting planar surface and specified PCB locations must meet minimum required regulatory agency specifications for electrical clearances or 1.0mm (0.0394in).
- The mechanical mounting surface designated as the thermal transfer surface must meet specified flatness specifications to prevent raised surfaces from interfering with heat transfer.

To address the mechanical clearance requirements between the mounting area and the edge of the PCB, it is recommended that provisions be made to allow a minimum of 1.0mm (0.0394in) of clearance from the edge of the PCB to the area surrounding the PCB mounting location. The DPFlex PCB will typically have a tolerance of +0.762mm (0.030in)/-0.0mm (0.0in) on the outer edge dimensions. Please refer to Figure A.1 for details on clearance and tolerance requirements. By providing the recommended clearance, it will accommodate any variations in manufacturing process that might occur and will facilitate the installation of the PCB during assembly while ensuring PCB reliability.

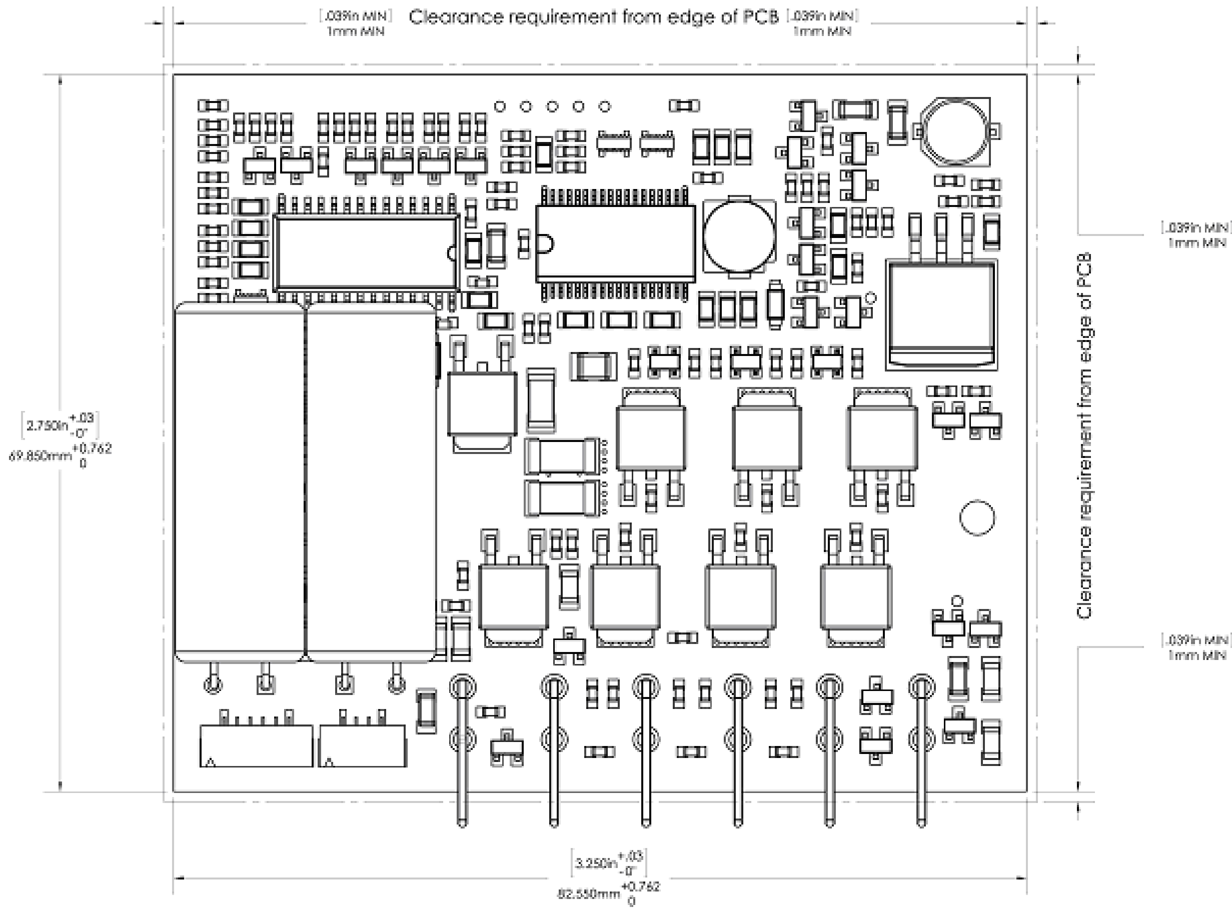


Figure A.1: DPFlex PCB dimensions

In addition to the clearance requirement on the edge of the PCB board, there is a minimum supporting outer edge requirement that is necessary for proper mechanical support of the assembly. Failure to include this edge may lead to additional stresses being placed on the PCB, which could cause component failures.

A maximum of 0.635mm (0.025in) supporting edge must extend underneath the PCB starting from the nominal board edge location. This edge must not extend any further under the PCB or risk of an electrical short may occur, and minimum creepage and clearance specifications may be breached for specified regulatory agencies. Please refer to Figure A.2 for details on edge dimensions and tolerances. Note that the supporting edge requirement is optional for the two edges that are perpendicular to the connector side edge of the PCB, so the use of an economical extrusion can be used to decrease manufacturing costs if desired.

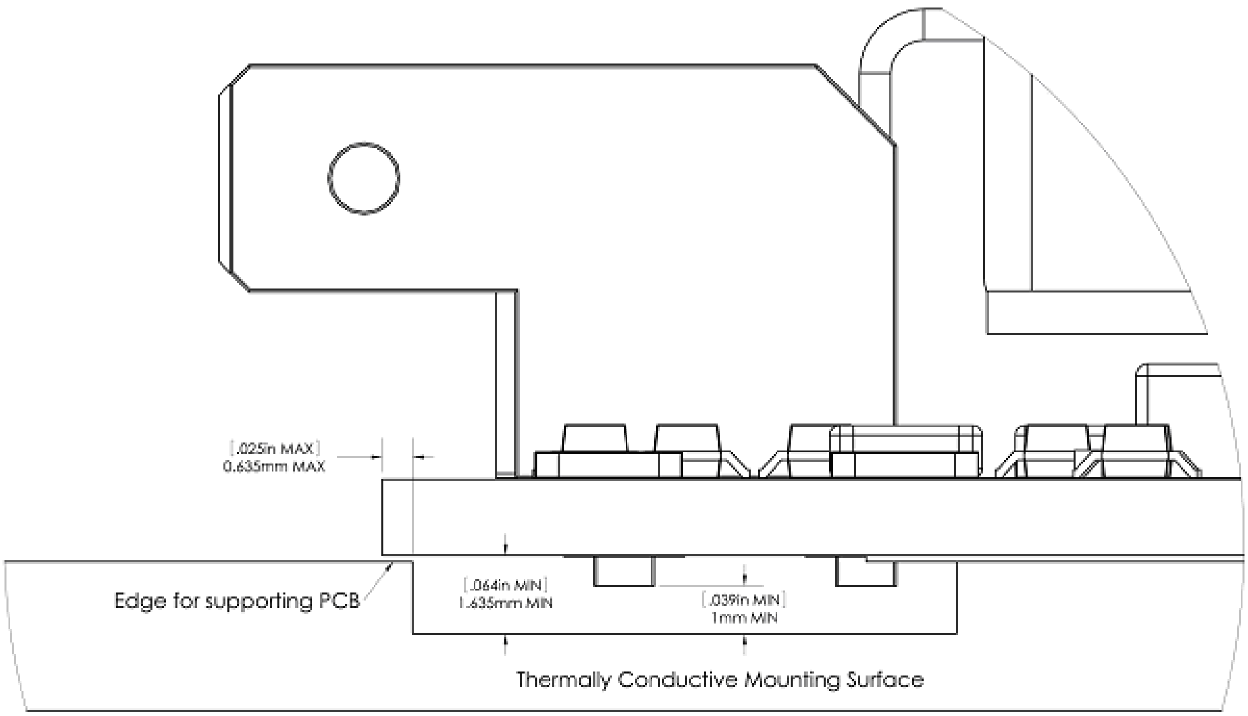


Figure A.2: DPFlex PCB edge dimensions and tolerances

Because the primary reason for providing a mounting surface is to give an adequate path for heat removal from the PCB, the surface directly beneath the power semiconductors located between the two mounting hole locations must maintain flatness and spatial dimensional as listed in the figures listed in this document. Please refer to Figure A. 3 for these details.

Failure to meet the flatness specification will lead to a poor thermal heat transfer out of the PCB, and may lead to premature shutdowns of the drive or complete failure of the assembly. Adequate thermally conductive material beneath the drive is essential for proper operation of the product. Failing to provide either increased surface area capable of dissipating the maximum expected power dissipation or a sufficient bulk thermally conductive material will require the de-rating of the DPFlex for reliable operation.

Please refer to the power dissipation curve for the product assembly that the mounting surface is being designed for. Please note that the recommended minimum thermal area is only for meeting the thermal transfer requirements. This surface can be extended to the outer edges of the PCB along the centerline of the mounting holes. If this extension is made, the thermal interface material will need to be extended to those additional areas as well.

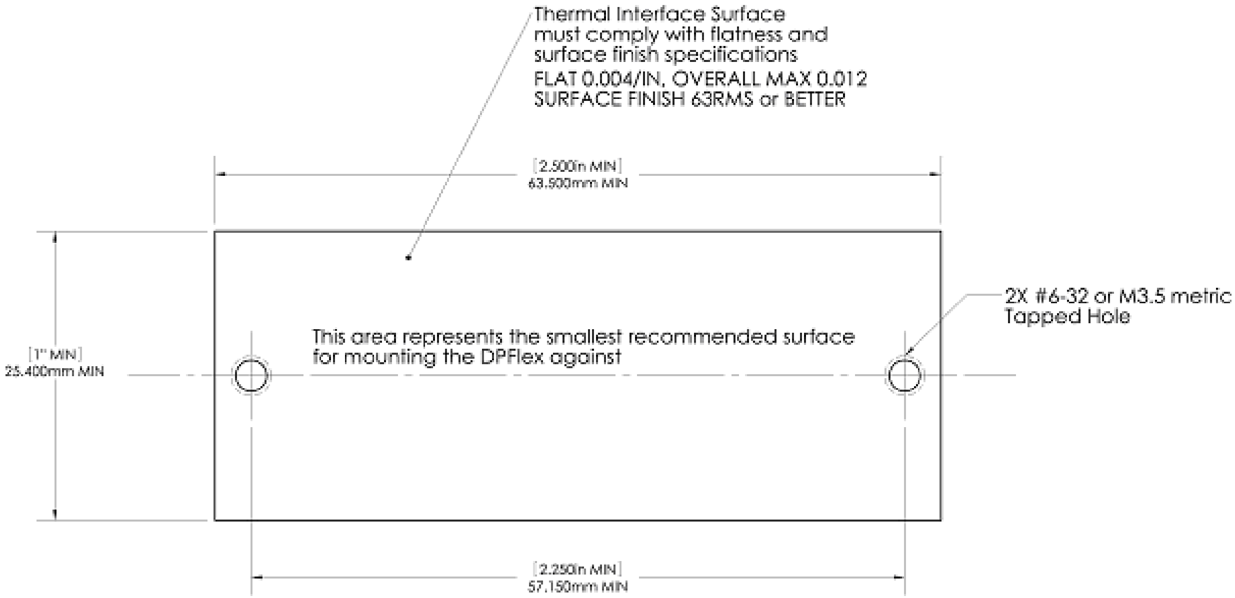


Figure A. 3: DPFlex PCB mounting surface considerations

In addition to observing the constraints on the mechanical clearances and interface surfaces as explained above, it is necessary to use a thermally conductive, electrically isolating interface material inserted between the PCB located at the specified thermal transfer surface underneath the PCB, and a compression clip to guarantee proper operation of the DPFlex.

The thermal interface material must be selected to have a low thermal resistance while filling in all voids between the mounting surface and the PCB, and providing 1100VDC of electrical isolation. Allied Motion recommends using the Berquist GAP PAD GPVOS-0.020-AC, 0.5mm (0.02in) thick thermal interface material. The material must extend pass the mounting surface by a minimum of 1.27mm [0.05in] or the PCB edge, whichever is less, to ensure that no contact will occur between the PCB traces and the thermally conductive mounting surface. The thermal interface material should provide close fit clearance holes for the mounting screws to allow sufficient insulation material around those locations.

Once the thermal interface material has been installed, a compression clip must be fitted on top of the PCB board above the power MOSFETS to ensure that adequate pressure is maintained on the PCB board to minimize thermal resistance and to provide mechanical restraint. An example design of a compression metal clip can be found in Figure A. 4 and the compression rubber strip in Figure A. 5.

Alternately, mounting hardware kits can be ordered from Allied Motion, which contain the compression clip, the Berquist thermal interface material, and two #6-32 3/16 inch machine screws. When mounting the DPFlex, care must be taken that no more than 113 N-cm [10 in-lb] of torque be applied to the screws during assembly.

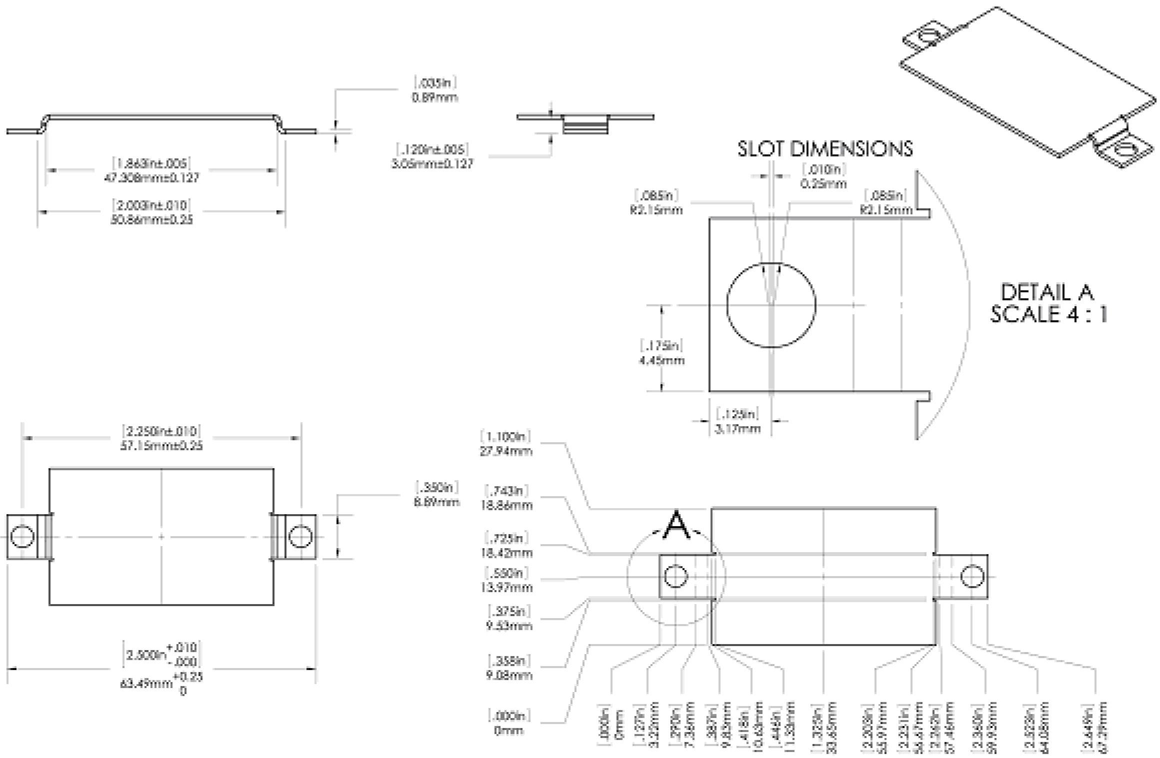


Figure A. 4: Compression metal clip design considerations

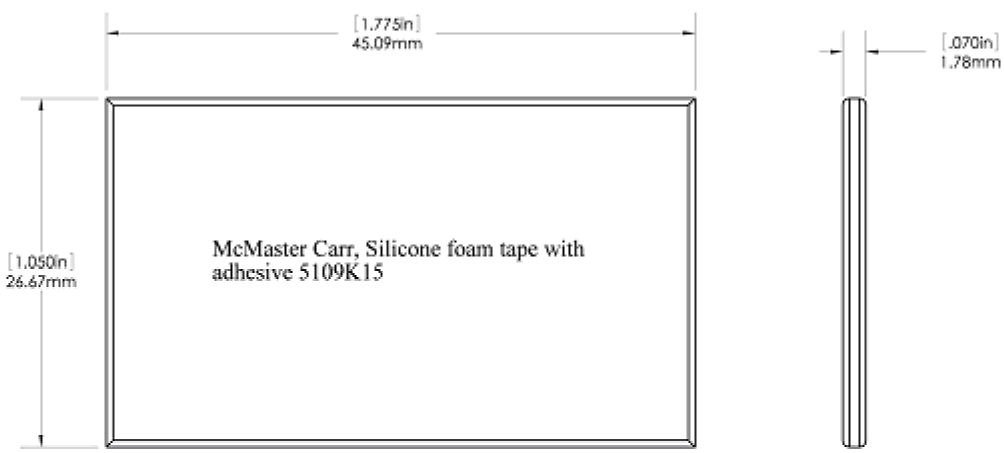


Figure A. 5: Compression rubber strip dimensions

A.1.2 Testing:

After completing the integration of the DPFlex into the target location, an insulation test should be performed to verify that the electrical insulation has not been breached. Further functionally tests can be done for verification of the thermal interface in addition to the insulation tests.

Appendix B

Compliance

A.2 EMC Related Installation Instructions

In order to maintain compliance with the EMC Directive, 2004/108/EC, in EN 55011 Class A Industrial and Commercial environments, the following guidelines must be observed:

- The signal cables for J1 must be less than 1m in length.
- Drive dc power supply cables connected to J3/J4 should be made as short as possible and should be twisted together using one (1) twist or more per cm.
- Motor cables connected to J5/J6/J7 should be as short as possible and should be twisted together using one (1) twist or more per cm.
- An additional electrolytic capacitor placed as close as possible to the J3/J4 power connectors is recommended. Approximate sizing for this capacitor is 30µF per amp. Wiring for the added capacitor cables connected to J3/J4 should be made as short as possible and should be twisted together using one (1) twist or more per cm. If extra capacitance is used, it is highly recommended that a pre-charge circuit be used to limit the inrush current required to charge this capacitance. The limiting resistor should then be shorted out using a relay or other appropriate means.
- If not using the DPFlex aluminum cover, an alternative enclosure providing similar or better attenuation between 30 MHz and 1 GHz must be used.

Use of this product in environments other than those defined as EN 55011 Class A may require the user to apply additional EM suppression techniques to meet the EMC requirements of the final installation environment.

> ***NOTE:*** *This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

> *This ISM device complies with Canadian ICES-001.*
> *Cet appareil ISM est conforme à la norme NMB-001 du Canada.*

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

DECLARATION OF CONFORMITY

in accordance with ISO/IEC 17050-1

Declaration Number:	A unique number or other identification is required
Manufacturer:	Agile Systems Inc.
Headquarters:	A12-550 Parkside Drive, Waterloo, Ontario N2L 5V4 CANADA
Phone:	+1 (519) 886-2000
Fax:	N/A
Web:	http://www.alliedmotion.com/
EU Address:	Contact Address for the EU Office or EU distributor:

Product:	Type	DP Flex
	Model	10-FX10-XX XX
Starting Serial Number		

The products described above are in conformity with the requirements of the following documents:

Document	Title	Edition or Date of issue
2004/108/EC	ELECTROMAGNETIC COMPATIBILITY DIRECTIVE	2004
EN 55011	INDUSTRIAL, SCIENTIFIC AND MEDICAL (ISM) RADIO-FREQUENCY EQUIPMENT - ELECTROMAGNETIC DISTURBANCE CHARACTERISTICS - LIMITS AND METHODS OF MEASUREMENT	2007
EN 55011/A2	AMENDMENT A2 TO BS EN 55011:2007	2007
EN 61326-1	ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL AND LABORATORY USE - EMC REQUIREMENTS - PART 1: GENERAL REQUIREMENTS	2006

Additional Information:

Document	Title	Edition or Date of issue
	Notified Body Certificate of Conformity – Technology International Inc.	

Documentation supporting this Declaration and the Notified Body Certificate of Conformity is kept on file at the Headquarters location listed above.

Issued at:	Waterloo, Ontario, Canada	yy-mmm-dd
	Place	Date

Signature

Name

Title/Function