DG2S series

DC Servo drive

User's Manual and Installation Guide

Contents

1.1. Safety Notes

Please read through this documentation before operating the device. The devices can operate on low and medium DC bus Voltages the model -08020 operates upto 80VDC and the model - 16035 operates upto 160VDC. Above 50VDC, the drive's metal case must be connected to safety ground for safety purpose. Above 80VDC motor supply Voltage an external braking circuit must be used on the powersupply.

Moving objects, like machine axis can be hazardous, avoid touching and keep distance from mechanic moving parts of the machine while the motor power supply is on and connected to the drives.

The device should not be used where it can cause personal injury, death or high financial loss. Never open the drive's chassis and never touch inner circuitry even if it's unpowered. Take care of power supply's correct polarity connection, wrong polarity connection of the Motor Power supply will cause permanent damage to the device.

Never disconnect the motor from the drive when power supply is connected to the drive and is under Voltage.

Do not short the motor output terminals, it may cause permanent damage to the device. The drives are in enclosure, but this metal case is not meant to protect the drive from dust and falling chips, liquid or other moisture material. Please take care to protect the drives from taint damage.

1.2. Policy

CNCdrive cannot take responsibility for any personal injury and/or financial loss caused by their drives' failure or caused by following an error in this documentation.

1.3. Warranty

We give 12 months of standard warranty period with our DG2S series drives. Customers may send back the drives within 15 days from reception date if they are not satisfied with the performance. Using the drive outside of the specified electrical ranges may cause permanent damage to the device and void warranty. Opening the drive's metal frame and making any modification in it voids warranty.

2. Electric specifications and limitations.

2.1.Operation ranges.

Property	Min	Typ	Max	Unit	Notes
Motor supply voltage (model 08020)	12	-	80	VDC	Optimal U=rated+10..20%
Motor supply voltage (model 16035 without using braking circuit)	12	-	80	VDC	Optimal U=rated+10..20%
Motor supply voltage (model 16035 with using braking circuit)	12	-	160	VDC	Optimal U=rated+10..20%
Motor current (model 08020)	0	-	20	A	Limited by drive at set threshold, maximum at 20A
Motor current (model 16035)	0	-	35	A	Limited by drive at set threshold, maximum at 35A
Logic supply voltage	11.5	12	14	VDC	
Logic supply current	100	200	250	mA	
Operating temperature	0		65	℃	Automatic shutdown at 65℃
Opto-isolator input Voltage	3	-	-		Use external series resistor in case of input Voltage>5VDC For 12V input use 1kOhm For 24V input use 2.2kOhm
Opto-isolator current	3	5	10	mA	
Step input frequency	0		400	kHz	
Direction signal stabile state minimum allowed valid time after step signal active edge	1	1	1	usec	Step signal active and inactive edges can be configured in software by user.
Encoder maximum frequency	1	1	1	MHz	With 4x decoding
Error line output current	10	10	20	mA	20mA continiously is destructive
Switching frequency	20	20	20	kHz	
PID loop sampling time	1		65535	*60usec	User setable in 60usec steps

Minimum allowed motor coil resistance	0.4	-	-	Ohm	If resistance is lower it should be extended with inductor or with resistor/resistor wire.
Minimum allowed motor coil's inductance	200	-	-	uH	If inductance of the motor coil is lower, it should be extended with series coil.

3.1. Connectors

3.1.1. Motor and Motor Power supply connector

These are heavy duty high current bare screw connectors with M4 diameter.

Connect the motor to
Motor Arm1 and **Motor Arm2**
It is OK if polarity is not known at this stage.
It will be determined during first startup and tuning.

Connect the power supply to
Power+ and **Power-**
Polarity MUST be correct

Figure 1. Power Connections

Be very careful to get the Power polarity correct!

Always put the drives into a closed box!

Never touch the terminals!

3.1.2 Using external braking circuit connector

The background: When a DC motor is rapidly deccelerating it acts as a generator. The generated energy pumps back into the drive, possibly higher the voltage in the motor power supply. Therefore if the used power supply rated voltage is greater than 80VDC, it is strongly recommended to use an external braking circuit which dumps and dissipates the generated extra Voltage and energy.

Working of braking circuits:
A braking circuit monitors the motor power supply voltage. If the voltage level rises above a set level the braking circuit activates and powers a braking resistor. The braking resistor is used to dissipate the generated extra energy.

We supply braking circuit products which fits our drives and can be used to protect the drives and the system from regenerative overvoltage events. For more information please check our BRKC-xxx braking circuit devices datasheet.

3.1.3. Main Connector

The socket labeled **Main** is a standard RJ45 socket and contains the following connections, as show in white numbers in Figure 2.
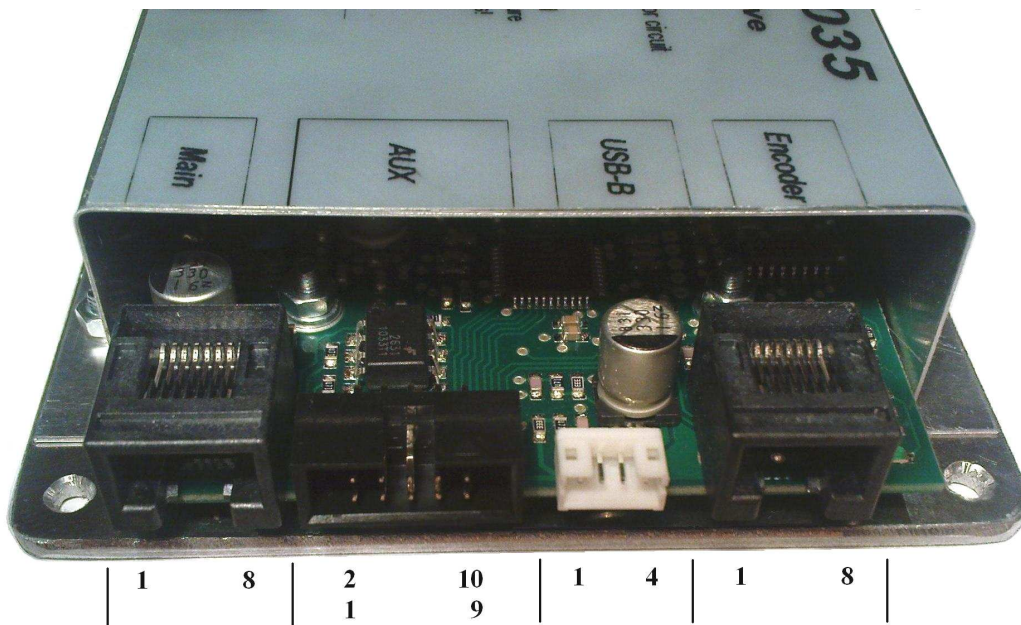

Figure 2. Control Connections

1) **Step** signal (input)
2) **Direction** signal (input)
3) **Ground** for Step and Direction signals (NOT for power).
4) Not used
5) **Reset** (input) and Stop (input)
6) **Error** (output) and Stop (input)
7) **DC Power ✚** (11.5V to 14V, tipically 12V for digital processor)
8) **DC Power ━**

Signal descriptions:

The **DC Power** must be smoothed with capacitor. An example is a typical low power universal power supply set to 12VDC voltage.

Step and **Direction** source signals are fed to the DG2S drive through built in high speed 10Mbit/sec optoisolators. The step and direction inputs interface includes an analog and also a digital filer, these filters out short pulses and noise spikes.

Reset (and *Stop*) signal is referenced to the digital power supply ground (pin8). This is a dual purpose signal which is 'active low', which means the drive normally keeps the signal high and the drive is stopped by pulling the line low (grounding the pin). After the pin is pulled low, releasing the pin initiates a reset.

Note: The drive is also reset by turning the digital power off and back on. Error conditions must be cleared and an encoder must be connected and functioning properly before the drive will start working successfully.

Error *(and Stop)* See Chapter 4.2 for features and function of the Error line.
                    See Chapter 5.4 for Error line connection options.

Note: A **Stop** signal can be sent on the **Reset** line or on the **Error** line. Grounding either of these pins will stop the drive, but in different ways. See Chapter 4.2 for Error line function.

3.1.4. Encoder Interface

The plug labeled **Encoder** is a standard RJ45 jack and contains the following connections, as shown in red numbers in Figure 2.

  1.) **Ground**
  2.) **5V** DC power for encoder
  3.) Not used
  4.) Not used
  5.) **A**
  6.) **A_**
  7.) **B**
  8.) **B_**

Encoders must be an incremental and TTL level type with square waves. Absolute encoders are not supported.

An encoder with differential A , A_ and B , B_ channels must be used for position feedback from the motor.

A single ended encoder can be converted to differential by using our DTSE differential to single ended encoder interface board. Mount the interface board near the encoder and connect the encoder wires to the interface **screw terminals** as shown.
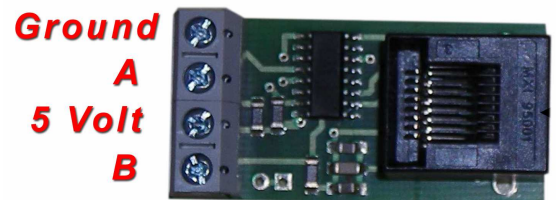

Figure 3. Encoder interface

The other end of the board contains an RJ45 jack for connecting a standard Ethernet patch cable to the **Encoder** jack on the DG2S drive.

3.1.5 USB interface

A 4-pin RM2.0 socket connector is provided for tuning and for making diagnostics on the drive. This connector plugs directly into our PRG1 programming cable and this cable contains the USB driver electronics. For tuning connect the drive's 4-pin socket to the PRG1 programming cable's 4-pin socket with the cables supplied with the programming cable.
And connect the PRG1 circuit to the PC USB port via a standard USB A-B cable.

The USB connection is provided for configuration and monitoring purposes. These lines are optically isolated from the device's other parts and from the PC.

Note: The USB A-B cable is not the part of the D2GS drive package and also not the part of the PRG1 programming cable package. This cable must be supplied by the user, but it is easy to get it in most of electric or informatic stores.

The drives can be configured/tuned with our Servoconfigurator3 software which can be downloaded from our website for free of charge.
The software documentation can be found in the software package.

Download the latest tuning software from our website.

4.1 LED indicators

Indicator lights are visible on the edge of the board to give visual feedback on the drive operation. There are 2 pieces of LEDs, one with green and one with red with color.
The LED states and the combination of the states gives clear information about the drive operation. Please read section 4.2 below for more information about the possible LED states.

4.2 Fault conditions and Error handling

Error line is pin number 6 in the Main connector and is a dual purpose, bi directional line.

This pin is *'active low'*, meaning that the line is normally *high* indicating no problems and normal operation. The drive will stop if this pin is pulled *low* (grounded) by one of these sources:

EXTERNAL activation; The line can be pulled low by an external source (CNC software, E-stop, etc). In this case, the drive will stop and remain stopped. When the pin is released, the drive will remain stopped, but can then be reset. CNC software should be set for 'active low' to use the Error line to stop the drive.

INTERNAL activation; The line is pulled low by the drive itself due to a fault condition. Once stopped by an internal fault condition, the drive will remain stopped until the fault is cleared and the drive is reset. This line may be monitored by your CNC software to trigger an e-stop in the event of a fault. See Chapter 5.4 for details on Error line connection options.

Fault handling by the DG2S series drives:

The possible operation states and their indications are as follows:

1.) **Controller running** - indicates normal operation of the controller.
Red LED *off.*
Green LED *Flashing.*
Description: This is the indication when there is no fault and the drive is up and running.

2.) **Limit override** - indicates that the set servo error limit is reached.
Red LED *blinking.*
Green LED *blinking.*
Description: This is a fault condition and occurs if the following servo error gets greater than the user set value.

3.) **Unconnected or faulty encoder** – indicates that the encoder is not working properly
Green LED *off*
Red LED *blinking rapidly*
Description: This is a fault condition. The drive detects unconnected and faulty encoder signals if it sensing an encoder fault it stops operation.

4.) ***Overheat*** – indicates that the drive's metal case reached 65°C
Green LED *on*
Red LED *blinking*
Description: This is a fault condition and indicates an overtemperature of the drive's metal case. When this fault happens the drive cannot be reset until it cools down to under 65°C.

5.) ***Overcurrent*** – indicates that the current on the motor outputs cannot be limited
Green LED *off*
Red LED *off*
Description: This is a fault condition and indicates a short circuit on the motor output or a too low resistance/inductance of the motor coil.

Note: Point 2 to 5 are error conditions and the error line of the drive actives in these cases.

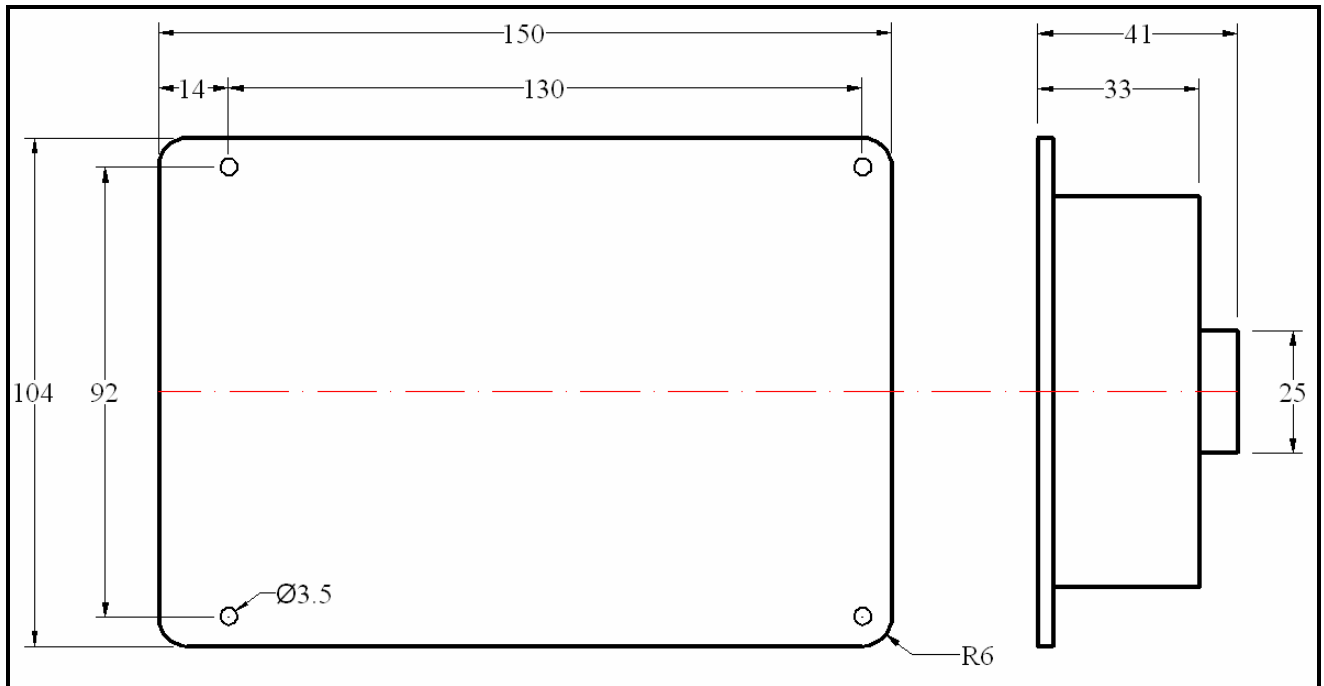## 5.1 Installation of Drive and Physical dimensions

Figure 4. Drive mounting dimensions

All dimensions in mm.
The drive has four 3.5mm mounting holes in the 3mm thick aluminium backplate.

The drive's metal base plate acts as a heat sink for the drive and can become hot under heavy current operation. It is recommended to install the drive on a thermally conductive frame, for example an aluminum plate of at least 1.5mm thickness, to improve cooling and power dissipation.

Use heat transfer paste or a silicon heat transfer sheet to get the best thermal connection between the drive's metal backplate and external mounting metal frame.

The drive has builtin thermal protection, but it is adviced to keep the metal frame as cool as possible to avoid overheating and shutdowns.

5.2. Motor wiring.

If possible use twisted pair of wires to connect motors to the drives to minimize radiated EMI from the wires. Use as high gauge wire as possible to minimize wire resistance.

5.3. Encoder wiring.

To connect a differential encoder to the RJ45 style encoder plug on the DG2S drive, there are two options:
1) Cut one end off of a standard Ethernet patch cable, expose the individual wires and connect them to the appropriate terminals (or plug) on the encoder. Ethernet cables normally have clear plastic connectors allowing the wire colors can be readily seen, so you can figure out which color wires go to what pins on the cable plug.
2) If the encoder vendor supplied pre-made cable of sufficient length then simply connect those wires to an RJ45 plug. These plugs are readily available at electronics supply stores in both crimp and IDS types.

If using our ENCD encoder interface board, a standard CAT5 grade Ethernet cable is all that is needed. A shielded cable is preferable. The cable length must be between 1 meter and 100 meters. Cables less than 1 meter in length or above 100 meters in length may not meet the cable driver circuit's impedance requirements. Use separate cables for motor power and for encoder signals and do not route them close to each other or in a common conduit.

5.4. Shielding techniques in general.

The drive has 'isolated' motor power supply and digital power supply sections. This means the digital power supply ground and motor power supply's ground are 'floating' to each other (not connected inside the drive) to avoid ground loops and therefore noise problems in communication. Do not use the same power supply for the motor power and the digital control power, for example a high voltage power supply that also has a low voltage output included which takes its primary power from the high voltage side.

To protect your new drives and also for the most reliable communications between the computer and the CNC electronics, always use separated Power Supplies for the digital power and the motor power and do not connect the two GND points together, keep them separated and run the ground lines back to their respective power supplies.

Use shielded cables for the *Main* connector and *Encoder* connector if possible. Connect the cable shields to an earth GROUND point at one end only, preferably at the Control box and not at the machine tool.

If you connect both ends of a cable shield to ground, then current can flow thru the shield creating communication problems and also can carry high voltage back to your control box electronics in the event of a short circuit at the machine tool.

5.5. Error Line wiring

The Error line is a bidirectional line and when looking to it as an output it acts as an open-collector output.

While the drive is running in normal operation the error line is released by the drive and only the internal ~100kOhm pullup resistors pulling the line to the internal 5 Volts potential.

The error line acts as an open collector output means that any number of error lines can be paralleled (connected together) which allows the user to create a "common error line".

When paralleling the error lines of all drives in a setup, if any of the drive has an internal fault, it pulls the error line low indicating the fault and stopping all other drives.

An external optical isolator may be used to interface the error line to the control computer or to a PLC or to any type of external control circuit. The external optical isolator may be connected as drawn on Figure 5.

An external pushbutton or NPN transistor may be used to trigger the error line by external circuits.

Take care to not to overstress the Error line output and never connect the error line to any other potential than GND (0 Volts of the digital powersupply).

The error line can sink maximum 10mAmpers of current and can live throu 20mA in peaks.

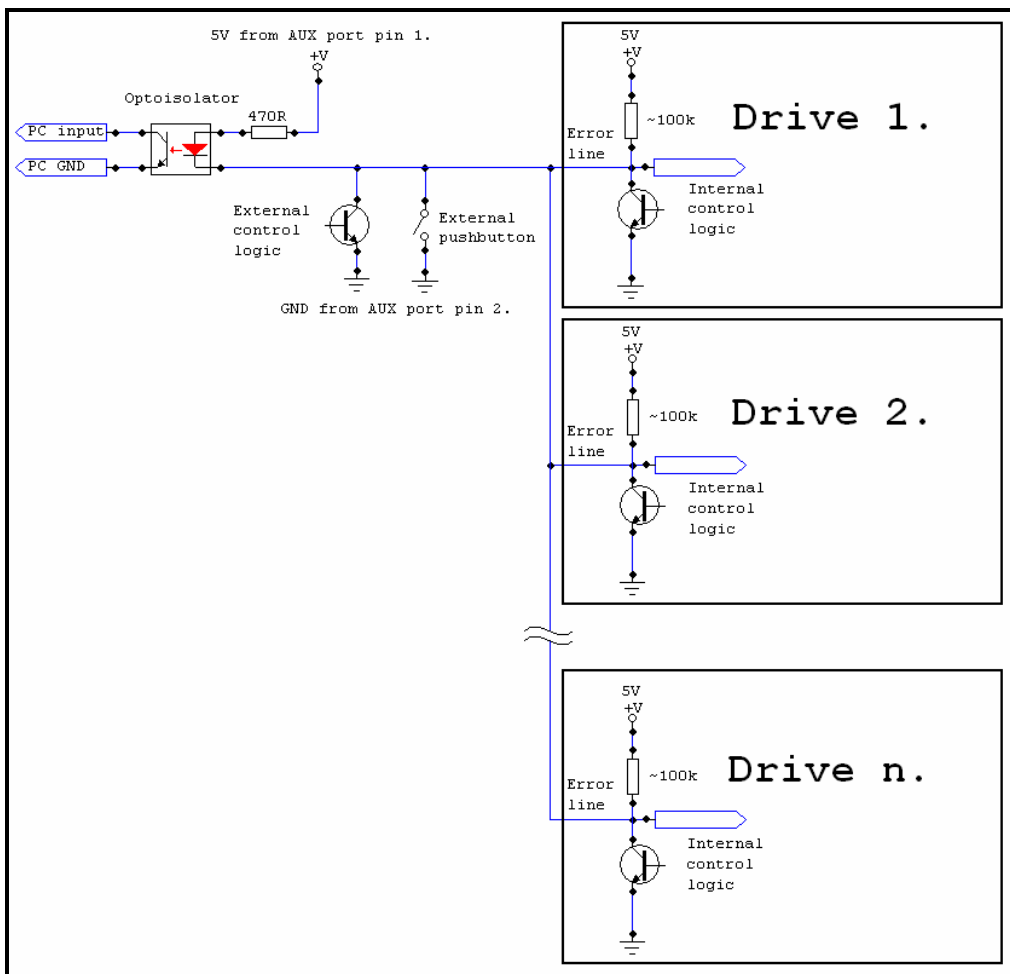Overstressing the error line may cause permanent damage to the device!

Figure 5. Interfacing the error line

5.6. Reset Line wiring

The reset line is a TTL level input. The line is help on 5Volts potential (referenced to the digital powersupply ground) by internal weak pullup resistors with an approximate value of 100kOhm. The reset line can be activated by external logic with pulling the line low. Releasing the line returns the line to a high (5V) state.

5.7. Mixing the Reset and Error lines

The error line acts as an opencollector output which means that many error lines can be connected together (paralelled or in other words OR wired).

The reset line is an input and therefor any number of reset lines may be also wired together.

It is also allowed to wire the error lines and the reset lines together. With making this connection we get a "common error/reset line" for a drive or for any number of drives in the setup.
If this common error/reset line is pulled to GND potential by external logic, it works as if it was just a reset line and the drive stops operation. If the line is released by the external logic, the drive(s) automaticly resets and starts operation again.
If an internal fault occurs in any of the drives in this chain, the commoned error/reset line is pulled to GND potential by the drive which got the fault, but because the reset line is also connected to the same wire, the drive automaticly resets itself. In this automatic reset procedure a short approximately 300msec long low pulse is generated on the common error/reset line which an external logic may read and may do the required steps of operation.
As mentioned the drives automaticly resets with this mixed connection of the error and reset lines and with this connection there is no need to use any external logic to force the drives to reset after a fault.

Ofcourse individual reset and error line handling is also possible, it is only an option to mix the error and reset lines. It depends on the application if this connection mode is useful or not.

6. Power Supply selection and filtering

The drive needs 2 power supplies for operation, one to feed the digital circuit and one to feed the motor. The digital power supply can be tipically a 12V DC voltage source with that has smoothed and regulated output and meets the other electrical requirements.

The motor power supply should be a 'linear' power transformer with continuous current capability at least of motor's rated continuous current rating.

The DC output should be smoothed with capacitors downstream of the rectifier using the following sizing rules;

  1000uF per amp up to 80V
  2000uF per amp over 80V

Connect each drive with separate feed wires from these main capacitors. Do not 'daisy chain' or connect the motors in series.

Keep the wires from the power supply to the drives under 30cm (12 inches) in length. If that is not possible, then install an additional 1000uf (or greater) capacitor directly across the power terminals on the drive.

Do not use 'switching mode' power supplies for motor power unless a properly designed power resistor-capacitor network is installed on the output, otherwise the SMPS may destroy the drive and/or the drive may destroy the SMPS!
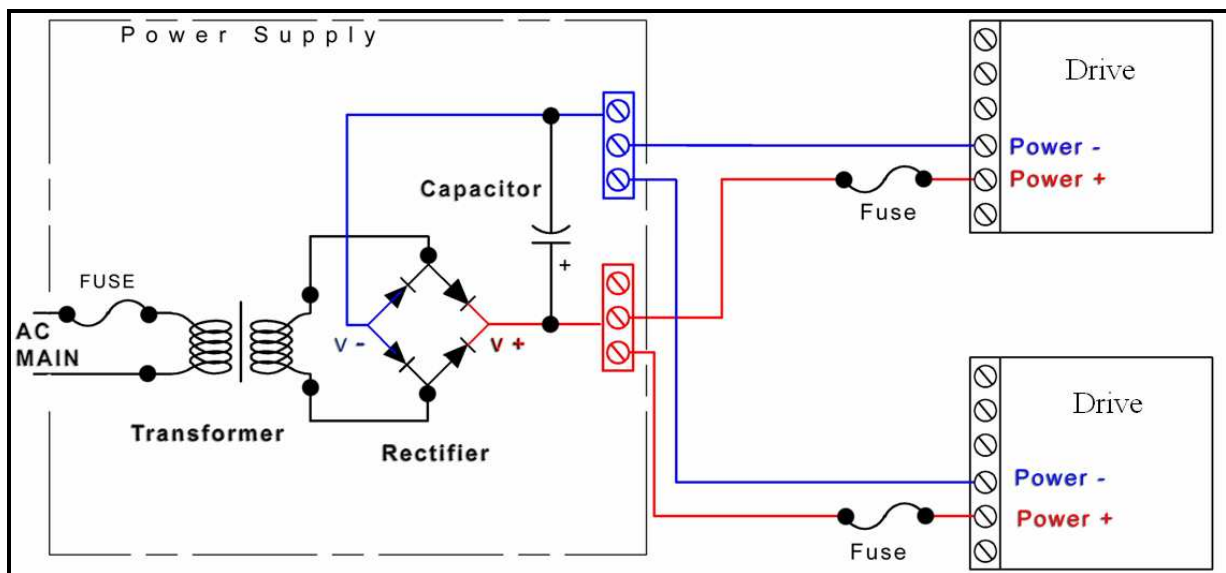

Figure 6. Ideal basic motor power supply configuration

7. Troubleshooting

Q: When powering up the drive, the motor runs with full speed to one direction and stops after a while with error-limit reached LED on.

A: Encoder is wired up in reverse, exchange motor Arm1 with Arm2 to reverse direction of the motor.

Q: The motor is oscillating over the nullpoint when powerup.

A: Tune the PID controller with the Servoconfigurator3 software.

Q: I like to control my motor with a PLC which has 24V I/Os, is it possible?

A: The step and direction pins are feed through optoisolators. Use a series resistor with the step and with the direction signal from the PLC. Resistor must be sized so that the opto-isolator current is limited under 10mA.

Q: I like to control an AC servomotor with the drive, is it possible?

A: No. The drive can only control brush type DC servomotors.

Q: I have a disk-type servomotor with coil resistance of lower than 0.4 Ohms and an inductance of lower than 200uH, what to do?

A: Use a resistor wire and/or inductor in series with the motor coil to extend resistance to at least 0.4 Ohm and inductance to at least 200uH otherwise the motor and/or drive may damage.

Q: I have a motor that have a rated Voltage greater than 160VDC, can I used it with the drive.

A: Yes, but do not connect a PSU with an overvoltage, absolute maximum motor Voltage ratings of the drive is 160VDC. If your motor has higher Voltage, it will operate from 160VDC, but with limited maximum torque. The best way is to use a higher Voltage rated drive in this case.

For more information visit:

http://www.cncdrive.com
e-mail: info@cncdrive

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