Quin Systems Limited

Q-drive Servo Amplifier

Installation & Users Manual

Issue 1.5

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(MAN430)

Copyright Notice

Software Version

This manual reflects the following software versions.

- QDRIVE.EXE version 2.0 or higher.

Important Notice

Quin Systems reserves the right to make changes without notice in the products described in this document in order to improve design or performance and for further product development. Examples given are for illustration only, and no responsibility is assumed for their suitability in particular applications.

Although every attempt has been made to ensure the accuracy of the information in this document, Quin Systems assumes no liability for inadvertent errors.

Suggestions for improvements in either the products or the documentation are welcome.

Relevant Directives

This product is designed to be incorporated into a system for the control of machinery, and needs external equipment to enable it to fulfil this function. It must not be relied upon to provide safety-critical features such as guarding or emergency-stop functions. It must not be put into service until the machinery into which it is incorporated has been declared in conformity with the Machinery Directive 89/392/EEC and/or its relevant amendments.

The installation instructions in this manual should be followed in constructing a system which meets requirements.

The product has been tested in typical configurations, and meets the EMC Directive 89/336/EEC When used with the recommended mains filter.

This product as normally supplied has mains level voltages accessible to touch, and requires to be mounted within a suitable cabinet to meet any required IP rating to BSEN 60529.

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1. Introduction

This document is the Installation Manual for the Q-Drive servo amplifier, a member of the Quin Systems Ltd. digital Programmable Transmission System (PTS) range.

The Q-Drive series of servo-amplifiers are intended to control 3 phase AC servo-motors with electronic commutation and resolver feedback, up to a maximum rating of 18 Amps, 6.8kW continuous.

Such servo-motors are generally called AC Brushless, but to avoid any confusion, motors which can be used with the Q-Drive series servo-amplifiers should have the following characteristics:

- Rotor constructed with permanent magnets arranged in 1, 2, 3, 4, 5 or 6 pole pairs, without commutator or slip rings.
- Stator constructed with 3 windings connected in star or delta.
- Electronic commutation is effected by means of a resolver (motors with Hall effect sensors or tachogenerators are not suitable).

Note:

> Servo-amplifiers which deliver a 3 phase sinusoidal supply are usually called AC Brushless. The name DC Brushless is reserved for servo-amplifiers whose output supply is trapezoidal.

PLEASE READ THIS MANUAL BEFORE INSTALLATION.

It is very important that the guidelines for installation are observed, otherwise damage to the system or to the machine may occur. Quin Systems Limited accept no liability for damage or costs arising from incorrect or inadequate installation of the systems, or from incorrect programming of the system for the required application. Digital control systems are not simple, but can be used successfully to control industrial machinery and provide great improvements in reliability, performance and flexibility.

1.1 Q-Drive Characteristics

The main characteristics of the Q-Drive servo-amplifiers are as follows:

- Digital servo-amplifier with analogue speed command +/- 10V, for Brushless motor with resolver.
- Utilises a 16 bit DSP (Digital Signal Processor)
- Compact unit for connection to 3 phase power supply with built-in braking module.
- Double Eurocard Format using Surface Mount Technology (SMD).
- Completely programmable by a multi-drop RS422 or direct RS 232 serial link.
- Sinusoidal current output assures smooth torque and optimum performance at low speed.
- Power and command circuits are optically isolated from each other.
- Protections and ruggedness for use in severe conditions.
- Easy to use external connections including two part connectors for resolver input and encoder output.
- Simulated incremental encoder output with adjustable resolution to 1024 ppr and adjustable marker pulse. Differential line driver outputs.
- 7 segment status indicator for diagnostic display.
- Short-circuit protected output stage.
- I^2t protection.
- Detection of resolver fault, motor overheating.
- Velocity or current regulation.
- Auxiliary voltages are produced within the drive, no external power supply required.
- Drive can be enabled using an optional opto-coupled input or using a volt free contact.
- Motor connections are constantly monitored.

1.2 EMC Compliance

The Q-Drive amplifier has been tested to and complies with BSEN 50081-1 and BSEN 50081-2 for radiated emissions. The Q-Drive also complies with mains borne interference tests when used with a suitable three phase filter and when both the Q-Drive and the filter are securely mounted and earth bonded to a conductive panel. If the auxiliary supply is used then this too must be filtered. Both filters must provide at least 55dB attenuation at 1MHz. The cable between the filters and the Q-Drive should preferably be screened and be kept as short as possible. Figure 1. below shows a typical arrangement between the filter and Q-Drive,

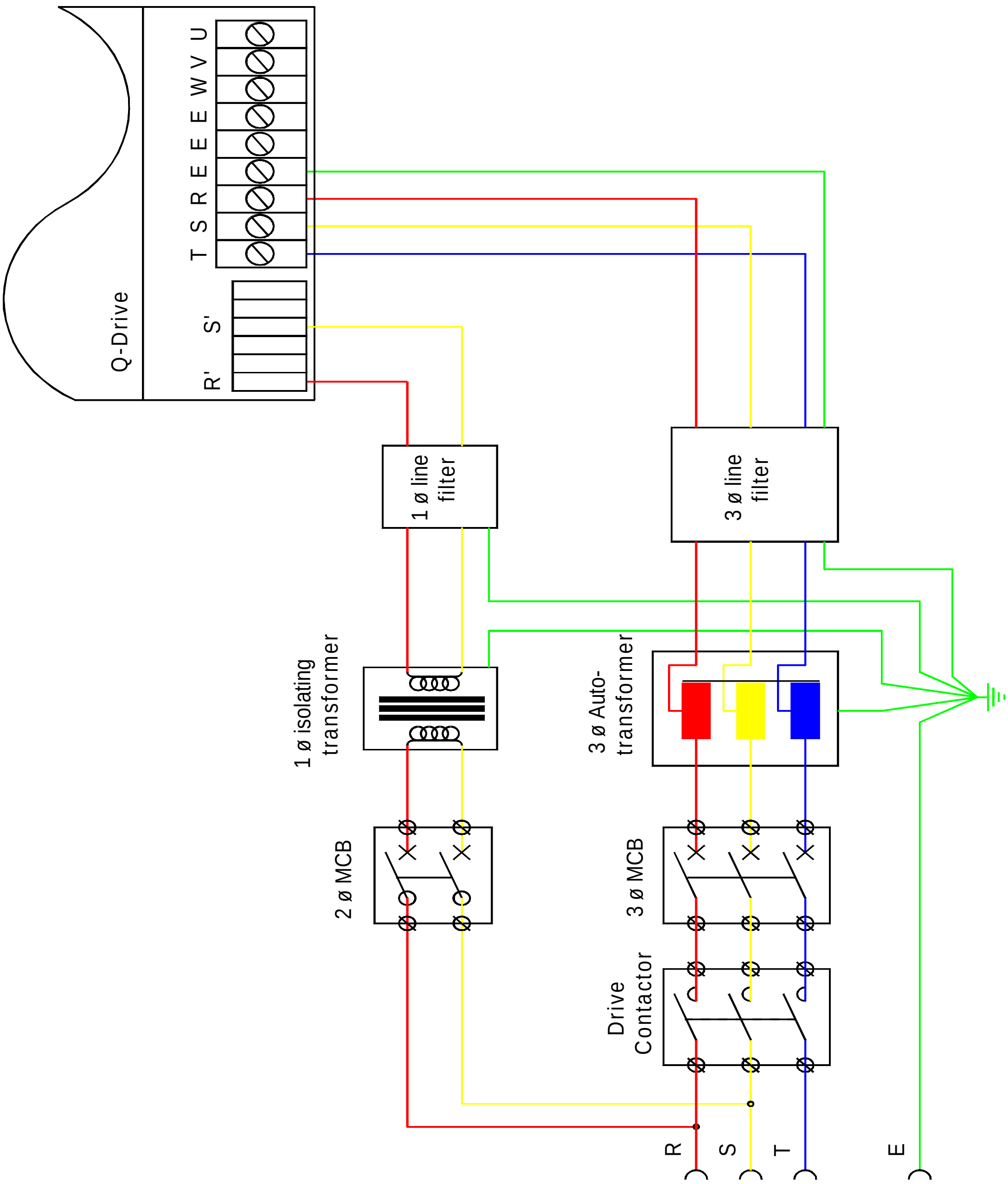

Figure 1. EMC filtering

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2. Unpacking and Inspection

Inspect the packaging for external signs of damage if possible before signing the delivery receipt, as this may indicate that the goods have been mishandled in transit. When unpacking the Q-drive, keep all the packaging materials if possible. If it is necessary to ship the Q-drive to another site, or to return it for service, the original packing can be reused.

Inspect the Q-drive carefully when it is unpacked. Check for any loose parts, any circuit boards loose in their card guides, cables not connected, or any bending of the case or chassis.

If any defect or damage is suspected, do not connect power to the system. Notify the carrier immediately, and contact your sales office or the Quin Systems Service Department:

Quin Systems Limited
Service Department
Oaklands Business Centre
Oaklands Park
Wokingham
Berkshire RG11 2FD
England

Telephone Wokingham	(01734) 771077
Fax	(01734) 776728

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3. Drive Specifications

This section gives the overall specifications of the drive, including mechanical details and environmental requirements.

3.1 Mechanical specification

The dimensions of the Q-Drive are as follows:

Height	400 mm
Width	115 mm
Depth	290mm
Weight	4 kg
IP Rating	IP20

The drive is designed to be mounted with the circuit board vertical, to allow cooling air circulation by convection. There should be at least 100mm clearance above and below the unit to allow free air flow. If the unit cannot be mounted with the drive vertical, then a fan must be fitted to blow air through the unit. The 18 amp model has built in fans for forced cooling, the fans are optional on other models.

3.2 Environmental specification

Temperature:	operating	0°C to 60°C
	full power	0°C to 45°C
	storage	-20°C to 70°C
Relative humidity:		20 to 80% non-condensing

The drive may be operated at higher ambient temperatures, but will require additional cooling such as forced air ventilation in order to do so. The drive is normally supplied in a case or chassis with ventilation holes top and bottom, and therefore is not protected against dust, particles, or liquids. If necessary, the unit can be supplied in a suitable sealed cabinet. Please contact your sales office or Quin Systems directly for further details.

3.3 Power supply specification

Supply voltage	3 x 220V AC +/- 15%
Supply frequency	45 to 65 Hz

An additional single phase 230V AC supply is required to keep the resolver interface powered when the main three phase supply to the drive is interrupted, i.e. during an E-stop situation. If this auxiliary supply is fitted it is very important to ensure that the correct phases are used, this is explained further in section 5.3 on page 25.

3.4 Electrical Specification

3.4.1 General data for all types

Supply voltage	3 x 220V AC +/- 15%
Supply frequency	45 to 65 Hz
Operating temperature range	0 to 60° C
Operating temperature range at full power	0 to 45° C
(from 45°C, reduce output current by 2%/°C to 60°C)	
Storage temperature range	-20 °C to + 70 °C
PWM chopper frequency	9.99 kHz
Differential input reference	+/- 10V
Speed control range	1/5000
Bandwidth:	
speed loop	300 Hz
current loop	2 kHz
Rated power dissipation during braking with standard resistance	125W
Max. output to motor	3 x 210 V, 0 to 500 Hz
Incremental encoder:	output 5V
“low speed” settings available	128, 256, 512, 1024 ppr
“high speed” settings available	128, 256, 512 ppr
Theoretical max. speed for motor with resolver:	
“low speed”	up to 3500 rpm
“high speed”	up to 6000 rpm
Switching threshold of brake module	385 V DC
Over voltage trip threshold	415 V DC
Voltage drop trip threshold	180 V DC
RS 232/RS422 serial link	
baud rate	
Standard:	9600 Bd
Configured by solder bridge:	19200 Bd
transmission	Full duplex
format	1 Start bit 8 Data bit no parity 1 Stop bit

RTS/DTR controls RS232 transmission flow

3.4.2 Drive Performance Specification

Servo-amplifier type:		**PQD506**	**PQD510**	**PQD518**
Rated rms current	Amps	5,9	10,0	18,7
Rated peak current	Amps	8,3	14,2	26,4
Max. rms current	Amps	11,8	20,1	37,3
Max. peak current	Amps	16,7	28,4	52,8
Rated power	(kW)	2,1	3,6	6,8
Max. power	(kW)	4,3	7,3	13,6

Table 1: Drive Data

Note:

$I_{rms} = I_{peak} / 1.41$
$P = 1.73 \times I_{rms} \times V_{rms}$ or $P = 3 \times I_{rms\ phase} \times V_{rms\ phase}$
- in star $V_{rms\ phase} = 210V / 1.73$

$I_{rms\ phase} = I_{rms}$

- in delta $V_{rms\ phase} = 210V$

$I_{rms\ phase} = I_{rms} / 1.73$

Example: **Type PQD506** $I_{rms\ max} = 11.8$ A $_{rms\ rated} = 5.9$ A

$P_{max} = 1.73 \times 11.8 \times 210 = 4.3$ kW

$P_{rated} = 1.73 \times 5.9 \times 210 = 2.1$ kW

3.4.3 Analogue readings on the motherboard

The Q-Drive motherboard contains several measurement points which permit an analogue reading of the three signals shown in Table 2-

Measurement point	**Description**	**Scaling**
Current	Instantaneous Current	10V corresponds to the max. current of the unit
Command	Internal command voltage	$V_{command} = V_{ext.\ cmd}$
Speed	Motor speed	+/- 10V corresponds to the max. speed of 6000 rpm

Table 2: Test Points

The location of the measurement points is shown in Figure 24. on page 61

3.5 Mounting Details

The Q-Drive has mounting holes on the rear plate for fixing to an electrical panel inside a cabinet. The unit is fixed with four M5 bolts using the fixing centres as shown in Figure 2. below.

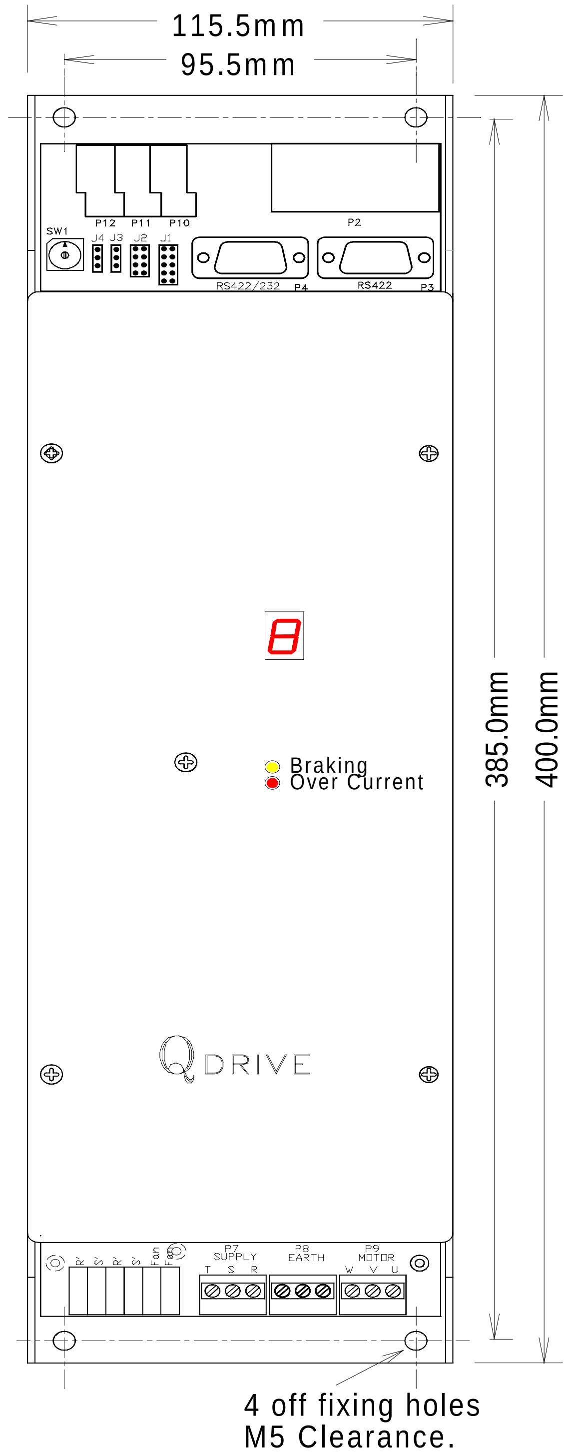

Figure 2. Fixing centres for the Q-Drive.

3.6 Relevant Directives

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4. Connections

4.1 General

High and low voltage cable connections have been segregated in the Q-drive. The positions of the various connectors are shown in Figure 3.

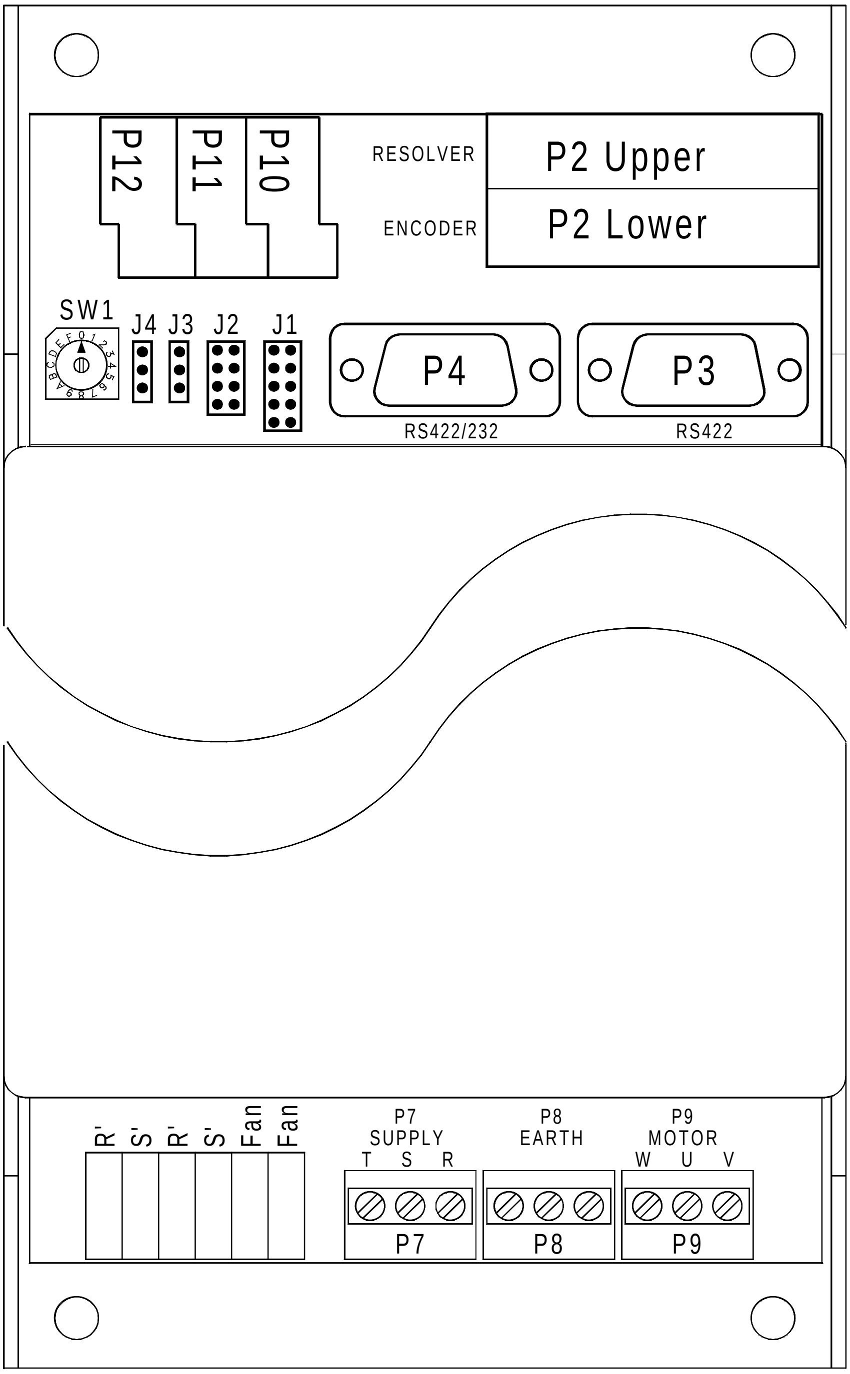

Figure 3. Connections

4.1.1 Wiring and connectors

The wiring of the Q-Drive series of servo-amplifiers must be carried out according to the schematics in these instructions. Local wiring regulations must be observed.
Special attention should be paid with respect to wiring rules regarding ground, earth and neutral.
The earth wire to the amplifier, motor and housing must be as short as possible and connected to a common earth point.
The complete wiring plan is represented in on the next page.

4.1.2 Cable lengths and cross-sections

Quin Systems recommend that the following cable cross-sections are used:

	Units	PQD506	PQD510	PQD518
Supply voltage	mm^2	1.50	2.50	4.00
Motor	mm^2	1.50	2.50	4.00
Earth	mm^2	1.50	2.50	4.00
Command signals	mm^2	0.18	0.18	0.18

Table 3: Cable Sizes

4.2 Low Voltage Connections

Details of the low voltage connections which include the Encoder, Resolver, RS422/ RS232 and discrete signals, are described in the following sections.

4.2.1 P2 Upper: Resolver

The resolver interface uses the upper half of connector P2 and is wired as shown in Table 4: and Figure 4. . The external screen should be connected at both ends; motor and amplifier. The overall screen must be connected at the amplifier end, pin 1 should be used, and it should also be connected to the motor earth terminal at the motor end of the cable. It is recommended that the three internal screens should be connected only at the servo-amplifier end of the cable. They should be connected to pin 8 along with the Ref. 2 connection. Pins 2 and 3 of the connector are used for the motor thermal overload which can be either normally open or normally closed, or (if a thermal sensor is used) have the following characteristics:

Contacts Open: *>10kΩ*
Contact closed *<1kΩ*

P2 Pin Number	Function	Suggested Wire Colour	SEM Motor Resolver connector
1	Screen	Braid	J
2	Thermal Trip 1	White	T
3	Thermal Trip 2	Brown	S
4	Sin 2	Pink	E
5	Sin 1	Grey	C
6	Cos 2	Yellow	P
7	Cos 1	Green	D
8	Ref. 2	Blue	B
9	Ref. 1	Red	A

Table 4: P2 Upper, Resolver Input Connections

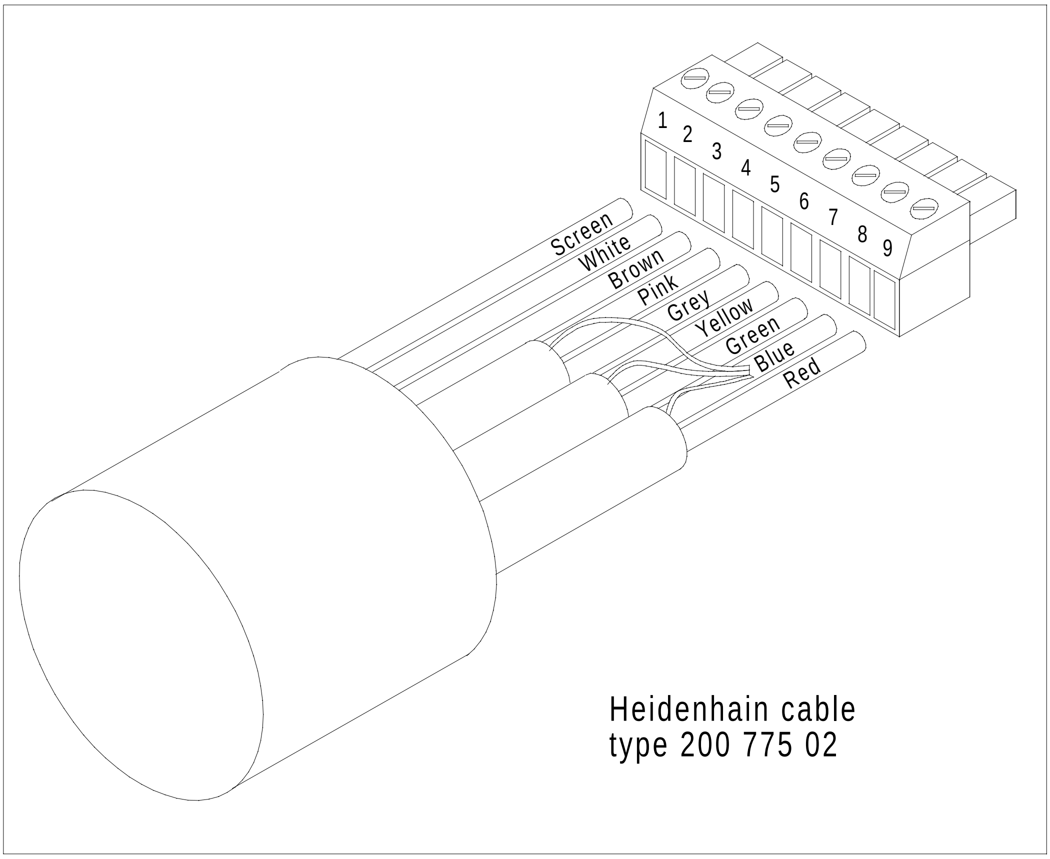

Figure 4. P2 Upper: resolver connector

4.2.2 P2 Lower: Encoder

The Encoder output uses the lower half of connector P2 and is wired as shown in Table 5: and Figure 5. . The Q-Drive servo amplifier simulates an incremental encoder using the positional information obtained from the resolver. The encoder resolution can be as high as 1024 pulses per revolution (PPR) when the drive speed is limited to 3500 RPM. If the drive is required to move the motor at higher speeds then the encoder resolution drops to a maximum of 512 PPR. If the drive is set to 1024 PPR and 6000 RPM then an incorrect encoder pulse train will be produced.

The cables used for the encoder signals should be high quality screened cables, using individually screened twisted pairs, with an overall cable screen as well. The cable screen should be connected directly to the main earth point, not via the control system 0V supply.

It is recommended that the maximum cable length for the encoder output should not exceed 25m, which should not be a problem as the Q-drive and control system can usually be mounted within the same cabinet. If the machine installation requires a cable longer than 25m, then it may be necessary to install an additional line driver unit to boost the encoder signals.

Q-Drive Pin Number.	Function.	PTS D-type Pin no.	Suggested Wire Colour.
1.	A.	1.	Pink.
2.	/A.	6.	Grey.
3.	B.	2.	Yellow.
4.	/B.	7.	Green.
5.	Z.	3.	Blue.
6.	/Z.	8.	Red.
7.	Not Used.	.	.
8.	0V.	9.	White.
9.	Screen.	5.	All screens.

Table 5: P2 Lower, Encoder Output Connections

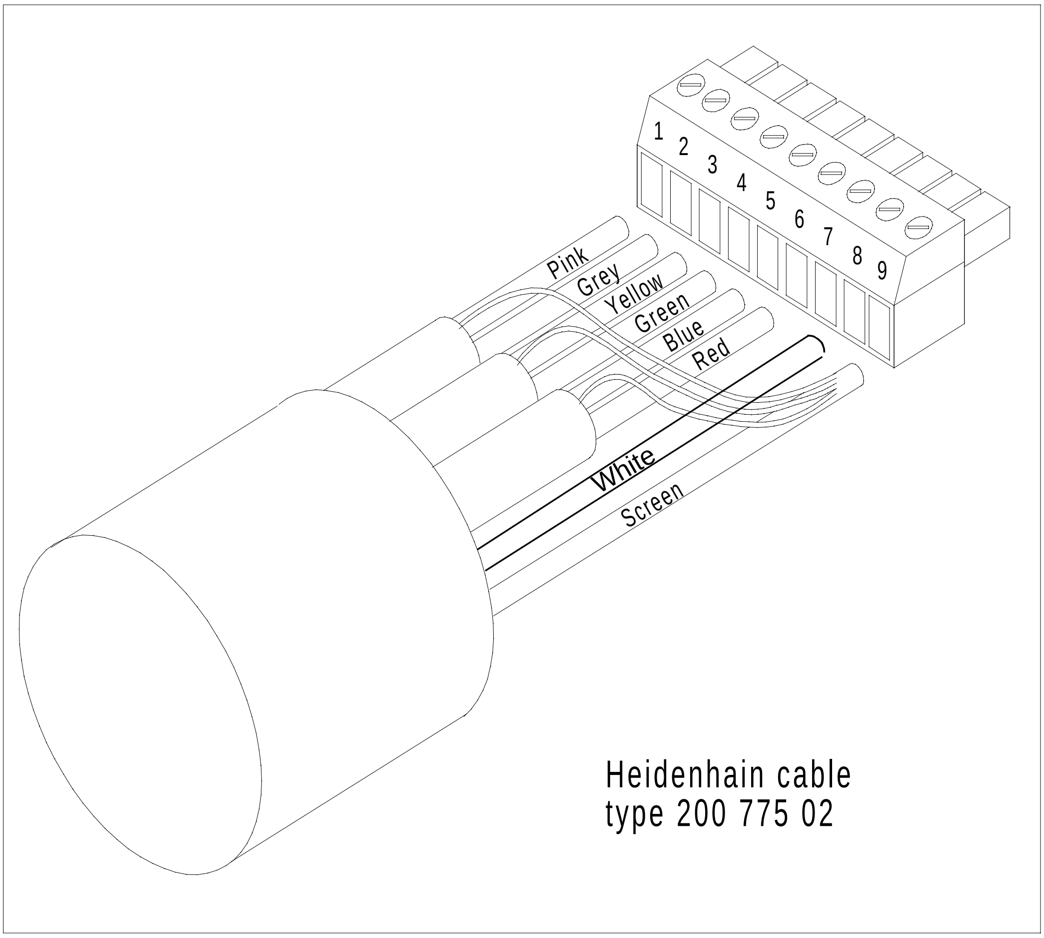

Figure 5. P2 Lower: encoder connector

4.2.3 P4 RS422 Out / RS232

The socket P4 is used as the daisy chain OUT connector in an RS422 multi-drop drive chain or the RS232 port in a single drive application. The RS232 option can only be used if the drive has been setup for this format by Quin systems. The default configuration is for RS422, the connections are shown below.

Pin Number.	RS422 Function.	RS232 Function.
1.	Not Used.	Not Used.
2.	Tx.	Tx.
3.	Rx.	Rx.
4.	Not Used.	Not Used.
5.	Gnd.	Gnd.
6.	Not Used.	Not Used.
7.	/Tx.	RTS.
8.	/Rx.	DTR.
9.	Not Used.	Not Used.

Table 6: P4 RS422 Out / RS232 Connections

4.2.4 P3 RS422 In

The plug P3 is used as the RS422 daisy chain IN connector in a multi-drop drive chain. If the unit has been configured for RS232 then this connector has no function.As a temporary measure, an RS232 device may connect to an RS422 drive (default linking) with the connections shown.

P4 (OUT Connector) Pin Number.	RS422 Function.	RS232 (temporary usage).	P3 (IN connector) Pin Number.
1.	Not Used.	.	1.
2.	Tx.	.	2.
3.	Rx.	Gnd.	3.
4.	Not Used.	.	4.
5.	Gnd.	Gnd.	5.
6.	Not Used.	.	6.
7.	/Tx.	Tx.	7.
8.	/Rx.	Rx.	8.
9.	Not Used.	.	9.

Table 7: P3 to P4 RS422 Daisy Chain Connections

4.2.5 P10, P11 & P12

These connectors are used for interfacing all other low voltage signals to the drive and are detailed below in Table 8: Figure 6. shows the pin 1 & 2 socket of connector P10,

Pin Number.	Signal Name.	Function.
P10.1.	Earth.	Command shield connection.
P10.2.	Gnd.	Drive internal Ground (not isolated).
P10.3.	S+.	Command signal +ve.
P10.4.	S-.	Command signal -ve.
P11.1.	EXTILIM.	External current limit,+10V corresponds to max peak current.
P11.2.	+12V Bat.	External 12V battery +ve.
P11.3.	RDY2.	Volt free drive ready relay contact.
P11.4.	RDY1.	Volt free drive ready relay contact.
P12.1.	-12V Bat.	External 12V battery -ve.
P12.2.	BGnd.	External 12V battery Gnd.
P12.3.	024V.	0V for ENABLE signal.
P12.4.	ENABLE.	Drive enable signal from controller.

Table 8: P10, P11, P12 Connections

P11 & P12 already inserted into their respective mating half, whilst the pin 3 & 4 connectors are shown waiting to be inserted.

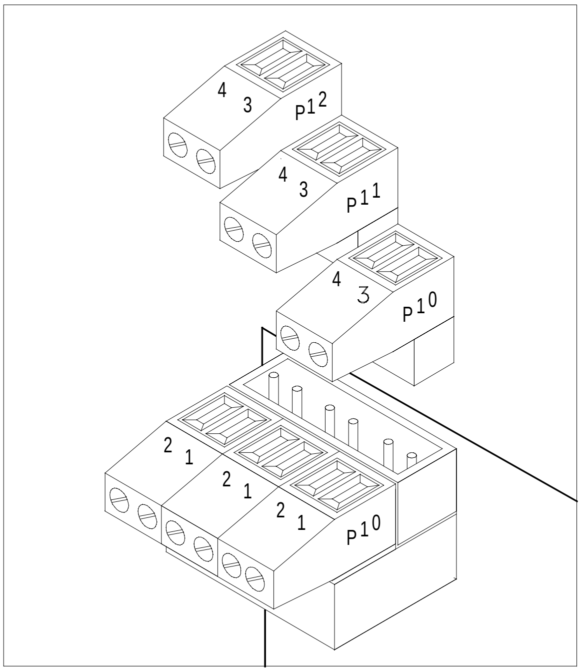

Figure 6. P10, P11, P12: discrete signals

4.3 High Voltage Connections

4.3.1 P7, Three Phase In

P7 is a block of three high current screw terminals used to connect the three phase or single phase supply to the Q-Drive. If a single phase supply is used then connections ‘R’ and ‘S’ should be used. The individual phases are identified by markings on the circuit board just above the terminals.

4.3.2 P8, Earth Terminals

P8 is a block of three terminals, all connected to ground. These terminals should be used to connect the earth wire from the three phase supply or transformer and an earth connection to the motor. One of these terminals can also be used to connect an earth bonding strap to the Q-Drive although there is an M4 stud just below these terminals designed expressly for this purpose. All metal parts of the Q-Drive are bonded to this stud and hence it is imperative that it is connected to ground. The earth terminals are marked as ‘EARTH’ on the circuit board just above the terminals.

4.3.3 P9, Motor

P9 is used to connect the three phase output to the motor. As with P7 and P8 it uses high current screw terminals, The output phases are marked just above the terminals and should be connected to the corresponding phases at the motor.The standard connections to an SEM motor plug are phase U to pin A, phase V to pin B, phase W to pin F, and earth to pin E.

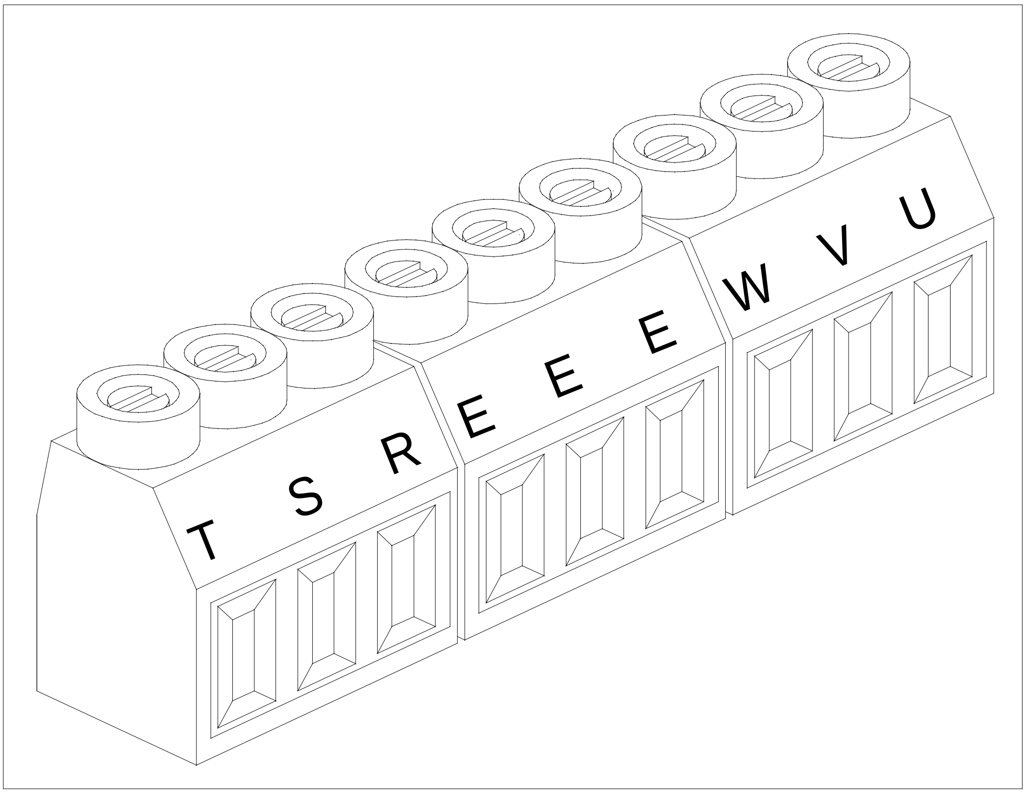

Figure 7. P7, P8, P9: power connectors

4.3.4 Wago Spring Terminals

A group of six Wago spring terminals are positioned to the left of the screw terminals. These are used to connect the auxiliary supply and an external fan.The terminals marked **R‘** and **S‘** are used to connect the single phase auxiliary supply to the Q-Drive. This supply is required if the resolver position and encoder output signals are to be maintained when the three phase supply is removed, i.e. during an emergency stop, it does not supply power to the amplifier part of the drive. There are two terminals each for **R‘** and **S‘**. It is vitally important to ensure that the same phase is connected to **R** and **R‘** and similarly that the phase connected to **S** is the same as that connected to **S‘**. A typical connection diagram is shown in Figure 10. on page 25 .

There are also a pair of terminals for the connection of an externally mounted fan, if one is used. Fans can be fitted internally and if so then the internal power connector should be used, leaving the external terminals free.

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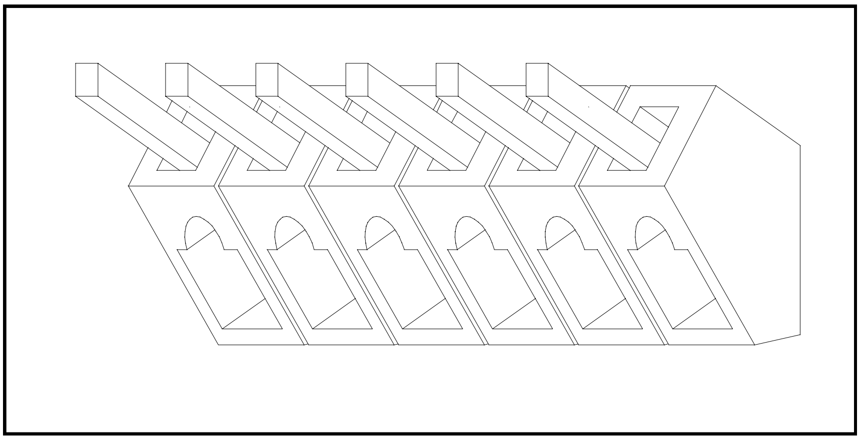

Figure 8. Wago spring terminals

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5. Electrical Installation

5.1 General

This section gives some guidelines for the electrical installation of the drive amplifier system. The diagram below shows a typical installation, and is used to highlight specific areas described in the following sections. Note that this is only a very simplified sketch, not a full installation wiring diagram. Details such as isolators, contactors and other switching arrangements are not shown but in most cases will be used. Please refer to the motor and control manufacturer's instructions for further details on electrical installation

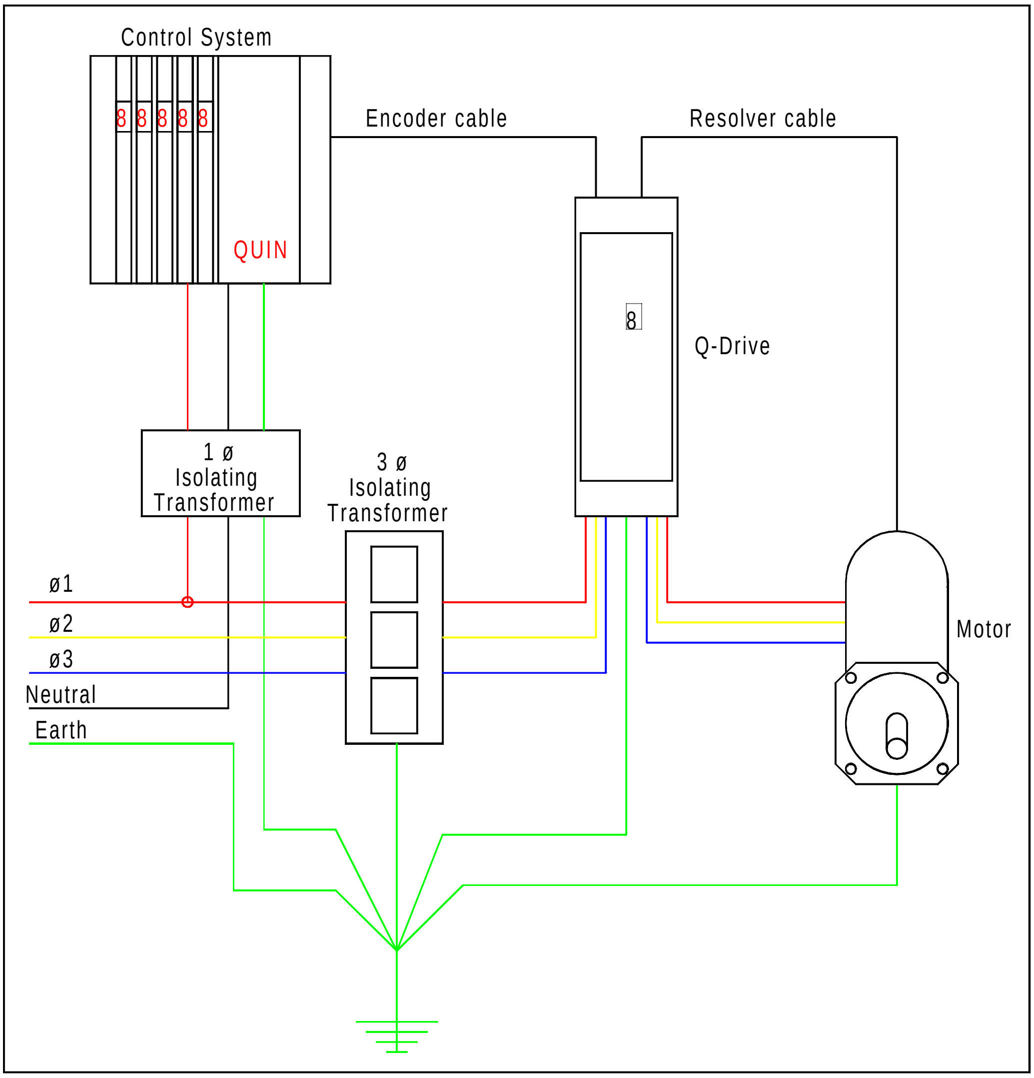

Figure 9. General installation arrangement

5.2 Mains supply

The Q-Drive can be powered from one of four sources:-

- 220V three phase supply
- Isolating transformer
- Auto-transformer.
- Single phase supply

The drives are fitted with surge limiting devices which prevent the bridge rectifier from being damaged by high inrush currents.
If the drive is to operated directly from a 220V three phase or single phase supply then a 4mH three phase choke should be installed between the supply and the drive.
The size of the mains transformer is approximately calculated from the incoming power per axis.

Mechanical power:

$$\frac{\text{Motor Torque(Nm)} \times \text{Motor Speed(RPM)}}{9550} = \text{Mechanical Power(kW)}$$

The power of the transformer in kVA should be about equal to the mechanical power if the motor efficiency is ignored.

5.3 Auxiliary Supply

A group of six Wago spring terminals are positioned to the left of the screw terminals. The first four of these (from the left) are used to connect the auxiliary supply. The terminals marked **R'** and **S'** are used to connect the auxiliary single phase supply to the Q-Drive. This supply is needed if the resolver position and encoder output signals are to be maintained during an emergency stop, i.e. when the three phase supply is removed, it will not supply power to the amplifier part of the drive. There are two terminals each for **R'** and **S'**. It is vitally important to ensure that the same phase is connected to **R** and **R'** and similarly that the phase connected to **S** is the same as that connected to **S'**. A typical connection diagram is shown in Figure 10. below.

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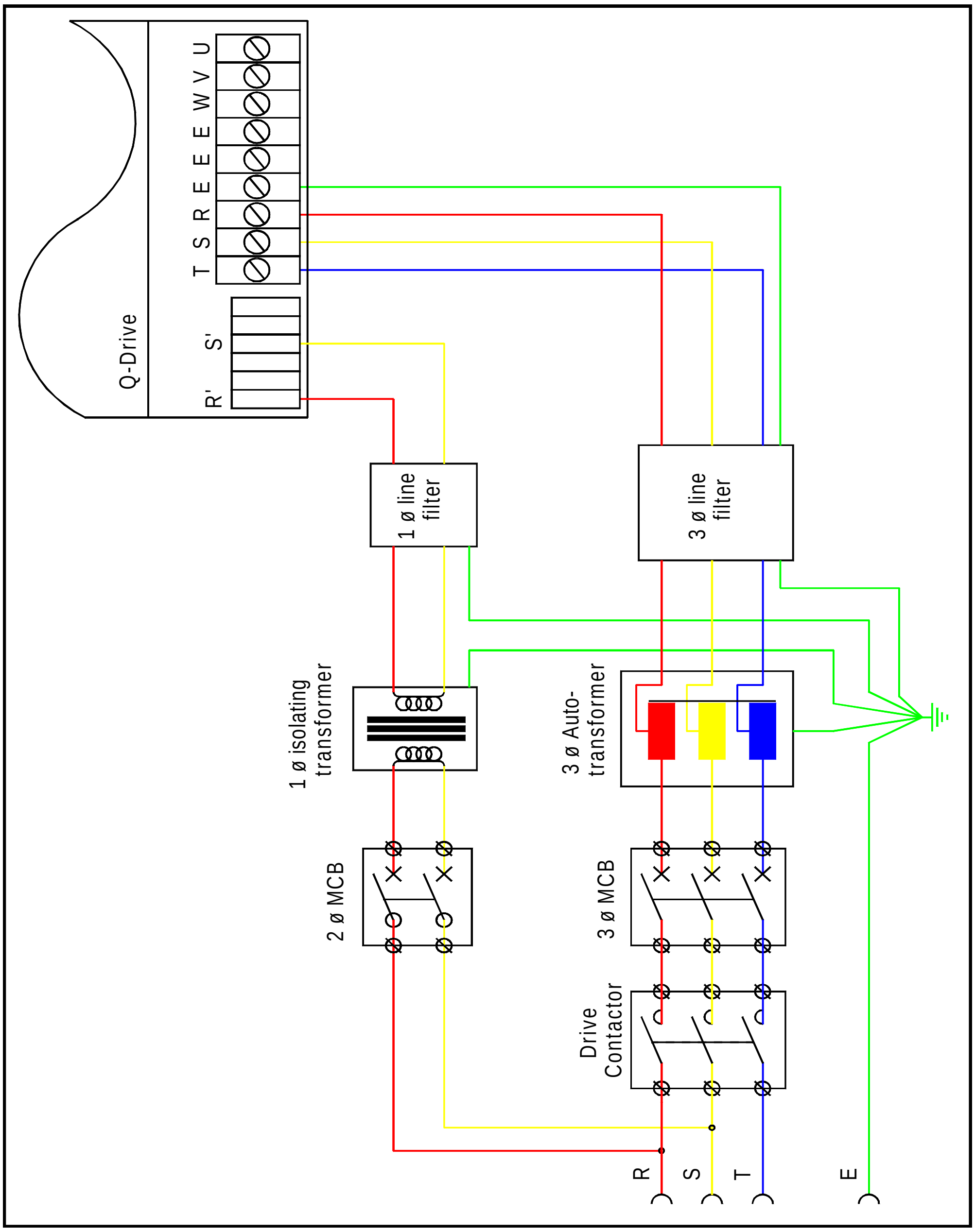


Figure 10. Auxiliary supply connection

5.4 Earth connections

Earthing is very important in any electrical installation. It is an essential safety measure to prevent electric shock in case of any failure of the equipment, and is also used for screening between different units. It provides a ground reference point for all units in the system. Incorrect earth connection can result in erratic operation due to noise or earth loops, or may prevent the system from operating at all. These problems can be avoided by careful arrangement of the earth connections, and by techniques such as isolation.

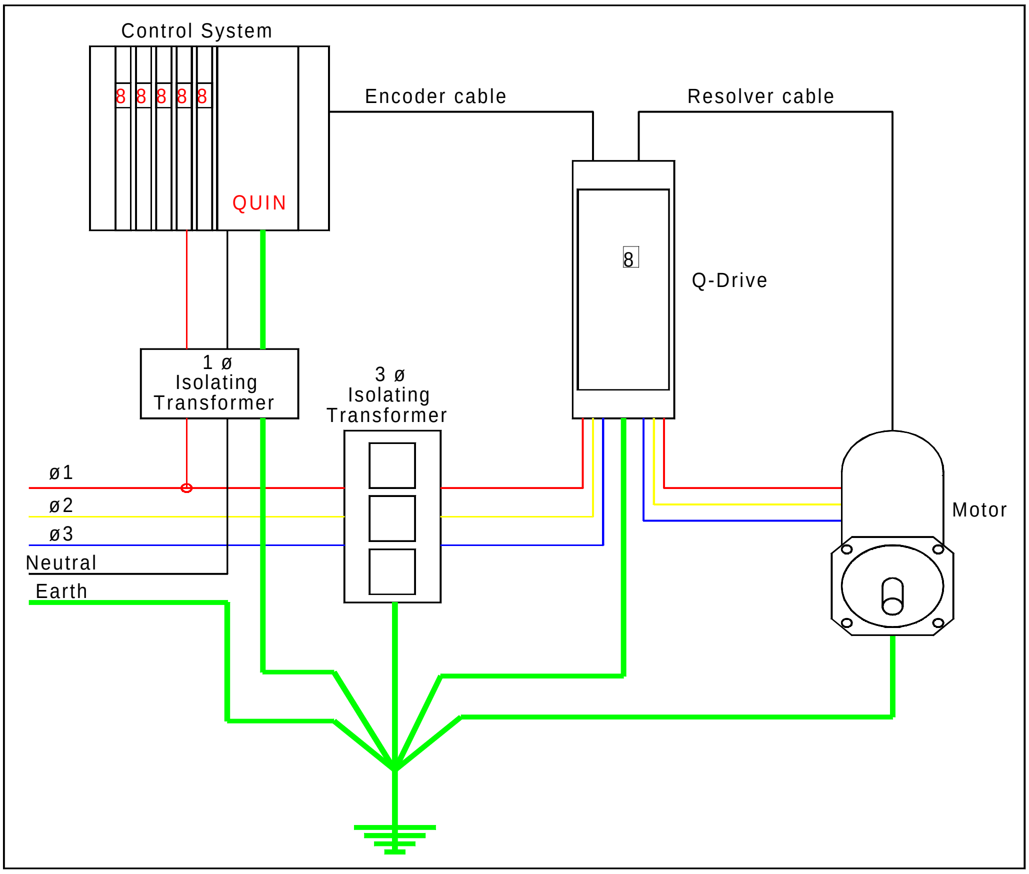


Figure 11. System earthing

- The earth connections from the isolation transformer or whatever source of supply is used should be made using a suitable gauge of wire. The IEE 16th edition wiring regulations (or appropriate local regulations) should be consulted to determine an appropriate gauge of wire for the earth bonding straps. All the earth connections should be connected together at one point, preferably on the electronics cabinet chassis earth connection.
- Do **not** tie the earth wires together with any low voltage signal cables, or run them close together in the same conduit or cable duct.
- All screened cables should have their screens connected directly to earth, not via the system 0V power supply. This is very important, as otherwise noise and transients picked up in the screen will pass through the system, instead of being dissipated directly to earth

5.5 Connecting the motor to the drive

A typical brushless A.C. motor is connected with two cables; one carries the power to the motor windings, and the other returns signals from a position or speed feedback device such as a resolver to the drive for positional speed sensing. The motor should be connected using cables as specified by the manufacturer. These cables usually have a strict specification with regard to size and length of motor connections.
In general though...

- Do **not** tie the motor cable and resolver cable together, or run them together in the same conduit or cable duct. The motor cable can carry high currents in normal operation, and the resolver cable carries low voltage signals back to the drive. The correct performance and accuracy of the motor and drive depend on the quality of the resolver signals.

- Do use a screened cable with individually screened twisted pairs for the resolver signals from the motor to the drive. This prevents crosstalk and noise interfering with the resolver signals, and gives the best performance.

- Recommended cable for motor drive power:

  RS part number **379-198**

  Recommended cable for Resolver or Encoder:

  Heidenhain cable part number **200-775-02**
  (Formerly part number 2449-5501)

5.6 Connecting the drive to the controller

The drive is connected to a Quin motion controller using usually two multicore cables and two discrete wire leads: one cable carries the analogue speed demand to the drive, and the other returns the position feedback as processed in the drive. A pair of leads connects the command to enable the drive

The analogue speed command uses a 2-core screened cable. The controller's command output for the chosen axis is connected to P10.3, with its 0 volts return to P10.4 and the screen of the cable to P10.1 - refer to table 8. A suitable screened cable is RS part number 367-325.

The encoder simulation output of the drive is connected to a Quin controller as per table 5 and figure 5, using the appropriate axis socket. The chosen axis parameters are to be set for Quadrature x 4 encoder, which is usually the default setting.

The axis enable relay output ("normally open" and "common" pins) is connected across P12.3 and P12.4, as per table 8: by default, the drive sources the 24 volts which is switched by the relay. If an external 24 volts is to be used (maybe to enable a quicker safety stopping), enable the "valid" opto isolator by removing backplane J2 links 1-2 and 3-4, then wire as per the PTS or TRC Installation Manual "typical example".

6. Safety - Using Guards and Limits

All machines should include comprehensive safety features. This is essential both for normal safety considerations, and to comply with Health and Safety requirements. It can also prevent any unwanted interference with the machine while it is running.

All moving machinery must be guarded so that it cannot be reached by anybody while in motion. The guards should be fitted with guard switches or sensors, connected so as to immediately cut power from the motors when any guard is opened. On some machines, it may be useful to lock the guards closed by means of a solenoid to prevent them from being opened while the machine is running. This allows the machine to detect any attempt to open a guard and shut down the machine cleanly before unlocking the guard and allowing it to open.

Motors which have constraints or limits on their range of motion should be fitted with hard wired limit switches. These should cut power from the motors if any motor goes outside its limits of travel. The machine must also have one or more locking emergency stop push-button switches, accessible from several positions around the machine. Anyone operating or working on the machine must be able to instantly stop the machine at any time by hitting an emergency stop switch.

There are no limit switches available on the Q-Drive but if the machine requires the use of limit switches then they may be implemented using the digital i/o functions available on the control system. If the control system is used to provide a limit switch function then this should be backed up with an mechanical switch which should cut the power to the Q-Drive.

Guards, emergency stop and limit switches may be connected into the control system motor control systems, by using the digital input lines. However, the programmable input functions on the control system should only be used in addition to the conventional hard wired guard and limit switches, not to replace them. The digital inputs can be used to trigger a smooth shutdown sequence, or to generate a limit switch error and shut down immediately. The control system can then remove power from the motors and drives if required, under software control, by using a digital output line to switch the motor supply contactors. **In all installations the limit switches and guard switches MUST remove all electrical power from the motors and drives, independently of any action of the control system.** If power is removed from the control system, then again all power must be removed from the motors. This is easily done by connecting the on board relay on each axis controller into the drive enable function, or into the control circuit for the motor and drive main contactors.

Note that in most cases, it is not necessary to remove power from the control system, only from all the high power equipment. If power to the control system and encoders can be maintained even when the motors and drives are shut down, then the system does not lose any position information. This can allow the machine to start up again much more quickly than if the control system is powered off as well, since the machine does not need to execute a complete initialisation before it can be restarted.

6.1 Choosing a motor

The choice of motor for a particular application depends on several factors. Some of these are given below.

- Maximum torque required.
- Continuous torque required (r.m.s.).
- Maximum motor shaft speed.
- Maximum acceleration rate.

The torque is the turning effort required from the motor in order to accelerate the mechanical load or system at the desired rate. It is usually measured in Newton metres (Nm), gram centimetres (gcm), pound feet (lb. ft) or ounce inches (oz. in). In order to calculate the torque required from the motor, it is necessary to find out the following information about the mechanical system.

- The reflected total inertia of the system or load, at the motor shaft.
- The reflected total friction of the load.
- The internal motor inertia and friction.
- The maximum acceleration rate of the motor.
- Any gear or pulley ratios in the mechanical system.

For example, consider a motor driving a load via a belt and pulleys. The total torque required from the motor is given by:

$$T = \left(D^{2} \qquad \right) \frac{d^2\theta}{dt^2} + \frac{D}{D_2} + F_M$$

where T = total motor torque required
D_1 = diameter of motor pulley
D_2 = diameter of load pulley
I_L = inertia of load
I_M = inertia of motor
$\frac{d^2\theta}{dt^2}$ = acceleration at motor shaft
F_L = friction torque of load
F_M = friction of motor.

In most cases, the inertia and friction can be assumed constant, unless the system has a changing load. In this case the maximum possible load should be used in the calculations. The required velocity profile of the motor should be sketched out by plotting motor velocity against time. The slope of this gives the motor acceleration, and thus the maximum required acceleration can be found from the steepest slope on the graph. This acceleration value can then be substituted in the torque equation for a given motor to see if the motor is powerful enough to do the job.

This can be repeated along the velocity-time plot for all accelerations to give a graph of torque against time. This can be used to find the average or r.m.s. continuous torque required by the system. Servo motors are often specified with both a continuous and a peak torque rating, and they should be chosen such that the torque requirement of the machine is well within the capacity of the motor. Care must also be taken to ensure that the maximum speed of the motor is not exceeded.

Note that if too large a motor is selected, the motor inertia is higher than for a smaller motor. This affects the maximum acceleration that the motor produces. It is not always the largest or most powerful motor that accelerates the load at the quickest rate. Also note that maximum power transfer from the motor into the load is obtained if the motor inertia and reflected load inertia are similar.

The ideal motor should have as high a torque to inertia ratio as possible. Pancake or printed armature motors are often used because they have low rotor inertias. This is also another advantage of brushless motors, in that they have low rotor inertias because the rotor often does not have any electrical windings but consists simply of a permanent magnet on a shaft. Brushless motors also exhibit better heat dissipation from their wound stator.

6.2 Mounting the motor

The motor must be mounted rigidly to the structure of the machine or to a solid floor. If it is not mounted securely, it may vibrate or oscillate when the motor is powered up and the position or velocity control loops closed. The motor exerts as much torque on its mountings as it does on the load. If the mountings are flexible, they may form a resonant system, with the motor supplying plenty of power to sustain severe oscillations.

6.3 Connecting the motor to the load

The motor shaft must be connected securely to the load. This may be by means of a drive shaft, a toothed belt and pulleys, or by a gearbox. In all cases the coupling between the motor and the load must be as stiff as possible, and must have minimum backlash. At the same time, care must be taken to avoid adding any unnecessary friction into the system, as this reduces the performance of the servo system.

A common problem when connecting the motor to its load is backlash. This is usually found in gearboxes, where the input gear is allowed to move by a small amount between the teeth of the output gear, while the output gear is stationary. A similar effect is seen if the motor mountings are loose or sloppy, or if the coupling between motor and load is too flexible. The effect of backlash is not just a loss of position accuracy, but may in extreme cases result in a highly unstable system. All possible precautions must be taken to minimise or eliminate backlash in the system.

7. Drive Parameters

7.1 Serial Link

The serial link is used to set or monitor drive parameters stored in non-volatile memory using the configuration program.

This program allows the user to:

- set all user adjustable parameters
- monitor inputs and fault status
- In a multi drive configuration it is possible to access all drives from a single PC without having to transfer the serial cable from one drive to another.

With the serial link connected it is possible to monitor the position of the resolver (0-1024) within one motor revolution.

Hardware:

A personal computer with either an RS422 adapter plus cable or an RS232 serial cable. The choice depends upon how the drive has been configured.

7.2 Getting Around the Configuration Program

The program **`QDRIVE.EXE`** should be installed on an IBM compatible personal computer (PC) and used to set the drive parameters and monitor the servo-amplifier status.

There are 80 parameters available on the Q-Drive that are divided up as detailed below. On the following pages are descriptions of various parameter and their range of values; parameters not described should not be changed.

0..10:	Motor parameters
11..31:	Installation parameters
32..43	
44..59:	Internal parameters (for testing)
60..63:	Parameter protection bits
64..79:	Status parameters, read only

Certain parameters only become active after they have been saved with the **`<F2>`** function key. These are denoted by an **`<F2>`** symbol in their title

Run the configuration program by typing;

`QDRIVE <Return>`

The initial screen, shown below, appears asking for the password **motor** to be entered. The program will allow changes to be made only if the password is correct, but will still run if the password is incorrect to allow parameter monitoring only.

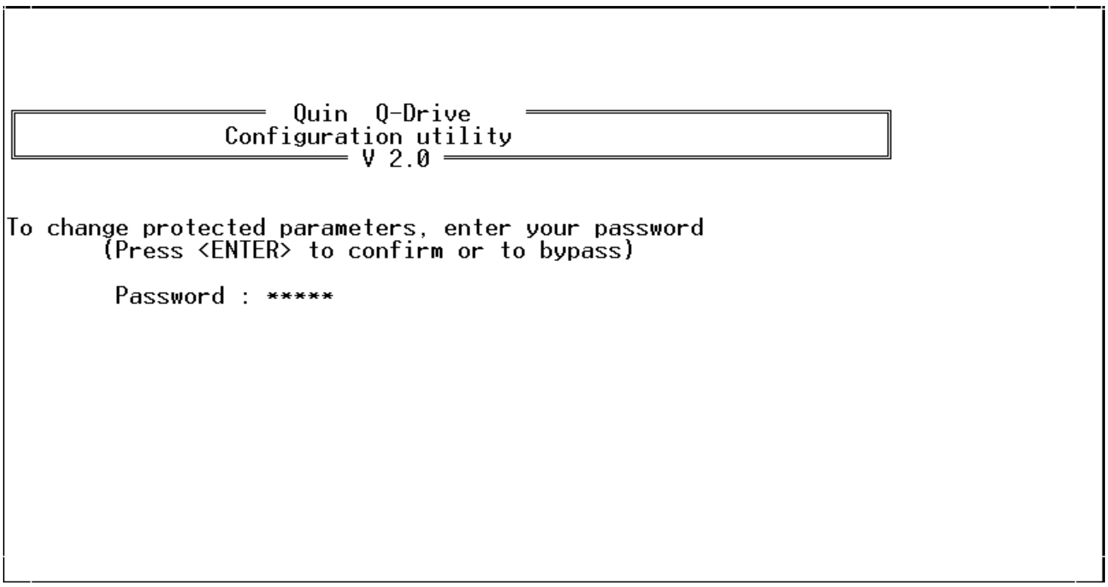


Figure 12. Q-Drive.exe: password entry page

The **`QDRIVE.EXE`** program presents the servo parameters using nine pages or screens. The first three pages involve the setup of the servo-amplifier and the absolute position of the resolver. The last page is used to monitor the inputs and alarm states. Only the parameters on the first three pages can be modified through the computer program. In order to change the parameters it is necessary to “Connect” to a particular drive. This is achieved in the following way.

1. Press the **`<F8>`** function key to put the program “On-Line”, the program will immediately start trying to communicate with drive 1.
2. If drive 1 is not connected then press function key **`<F4>`** to scan for active drives, Figure 13. on page 35 shows the program scanning for drives and finding drive 1. When the active drive has been identified use the procedure in steps 3 to 5 to connect to it.
3. To change to the required drive press and hold down the **`<Shift>`** key and then press a function key from **`<F1>`** to **`<F10>`**, this will access drives 1 through to 10.
4. To access drives 11 to 15 press and hold down the **`<Ctrl>`** key and then press a function key from **`<F1>`** to **`<F5>`**
5. When the desired drive has been selected, the message near the top of the screen will show **“`ONLINE Connected`”**

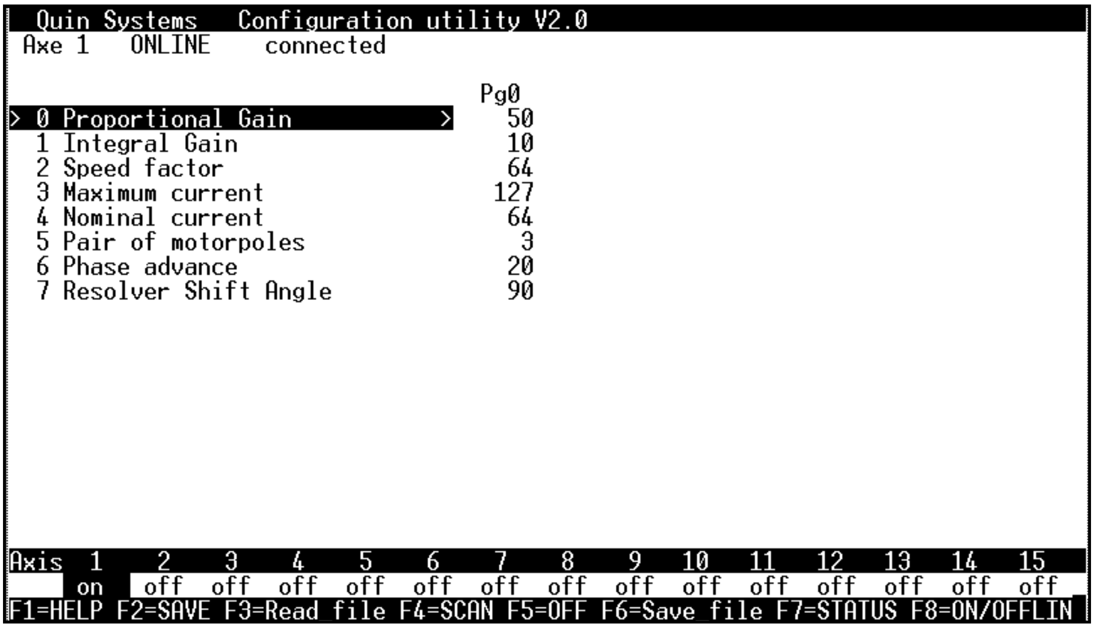


Figure 13. Q-Drive.exe: scanning for active drives

Once a drive has been connected to it, it is possible to change the various parameters available on each page. Moving around and selecting the parameters is done using the following keys:

Change Pages:
The page displayed on the computer is changed by pressing the **`<TAB>`** key. **`<Shift><Tab>`** will move backwards through the pages.

Select Parameters

The up/down arrow keys are used to select the desired parameter on each page. The selected parameter appears in reverse video, Figure 13. shows Proportional Gain as the selected parameter.

Change Values:

The plus key **`<+>`** and the minus key **`<->`** change the value of the selected parameter displayed in reverse video. It is also possible to directly enter a value from the keyboard, simply type in the new value and press the **`<Return>`** key.

Save Settings:

The **`<F2>`** key saves all settings to non-volatile (EEPROM) memory and in some cases activates the changed value.

Read File:

A file containing preset drive parameters can be downloaded to the drive using the **`<F3>`** key. Pressing this key will present the default drive parameter file name, **`QDRIVE.CFG`**, this file name can be erased and replaced with another file name.

Exit Program:

Press **<ESC>** to exit the program.

New Release:

For more information on new releases please look at the file **README.TXT**.

7.3 Page 0 Parameters

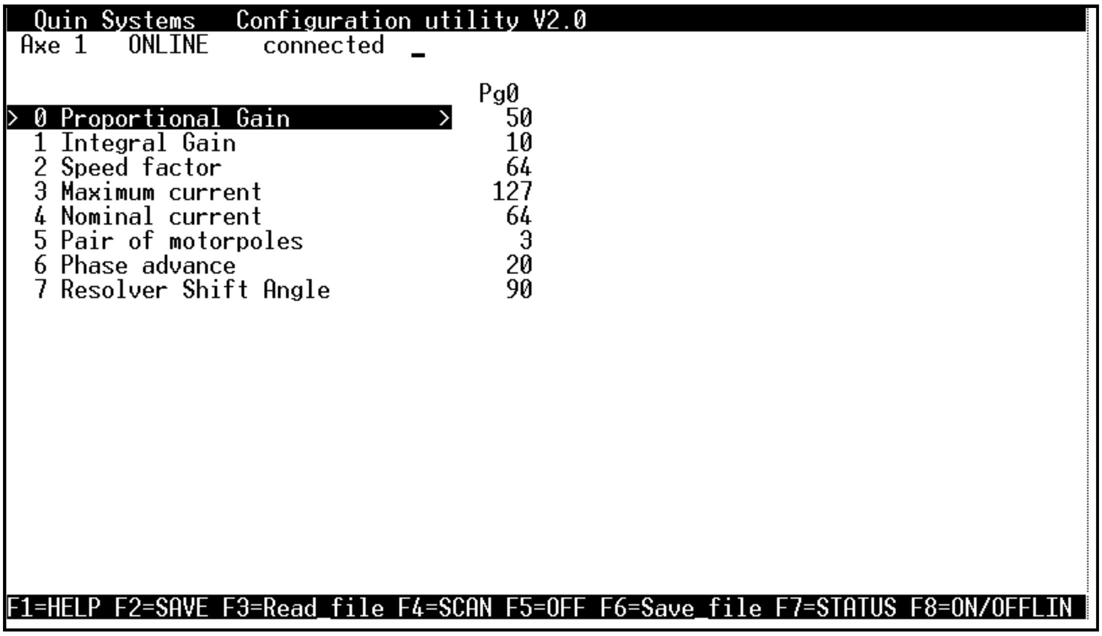


Figure 14. Q-Drive.exe: page 0 parameters.

0 **Proportional Gain: (0..127)**

1 **Integral Gain: (0..127)**

These two parameters determine the proportional and integral gain of the servo velocity control loop. They are programmable from 0 to 127. Higher values represent higher gains. The integral gain is cancelled for a value lower or equal to 3.

2 **Speed factor: (-127..+127)**

This parameter sets the maximum speed and the direction of rotation of the motor. This parameter is programmable from -127 to 127 corresponding to a speed of -6000 rpm to +6000 rpm +/- 10%.

3 **Maximum current: (0..127)**

This parameter sets the peak current delivered to the motor. This parameter is programmable from 0 to 127 (127 = maximum peak current of the amplifier shown in Table 1: on page 9.

4 **Nominal current: (10..64) <F2>**
This parameter sets the continuous current delivered to the motor. This parameter is programmable from 10 to 64

5 **Pair of motor poles: (1..6)**
This parameter sets the number of motor pole pairs for proper commutation. This parameter is programmable from 1 to 6 (number of motor pole pairs).

6 **Phase advance: (0..360)**
This parameter is used to optimize the phase advance angle for each type of motor. At max. speed (speed factor parameter = 127), this parameter can vary the phase advance angle from 0 to 360 electrical degrees.
This parameter is programmable from 0 to 360° (typical value: 20).

7 **Resolver Shift Angle: (-180..+180)**
This parameter is used to set the resolver shift angle in software to accommodate any resolver shift angle set by the motor manufacturer.
This parameter is programmable from -180 to +180 (electrical degrees).

7.4 Page 1 Parameters

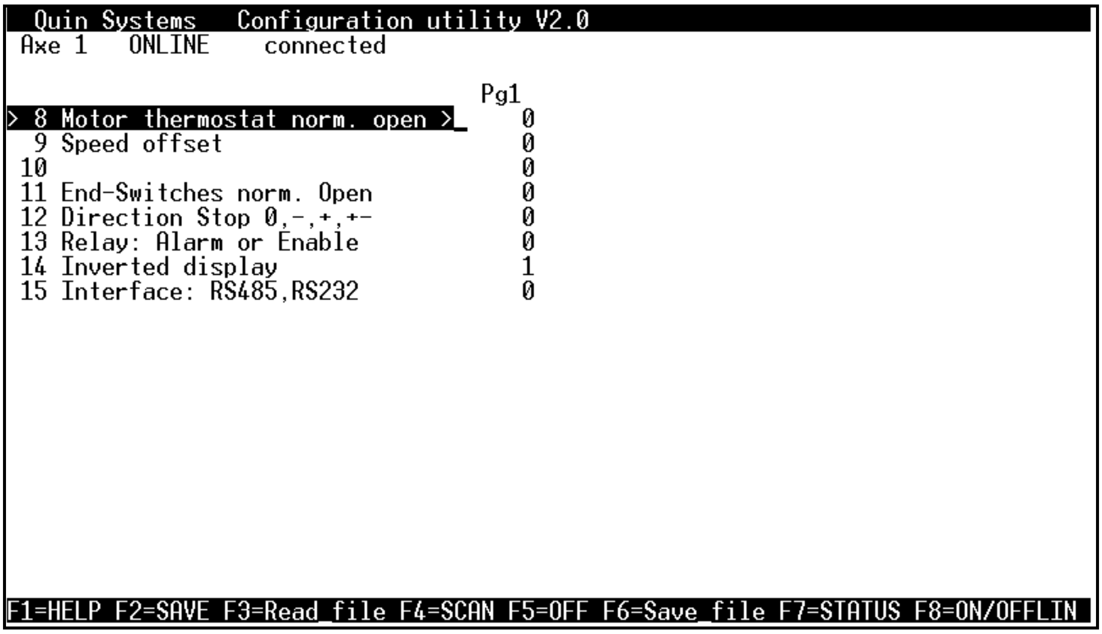


Figure 15. Q-Drive.exe: page 1 parameters

8 **Motor thermostat normally, open: (0,1)**
The servo-amplifier is set to suit the motor thermal switch type by selecting:

0: for motor thermal switch normally CLOSED (or for PTC)
1: for motor thermal switch normally OPEN (or for NTC)

9 **Speed Offset:(-127..+127)**
The setting of the servo-amplifier speed offset is done with this parameter. which is adjustable between -127 and +127.

10 Parameter not used

11 Not used on Qdrive

12 **Direction Stop: (0..3)**
This parameter is used to prevent the motor from turning in a particular direction and is setup as follows.

0:	Turns in both +ve and -ve directions
1:	Only turns in a +ve direction
2:	Only turns in a -ve direction
3:	Will not turn in either direction

13 **Relay, Alarm or Ready: (0,1)**
This parameter is used to define the function of the on-board relay:

0:	Relay is on when there are no alarms
1:	Relay is on when the drive is enabled

14 **Inverted display: (0,1)**
The 7 segment display can be inverted if the drive is to be mounted upside down.

1:	Normal display
0:	Inverted display

15 **RS232, RS422 Address: (0..17)**
This parameter is used to set the address to which the drive amplifier will respond and whether the drive is using RS232 or RS422 communications. For use with an RS422 interface the drive can be set to read the address from the Q-Drive backplane or be set to address 1. For use with an RS232 interface it can be set to read the address from the Q-Drive backplane or set to an address in the range 1 to 15:

0:	RS422	Read address from backplane
1..15:	RS232	Address 1..15
16:	RS232	Read address from backplane
17:	RS422	Set to address 1

7.5 Page 2 Parameters

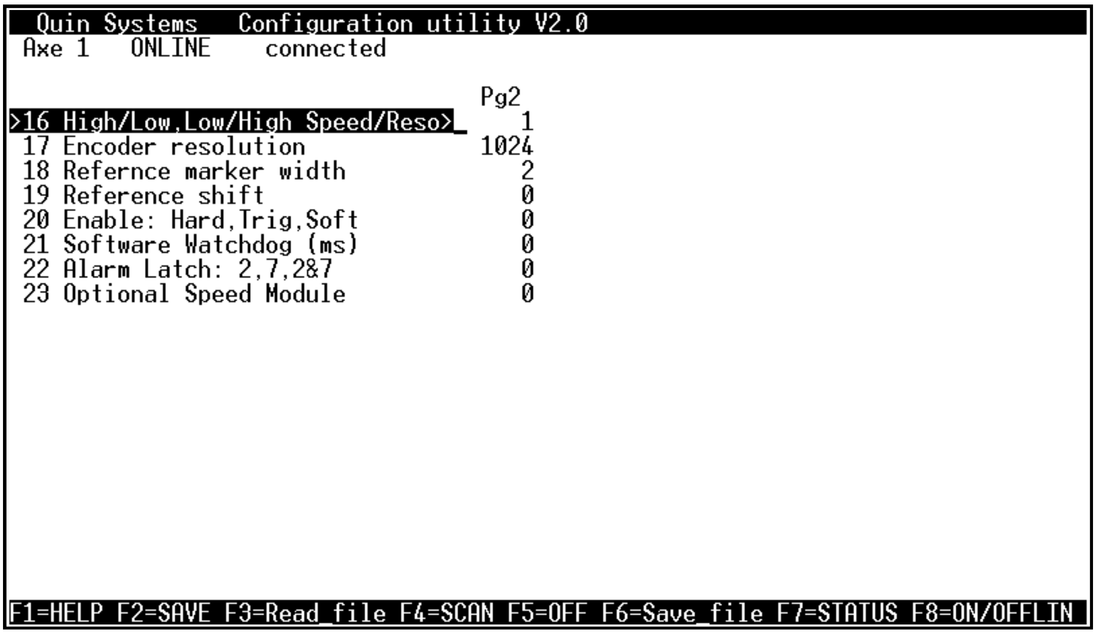


Figure 16. Q-Drive.exe: page 2 parameters

16 **Speed/Resolution: (1,2) <F2>**
This parameter selects one of two maximum motor speeds in order to enable the servo-amplifier for the appropriate encoder resolution range.
The limits are:

1:	Max. speed = 3500 rpm	Max. resolution = 1024 ppr
2:	Max. speed = 6000 rpm	Max. resolution = 512 ppr

NOTE. The encoder simulation will not work if the encoder simulation is set to 1024ppr and the maximum speed is set 6000rpm

17 **Encoder Resolution: (1..1024) <F2>**
This parameter selects the number of pulses generated by the encoder simulator and can be set anywhere in the range 1 to 1024.

18 **Reference Marker Width: (0..2) <F2>**
This parameter selects the width of the simulated encoder marker pulse (Z pulse) relative to the width of the A channel period. The following values are available: 1/4 , 1/2 and 1 and are set up as follows

0:	1/4 pulse width
1:	1/2 pulse width
2:	1 pulse width

19 **Reference shift: (-512..+512) <F2>**
This parameter is used to shift the simulated encoder reference marker pulse by +/- 180° relative to the null position of the resolver. It is programmable over a range of, 512 (-180°) to +512 (+180°).

20 **Enable: Hard, Trig, Soft**: (0..2) **<F2>**
This parameter defines the way in which the amplifier is enabled. The first setting, “Hard”, means that the amplifier can only be enabled using the external contacts available at P12 pins 3and 4. The second setting, “Trig”, means that the amplifier has to be hardware enabled as in setting 1 above and then software enabled using the **<F5>** key. If at any time the amplifier becomes disabled e.g. because of a motor fault then the <F5> key will no longer work until the hardware enable has been reset, i.e. removed and then replaced. The third setting “Soft”, allows the amplifier to be enabled and disabled using the <F5> key, the hardware enable needs to be set all of the time for this function to work.

0: Hard
1: Trig
2: Soft

21 **Software Watchdog: (0..65535)**
The value set in the watchdog parameter determines the time in milliseconds which the amplifier will wait after the QDRIVE.EXE goes off-line or is disconnected before reporting error code 9 and disabling the motor. The watchdog is only active when the drive is enabled. Setting this value to 0 will disable the watchdog

22 **Alarm Latch 2,7,2&7: (0..3) <F2>**
This parameters determines how the amplifier treats the Over current (I^2t) and Under voltage alarms, i.e. whether or not they are latched.

0: Neither alarm latched
1: Over current alarm latched
2: Under voltage alarm latched
3: Both alarms latched

23 Optional Speed Module

7.6 Page 3 parameters

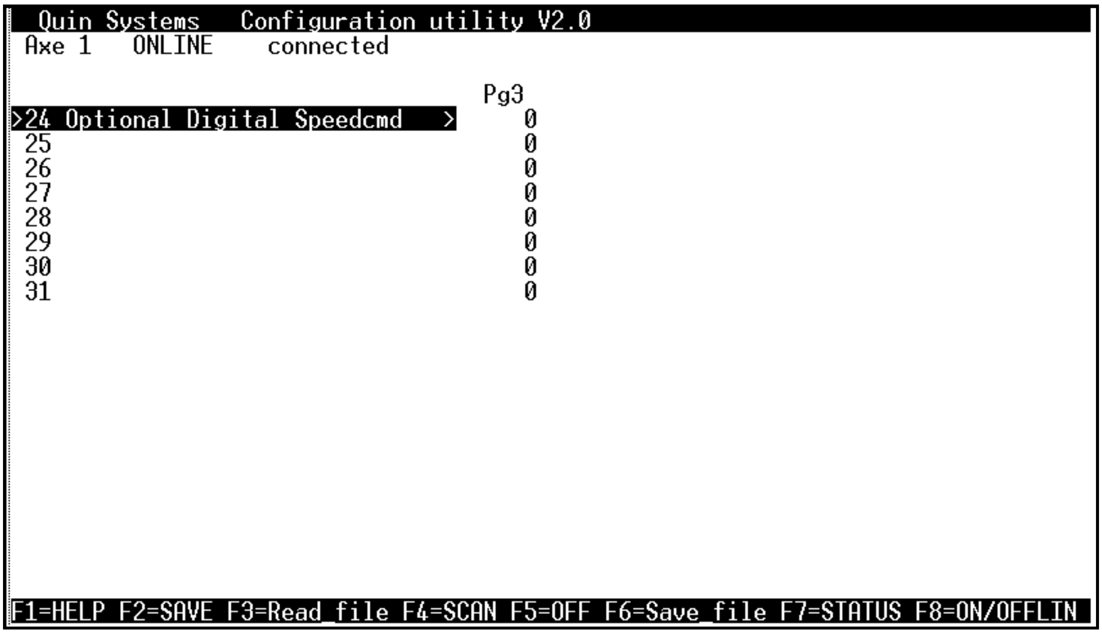


Figure 17. Q-Drive.exe: page 3 parameters

24 to 53: Not used

7.7 Page 6 parameters

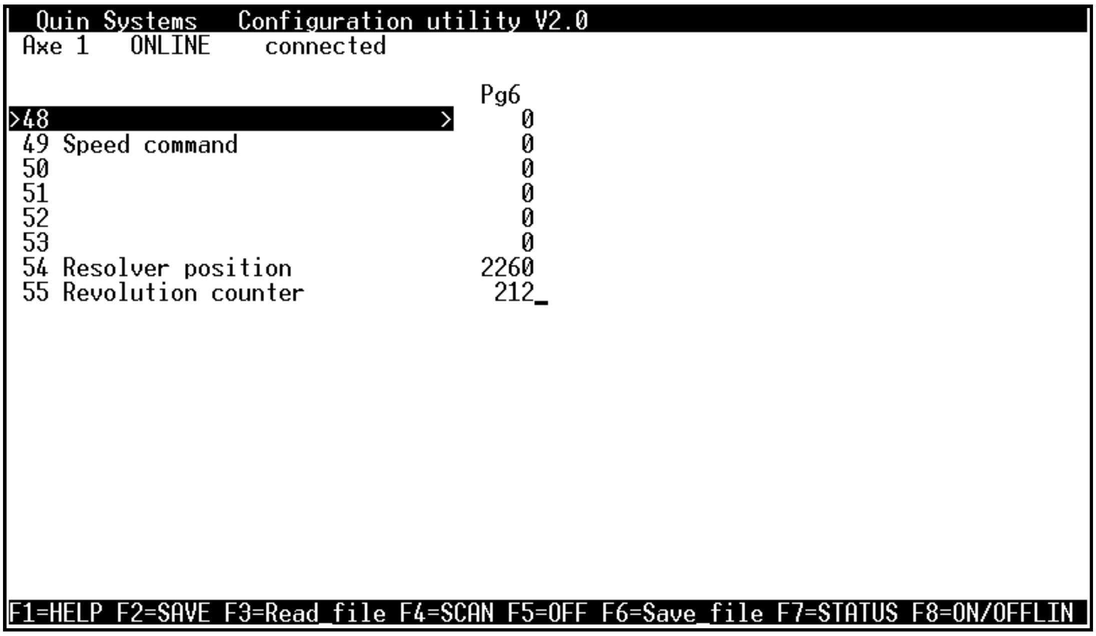


Figure 18. Q-Drive.exe: page 6 parameters

The parameters on Page 6 are Read only and as such cannot be changed.

54 **Resolver position**
The resolver position is a 12 bit value of the current resolver position within one rotation.

55 **Revolution counter**
The revolution counter is a 24 bit count of complete resolver revolutions. This value can be used with the **resolver position** to effectively produce an absolute encoder.

7.8 Page 8 parameters

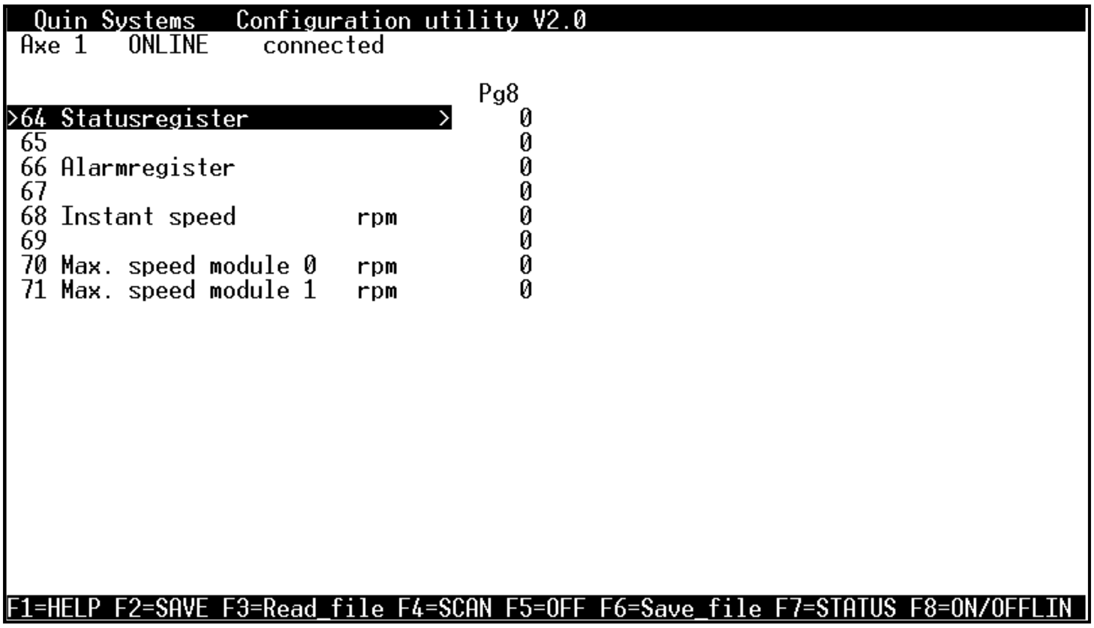


Figure 19. Q-Drive.exe: page 8 parameters

The parameters on Page 8 are Read only and as such cannot be changed.

7.9 Page 9 parameters

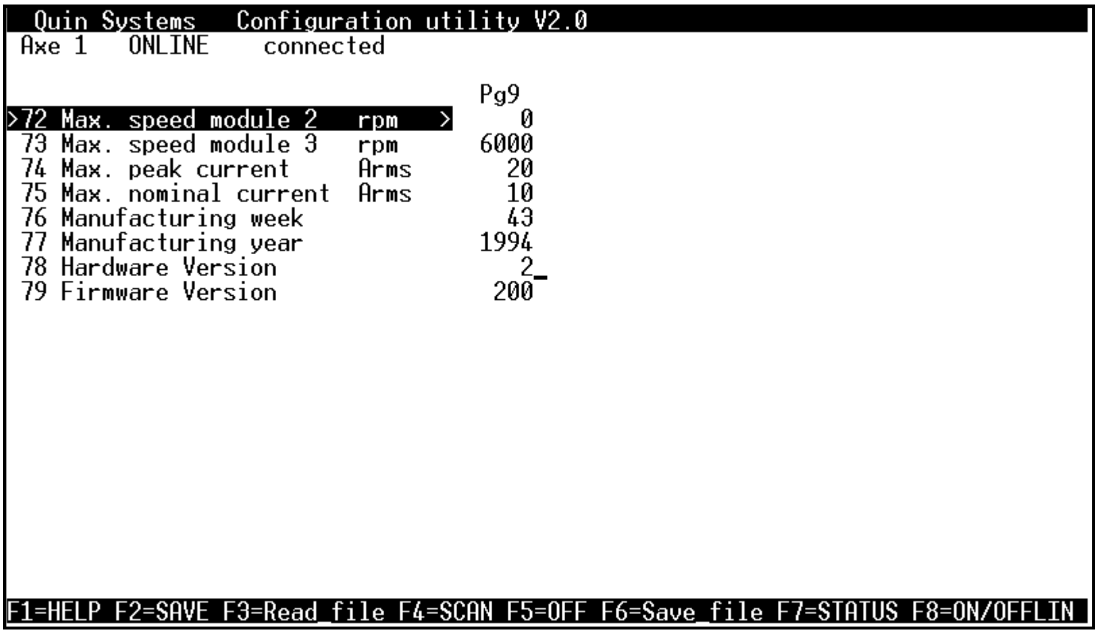


Figure 20. Q-Drive.exe: page 9 parameters

74 **Max Peak Current (0..127):**
This parameter defines the maximum peak current that the drive will deliver to the motor

75 Max Nominal Current (0..127):
This parameter defines the maximum nominal current that the amplifier will deliver

76 Manufacturing week:
The week number in which the drive amplifier was manufactured.

77 Manufacturing year:
The year in which the drive amplifier was manufactured.

78 Hardware Version:
The hardware version number or revision number of the drive amplifier.

79 Firmware Version:
The firmware or EPROM revision number.

7.10 Status & Alarm page

```
 Quin Systems   Configuration utility V2.0
 Axe 1   ONLINE    connected
     S T A T U S  &  A L A R M S
                          STATUS ALARM
 Earth Default              OFF   OFF
 EEPROM fault               OFF   OFF
                            OFF   OFF
                            OFF   OFF
 Resolver fault             OFF   OFF
 RDC fault                  OFF   OFF
 Battery undervoltage       OFF   OFF
 Software Watchdog          OFF   OFF
 Endswitch 1                OFF   OFF
 Link Motor fault           OFF   OFF
 I2t reached                OFF   OFF
 Torque Enable Input        OFF   OFF
 Motor Thermostat           OFF   OFF
 Heatsink Thermostat        OFF   OFF
 Endswitch 2                OFF   OFF
 Power Fault                OFF   OFF
Nr of turns      D4 Resolver pos     8D4
Speed   RPM       0 Pos 24bits      $0D4954

F1=HELP F2=SAVE F3=Read_file F4=SCAN F5=OFF F6=Save_file F7=STATUS F8=ON/OFFLIN
```

Figure 21. Q-Drive.exe: status display

Pressing function key **<F7>** from any of the nine pages will bring up the status page as shown above. This page gives a continually updated display of all alarms and the current status of the drive and is particularly useful whilst commissioning the drive. Whilst this page is displayed it is possible to change from one drive to another to obtain the new drive's current status. If a non existent drive is selected, i.e. drive 6 in a 5 drive system then the display will continue to show the previous drive's values except for the top line which will show

"Axe 6 ONLINE no connect"

i **Earth Defect:-**
If the optional Earth Fault module is fitted and the Q-Drive is supplied from an Auto-transformer then this alarm indicates a problem with the amplifier earthing

ii **EEPROM Fault**
The amplifier has been unable to read data from the EEPROM non-volatile memory or the data is corrupt

iii **Resolver Fault**
The resolver or the connections to it are faulty and the system can no longer read the resolver.

iv **RDC Fault**
The part of the system designed to convert the resolver signals into digital signals is faulty.

v Battery Under voltage
The backup battery voltage is too low to reliably maintain the system in the event of a power failure.

vi Software Watchdog
Software watchdog has tripped, this usually means that the processor has stopped running or it is stuck in a perpetual loop.

vii End Switch 1
This alarm cannot occur in the Q-Drive as it does not support end switches.

viii Link Motor Fault
Failure in the wiring from the amplifier to the motor.

ix I^2t reached
The amplifier has reached it's power limit, if the control system is trying to push the amplifier harder

x Torque Enable Input
This will show ON when the drive is enabled and OFF when the drive is disabled.

xi Motor Thermostat
The thermostat built into the motor has tripped, the motor should be shut down and allowed to cool.

xii Heatsink Thermostat
The amplifiers built-in heatsink has overheated, the amplifier should be switched off and allowed to cool. The optional fans should be fitted into the Q-Drive enclosure if the fault occurs on a regular basis.

xiii End Switch 2
This alarm can not occur in the Q-Drive as it does not support end switches

xiv Power Fault
The power amp section of the Q-Drive has developed a fault and can no longer reliably drive the motor.

This Page is intentionally Left Blank

8. Switching On

Preparation of AC Brushless servo motors and servo-amplifiers requires a little more attention than that of DC servo-drives. We recommend that switching on for the first time is done according to the following instructions.

8.1 Switching the Servo-Amplifier On Without a Motor

The first time the amplifier is switched on the enable contacts (connector P12 pins 3 and 4), should be open circuit. This will disable the power stages of the amplifier. The resolver should be connected to the servo-amplifier and some method of reading the encoder output, i.e. a Quin PTS system, should also be connected.

The three-motor phases must not be connected to the servo-amplifier.

8.2 Checking LEDS and 7 segment display

LED

"OVER I" red LED normally off

This LED lights up during a short-circuit between two motor phases or a power stage fault.

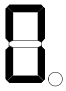
The state of the LED and the output stage inhibit are latched. To clear a latched fault it is necessary to cycle the power. If the power is cycled, ensure that at least 30 seconds is allowed between switching off and switching back on. If this delay is shortened then it is possible that the residual power in the smoothing capacitors will hold up the amplifier control circuits and the alarm latch will not be cleared.

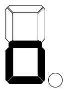
"Braking" yellow LED normally off

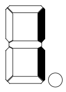
This LED lights up when the braking module operates. This is a non latching alarm and it is quite normal to see this LED illuminate particularly under fast braking conditions with a heavy load.

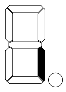
8.3 7 segment display on the front panel

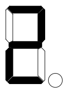
This display shows the state of the servo-amplifier and motor. The alarm d has the highest priority (following C, 7, 6, 5 etc.). If some alarms take place simultaneously, only the one with the higher priority will be displayed. A alarm reset is only possible by switching off the servo-amplifier supply.

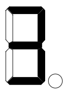

Servo-amplifier powered on
and enable contact closed

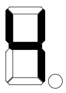

Servo-amplifier powered on, enable
contact closed and motor at zero position

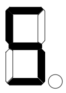

Servo-amplifier powered on
and enable contact open

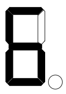

Servo-amplifier powered on, enable
contact open and motor at zero position

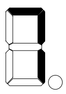

Continuous current limit reached

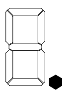

Motor over temperature fault (alarm latched)

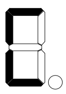

Amplifier heatsink over temperature fault.
Alarm latched


Resolver digital converter not functioning.
Alarm latched


Resolver feedback fault.
Alarm latched


Power amplifier section faulty.


Decimal point displayed with any other
display to show clockwise motor rotation.


Motor connection failure

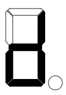

Ground fault detected.
only if option fitted

Figure 22. Seven segment display codes

8.3.1 Checking the electrical rotation sense of the resolver

The decimal point of the 7 segment display lights up when the motor shaft is turned clockwise.

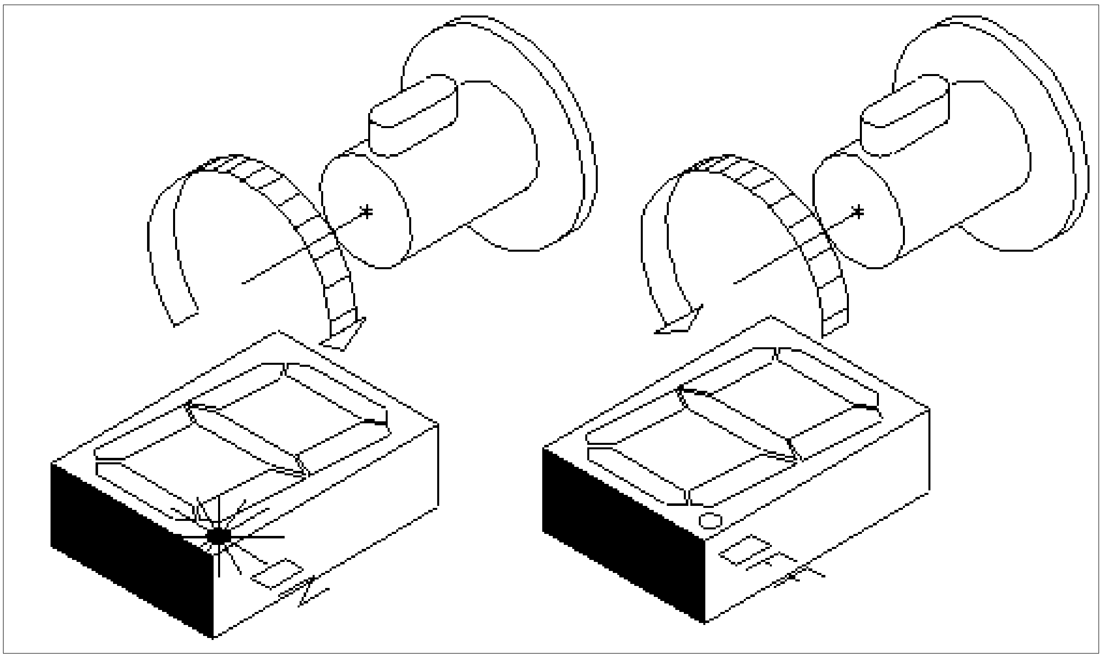


Figure 23. Electrical rotation sense of the resolver

If the decimal point lights up during anti-clockwise rotation, connections to the upper half of connector P2 pin 7 (COS1) and pin 6 (COS2) must be reversed.

8.4 Determining the motor phases

This operation must only be done when the three-phase motor order is unknown (motor prototype or no documentation).
It is necessary to have a DC supply of about 3A. and of sufficient voltage to move the motor but not in excess of the motor rated voltage.

The procedure is as follows:

1 Define arbitrarily the Phase **U** as one of the 3 motor phases.

2 Connect **U** to **“+”** and a **2nd phase** motor to **“-”** of the DC supply.

3 Switch supply on. The shaft will move to a stable position.

4 Mark the new shaft position with a pencil, at top dead centre.

5 Disconnect the “-” of the supply from the **2nd phase** of the motor and

6 connect the “-” to the **3rd phase** motor. Observe the axis rotation direction.

7 Mark with a pencil the new shaft axis position.

With the help of the table below, determine the 2 unknown motor phases.

sense of axis rotation	2nd phase	3rd phase
clockwise	V	W
anti-clockwise	W	V

Table 9: Motor Phase Determination

8.5 Switch the Servo Amplifier on with a Motor and Optimization

8.5.1 Preparation before switching the mains voltage on

a) *Disconnect motor from the machine.*
The 3 phases motor should be again connected to the servo-amplifier. Check if the axis is stopped and release the motor brake.

b) Check the following connections:

- motor cable to the backplane
- resolver cable is plugged into P2 (Upper)
- control signals connected to P10 pins 3 and 4, +ve to pin 3, 0v to pin 4.
- enable contact connected to P12 pins 3 and 4.

c) Reduce the maximum current setting of the servo-amplifier using the Q-DRIVE software. Save this value using the key < F2 >.

d) Set the proportional and integral gains to 25 and 10 respectively. Also set the resolver shift angle to 90 degrees. Save these values using the < F2 > key.

e) Open the enable contact connected on P12 pins 3and 4.

8.5.2 Switching the mains voltage on

a) Switch on the amplifier.

b) The 7 segment display should indicate “1”.

c) Set a positive speed voltage (about 1 V) to the servo-amplifier and close the enable contact. The 7 segment display should now show “0”.

d) Increase the **max. current** parameter until the motor starts running.
If the motor doesn't turn or turns very slowly, check the state of the motor brake if fitted.

e) Reverse the polarity of the speed command and check that the motor turns in the reverse direction.

f) Set the **max. current** parameter to the initial state.
Save the **max. current** using the key **<F2>**.

8.6 Compensating the speed controller

Optimizing the performance of the motor over the whole speed range can be achieved by adjusting the drive amplifiers **Proportional Gain** and **Integral Gain** parameters. Connect a Personal computer to the amplifier and run the **QDRIVE.EXE** configuration program:

a) Set the value of both proportional (KP) and integral (KI) gain to a value of 10, this represents a very low gain setting.

b) Connect an oscilloscope between measuring points on J1, pins 9 and 10, pin 9 is signal and pin 10 is ground.

c) Switch on the servo-amplifier and close the enable contact.

d) Apply a low command speed voltage (<100 m V)

e) Increase the value of the **Integral Gain** parameter whilst ensuring that the following factors are maintained:

- i good static torque
- i smooth shaft rotation

f) Apply a step function of 2 volts to the command input and monitor the response of the drive using an oscilloscope. One of the three following results will occur:

- i The signal shows several oscillations, this means the system is under damped, in this case increase the **Proportional Gain** value
- ii The motor is noisy, this means that the motor is over damped, in which case decrease the **Proportional Gain** value
- iii The signal shows only one small overshoot, this indicates critical damping has been achieved and therefore the speed loop overshoot is optimized

g) When the **f iii)** condition is achieved, save the gains obtained with key **<F2>**.

8.6.1 Offset and speed compensation

a) **Offset compensation**

The setting of the servo-amplifier speed offset is done with the **offset control** parameter in the **QDRIVE.EXE** software.
The setting of the offset can be done with or without the position controller. If a position controller, such a Quin PTS unit, is used then all of the controller gain parameters must be set to zero. Having set the controller gain parameters to zero enable the controller output and adjust the servo-amplifier offset compensation value until the motor stops moving. There will probably be a range of values where the motor appears to be stationary, find the limits of this range and set the value to the mid point. To set the offset value without a controller attached then short out the command input terminals and adjust the offset value. Again there will probably be a range of values which result in

the motor remaining stationary, find the limits of the range and set the value to the mid point.
Press the **< F2 >** key to save this value.

b) **Speed compensation**
The **Speed factor** parameter allows adjustment of the motor speed from -6000 rpm to + 6000 rpm.

Press the **<F2>** key to save this value.

8.7 Trouble Shooting

The following table shows the most frequent troubles and their causes.

No	Trouble	Possible cause
1	LED "OVER I" switched on	short-circuit between 2 motor terminals
2	Display 2	limit of continuous current reached - **Resolver Shift Angle** parameter incorrect
3	Display 3	motor overloaded - badly wired or loose connection of wires for motor thermal switch
4	Display 4	servo-amplifier overloaded - cooling fan failure
5	Display 5	resolver conversion circuit failure - **Resolver Shift Angle** parameter incorrect
6	Display 6	resolver failure - resolver wiring failure
7	Display 7	appears with OVER I LED - brake fuse failure or missing - appears in case of over-voltage or supply missing
8	Display C	motor connection failure
9	Display d	detection of a motor ground defect (option) with auto-transformer
10	Motor doesn't turn. Display shows 0 when speed command is applied	- max. current of servo-amplifier limited too low - motor brake engaged - speed reference short-circuited by **REF** Jumper
11	Motor rotation is not smooth	**Motor pole pairs** parameter incorrect - Motor wiring on terminal U, V, W not in the correct sequence
12	Motor turns in wrong direction	Command signal is wired incorrectly, Reverse connections to PP10.3 and P10.4 and change the setting of jumper J3.

Table 10: Q-Drive Trouble Shooting

9. Testing the System

9.1 General

This section describes some simple test procedures for some parts of the Q-Drive systems. These do not comprise a full system test, but may be useful to verify the basic operation of the system, the motor and the encoder.

All these tests require the use of a personal computer with a serial port, preferably RS422. Most test can be carried out on the PC but additional test equipment may be necessary. The test are given in a logical sequence i.e. it is not possible to check the resolver interface if the Serial communications do not work and the encoder simulator will not generate signals until the resolver interface works.

9.2 Serial port

The serial port only transmits data after it receives a request from the **QDRIVE.EXE** software, this means that it is necessary to connect a personal computer (PC) and run the **QDRIVE.EXE** software in order to test the serial port. Ensure that the program is requesting data from the axis number which the drive is set to, i.e. if the drive is set to address 7 then the program should request data from axis 7. If the serial communications are working correctly then the program will display the line:

"Axe 7 ONLINE"

Press the **<F2>** key this should make the 7 segment display on the front of the drive flash. If there is no response from the drive then check the connections between the PC and the drive. If there is still no response from the drive then check the serial data signals using a data analyser or an oscilloscope, to verify whether the drive is actually responding to the characters being sent to it. The serial data analyser should be set for 9600 Baud, 8 data bits, no parity and 1 stop bit.

9.3 Resolver Interface

Connect a resolver to the drive and monitor the "Resolver Position" read out on page 6 of the QDRIVE.EXE program whilst turning the shaft of the resolver. If this does not produce an updating display every time the resolver shaft is moved then the drive will need to be returned to Quin Systems Ltd. for repair.

9.4 Encoder Simulator

The operation of the encoder simulator can be checked using a control system such as a Quin Systems PTS unit. Connect the encoder output of the drive to the encoder input on a PTS system and switch on both the drive and PTS system. Using a terminal connected to the PTS type the command **"DM"** and then turn the shaft of the motor.

Whilst monitoring the second column of data turn the shaft in one direction, this should produce positional data climbing in a positive or negative direction, turning the shaft in the opposite direction should take the data back to zero and then climbing in the opposite direction.

If the encoder position counts up and down by only one count, then one of the two phases of the encoder signals is not being detected. If the encoder position value does not change at all, then either or both phase signals are missing. If the position tends to count either up or down whichever direction the shaft is turned, then the track A and B signals are mixed up with their complementary signals, such that instead of the system receiving two signals in quadrature, it always receives two signals in opposite phase regardless of the shaft direction. These problems can be confirmed by monitoring the encoder signals with an oscilloscope.

10. Configurations

10.1 General

This section gives details of the configuration options on all the drive boards used in the Q-Drive range of servo amplifiers, although the settings are not normally changed. The amplifiers are set up as described below when shipped.

10.2 Resolver Ratio

The ratio and the amplitude to the primary of the resolver are determined by resistors RSIN, RCOS and RREF.
Standard fitting:
RSIN = RCOS = 0 (bridge) for a resolver ratio of 2:1
RREF = 12 k ohm to obtain 4V $_{eff}$ to the resolver primary
Special cases:

Use the following formula: $Rref = \frac{88}{Vref} - 10$

Where: - RREF is expressed in k ohm

where: -Vref is rms voltage applied to the primary of the resolver.
Vref max. = 6 V
To calculate the values of Rsin and Rcos use the following formula, where Rcos and Rsin are expressed in k ohm

$$Rsin = \quad = \frac{4400 \times Kr}{10 - Vref} - 100$$

Kr is the resolver ratio
(Resolver ratio 2 : 1 corresponds to Kr = 0,5)

10.3 Amplifier Configuration

The location of the solder bridges and jumper links used for configuration and the fuse locations is given in Figure 26. on page 64 .

Name	Element	Function
SAD	Solder bridge	**1-2**: analogue command voltage (default) **2-3**: numeric command voltage through RS 232 serial link or through synchronous link (option)
VITCRT	Solder bridge	**1-2**: speed regulation (standard) **2-3**: current regulation
BD1 BD2	Solder bridge	RS 232 serial link baud rate: only BD2 soldered: 9600 Bd (default) only BD1 soldered: 19200 Bd
BD3 BD4 BDOUT	Solder bridge	Synchronous link (option): only BD3 and BDOUT soldered: internal clock at 38400 Hz only BD4 soldered: external clock
INCABS	Solder bridge	**2-3**: encoder simulation available at the encoder output connector (default) **1-2**: absolute position available through the serial link (option)

Table 11: Amplifier Configuration

10.4 Servo-amplifier fuses

The following fuses are factory fitted on all Q-Drive units, the location of the fuses can be found in Figure 26. on page 64

Servo-amplifier type	QDV-1-6	QDV-1-10	QDV-1-18
DC-BUS	10 AT	15 AT	20 AT
Braking module	4 AF	5 AF	8 AF
Supply	1 AT	1 AT	1 AT

Table 12: Amplifier Fuses

DC-BUS Fuse (F1)

“Littlefuse 326" are used on the DC-BUS. Dimensions: 6,3 x 32 mm.

Braking module fuse (FFR)

For units type QDV-1-6, “Wickmann 19194" type fuses are used.
Dimensions: 5 x 20 mm.

For unit types QDV-1-10 and -18, “Littlefuse 314" type fuses are used.
Dimensions: 6,3 x 32 mm.

Supply fuse(FHT)

All QDV-1 drives use a 20mm fuse

Warning:

Blown fuses should only be replaced with the same type and rating fuse and only after the fault has been corrected. This work should be undertaken by qualified personnel.

10.5 Backplane configuration

The various jumpers available on the Q-drive backplane are detailed in Table 13: below. Figure 24. on page 61 shows the jumpers in their default positions

Name	Jumper	Function
Test points	J1	**1**: Not used **3**: Not used **5**: ISMO **7**: COMO **9**: VEMO **2, 4, 6, 8 & 10**: Gnd connection
"Valid" by-pass & RS422 terminators	J2	**1-2**: By-pass "Valid" opto isolator.(Default) **3-4**: 0V connection when "Valid" is by-passed.(Default) **5-6**: RS422 transmit terminator.(Default) **7-8**: RS422 receive terminator.(Default)
Ground reference	J3	**1-2**: "S-" differential input connected to 0V (P10-4) (Default) **2-3**: "S+" differential input connected to 0V(P10-3)
Address range	J4	**1-2**: Address range 1 to 15 (Default) **2-3**: Address range 16 to 31
Tx inversion	J5	**1-3 & 2-4**: Tx and /Tx non-inverted (Default) **1-2 & 3-4**: Tx & /Tx inverted
Rx inversion	J6	**1-3 & 2-4**: Rx and /Rx non-inverted (Default) **1-2 & 3-4**: Rx & /Rx inverted

Table 13: Backplane configuration Jumpers

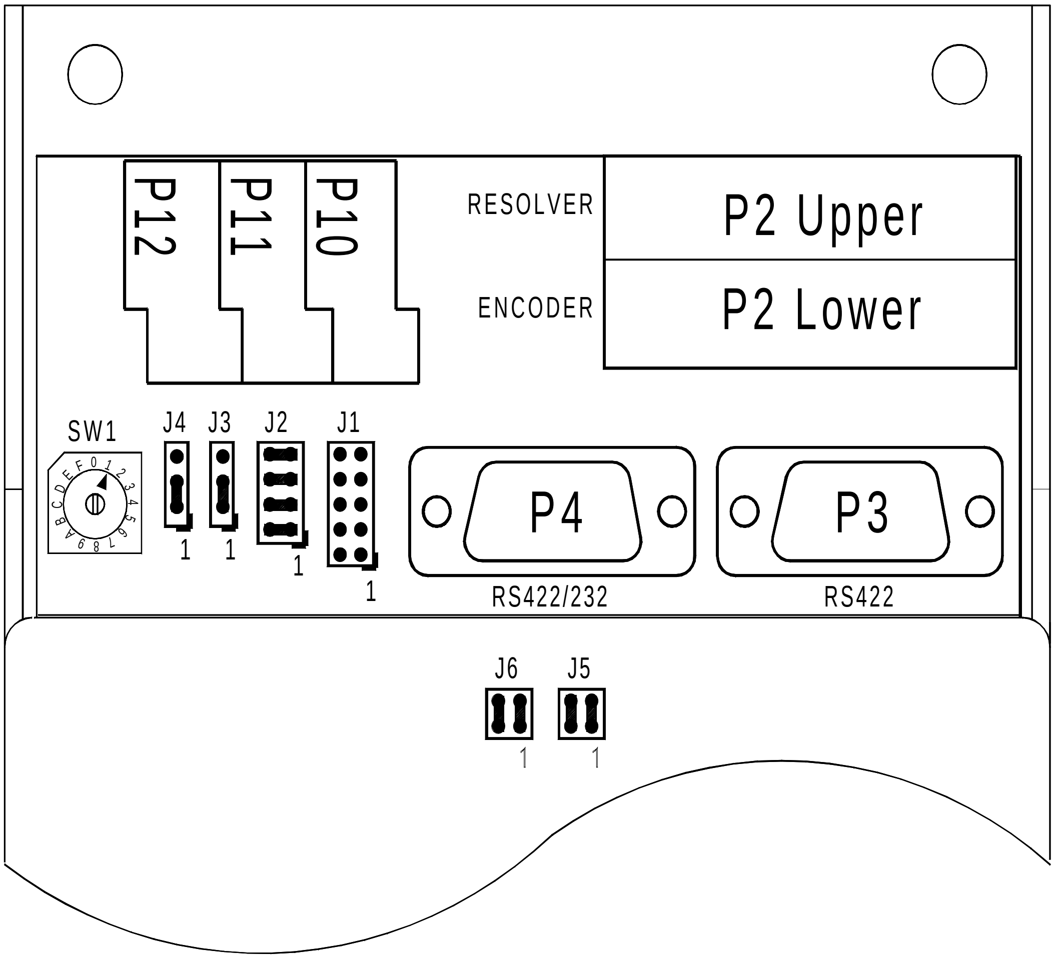


Figure 24. Backplane configuration

10.6 Backplane Fuse

The backplane is fitted with a single fuse rated at 500mA fast blow. This fuse is used to protect the auxiliary supply when this option is fitted. It is accessed by removing the front panel and extracting the drive amplifier card, the fuse can then be seen in the lower left hand corner as shown in Figure 25. below.

IMPORTANT: Ensure that the auxiliary power is removed from the drive before attempting to replace this fuse.

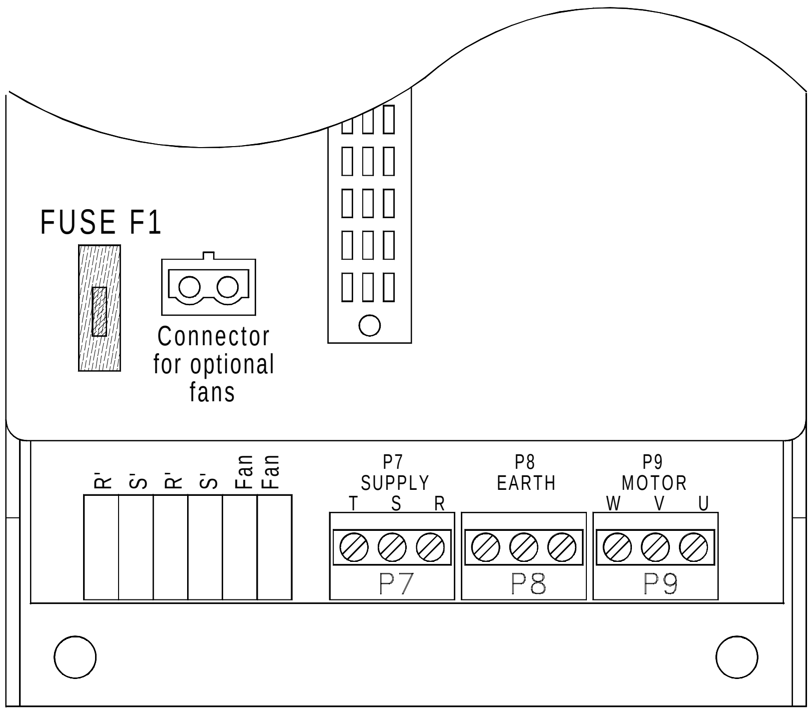


Figure 25. Backplane fuse

11. Options List

Absolute position
The resolver and associated circuits can be permanently powered by an external +/- 12V battery supply. This option is wired onto the Q-Drive backplane using connectors P11 and P12

Ground Defect
With this option it is possible to detect a ground defect in the supply but will only work with an auto-transformer**.**

220V Auxiliary Supply
An auxiliary supply can be wired into the drive using the connections marked R’ and S’. This auxiliary supply is used to maintain the power to the low voltage part of the drive so that positional information will not be lost in the event that the main contactor drops out, it will not supply power to the amplifier part of the drive. It is vitally important that the phase wired to R’ is the same phase that is wired to R and similarly that the phase wired to S’ is the same phase that is wired to S. A typical connection diagram is shown in chapter 3

Multi-Modules
Option 4 RDC modules. Each module define a maximum speed motor for a command of +/- 10V.Ex: 6000 rpm - 3000 rpm - 1500 rpm - 700 rpm

Layout of Drive Amplifier

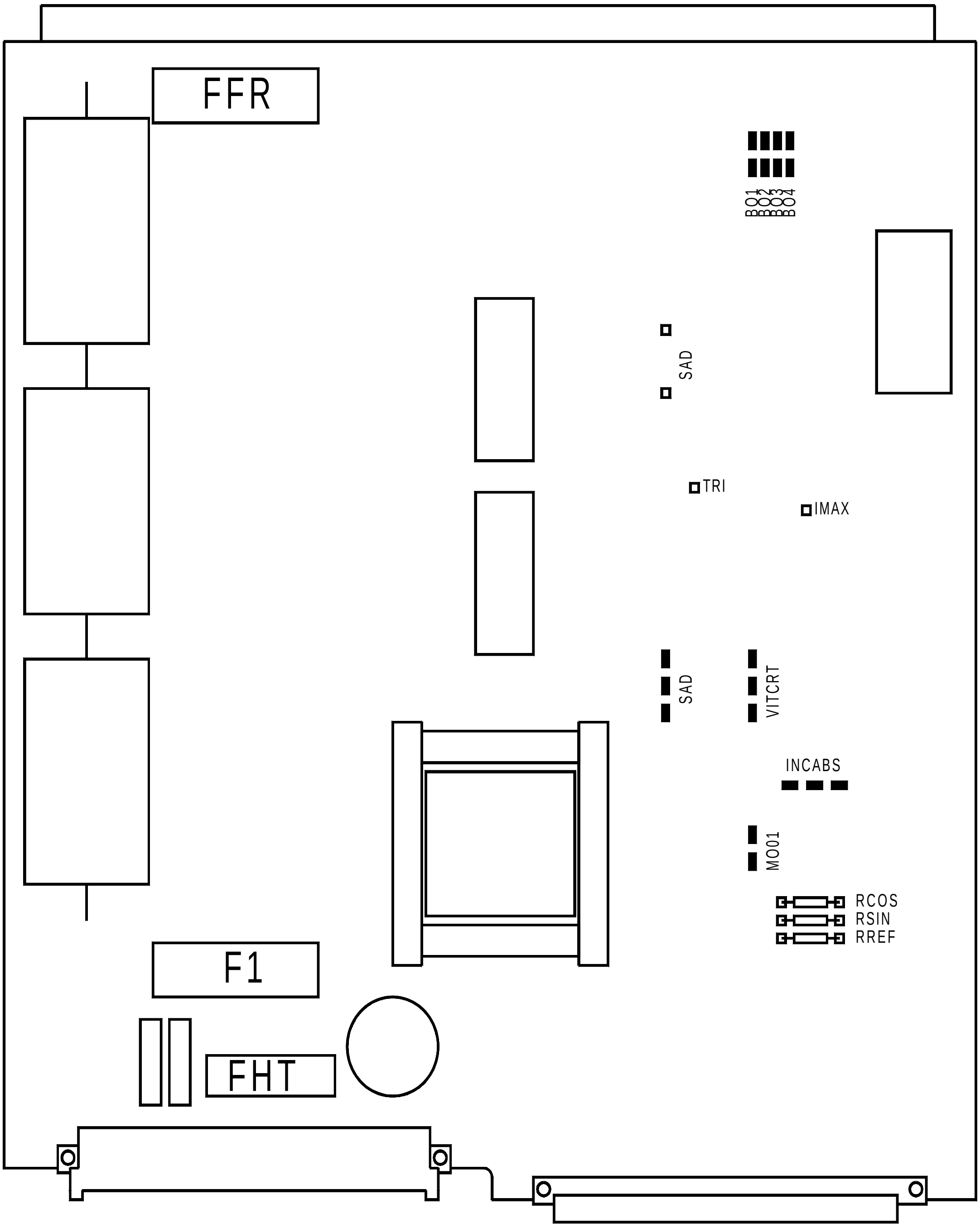


Figure 26. Drive amplifier jumper & fuse locations

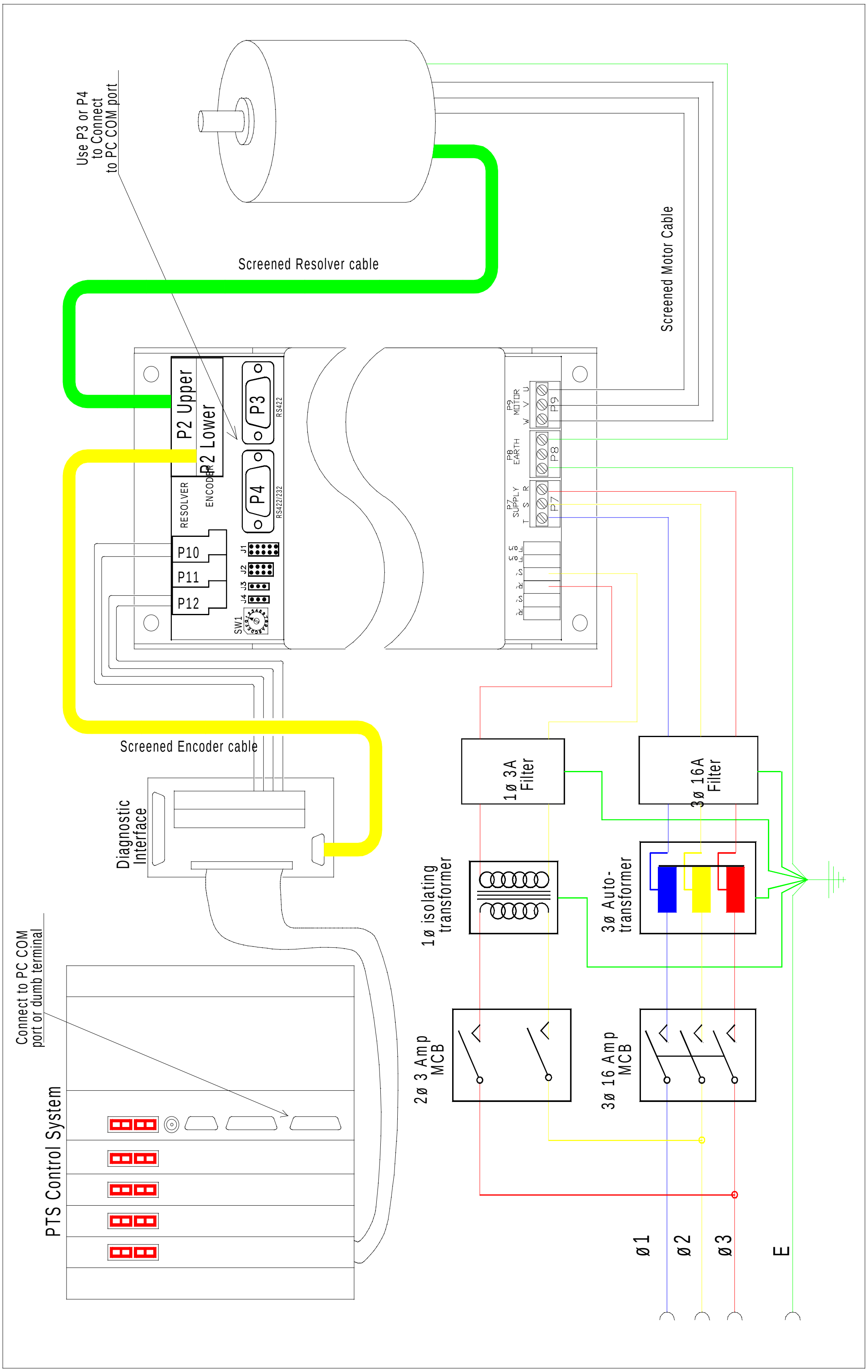


Figure 27. Complete wiring plan

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