World Class Design | World Class Function | 30 Years Expertise in Industrial Motor Control

DC MOTOR DRIVE

370

SPRINT ELECTRIC

Product Manual

HG105269EN00 Issue 1 (05/2022)

Please read this information before installing or using the product.

Install, use and maintain this product following the procedures provided.
The manual(s) cannot provide all details, variations and contingencies required for your installation, operation and maintenance of this product or the apparatus with this product installed. For further help or information, refer to your local Supplier sales office.

Application area

The equipment described is intended for industrial (non-consumer) motor speed control.

Intended users

To safely enable the user to obtain maximum benefit from the equipment:

- Ensure this information is available to all persons required to install, configure or service the described equipment or any other associated operation.
- Always store the manual in a conveniently accessible area for quick reference.
- Make it available for the next user/owner of the product.

This product is of the restricted sales distribution class according to IEC 61800-3 and has a "professional equipment" designation as defined in EN 61000-3-2.

Safety

Ensure all users and operators understand the included WARNINGS, CAUTIONS and NOTES, which alert the user to safety issues. COMPLY WITH WARNINGS AND CAUTIONS AT ALL TIMES. Each of these carries a special meaning and should be read carefully:

WARNING!

A WARNING is given when non-compliance with the warning may result in personal injury and/or equipment damage.

CAUTION!

A CAUTION is given when non-compliance with the caution may result in permanent equipment damage.

NOTE A note provides specific information to make important instructions clear.

Symbols

 **Attention**	 **Electrostatic Discharge (ESD)**	 **Electric Shock Hazard**
See the instructions for use. Specific warnings not found on the label.	This equipment contains ESD sensitive parts. Observe static control precautions when handling, installing and servicing this product.	Disconnect the mains supply before working on the unit. **Do not touch presets, switches and jumpers!** Always use the correct insulated adjustment tools.

WARNING!

Only qualified personnel must install, operate and maintain this equipment.
A qualified person is someone technically competent and familiar with all safety information, established safety practices, installation, operation, maintenance and the hazards involved with this equipment and any associated machinery.

Hazards

This equipment can endanger life through rotating machinery and high voltages.

WARNING!
PERSONAL INJURY AND/OR ELECTRICAL SHOCK HAZARD

- Always isolate all power supplies from the equipment before starting any work.
- Never perform high voltage resistance checks on the wiring without first disconnecting the product from the circuit under test.
- Use guarding and additional safety systems to prevent injury and electric shock.
- Metal parts may reach 90°C during operation.

CAUTION!
EQUIPMENT DAMAGE HAZARD

- We thoroughly test our products. However, before installation and start-up, inspect all equipment for transit damage, loose parts, packing materials, etc.
- Installation must observe the required environmental conditions for safe and reliable operation.
- In a domestic environment, this product may cause radio interference, requiring adequate measures to be taken. Obtain the permission of the supply authority before connecting to the low voltage supply.

General risks

Installation

- Ensure mechanically secure fixings are in use as recommended.
- Ensure cooling airflow around the product is as recommended.
- Ensure cables/wire terminations are as recommended and are torqued correctly.
- Ensure the product rating is correct - do not exceed the rating.

Application risk

Electromechanical safety is the responsibility of the user. The integration of this product into other apparatus or systems is not the manufacturer's or distributor of the product's responsibility. It is the user's responsibility to ensure the compliance of the installation with any regulations in force.

Health and safety at work

Electrical devices can constitute a safety hazard. Thorough personnel training is an aid to SAFETY and productivity. SAFETY awareness not only reduces the risk of accidents and injuries in your plant but also has a direct impact on improving product quality and costs. If you have any doubts about the SAFETY of your system or process, consult an expert immediately. Do not proceed without doing so. If in doubt, refer to the Supplier.

Weight

Consideration should be given to the weight of our heavier products when handling.

Risk assessment

Under fault conditions or conditions not intended: the motor speed may be incorrect; the motor speed may be excessive; the direction of rotation may be incorrect; the motor may be energised.

In all situations, the user should provide sufficient guarding and/or additional redundant monitoring and safety systems to prevent risk of injury.

NOTE: During a power loss event, the product will commence a sequenced shut-down procedure. Therefore, the system designer must provide suitable protection for this case.

Maintenance

Only qualified personnel should maintain and effect repair using only the recommended spares, alternatively return the equipment to the factory for repair. The use of unapproved parts may create a hazard and risk of injury.

WARNING!

PERSONAL INJURY AND/OR EQUIPMENT DAMAGE HAZARD

When replacing a product, all user-defined parameters that define the product's operation must be installed correctly before returning to use. Failure to do so may create a hazard and risk of injury.

The packaging is inflammable and incorrect disposal may lead to the generation of lethal toxic fumes.

Repairs

Repair reports can only be given if the user makes sufficient and accurate defect reporting. Remember that the product without the required precautions can represent an electrical hazard and risk of injury, and that rotating machinery is a mechanical hazard.

Protective insulation

Non-isolated product

WARNING!

The motor must be connected to an appropriate safety earth.
Failure to do so presents an electrical shock hazard. Exposed metal work in this equipment is protected by basic insulation and bonding to a safety earth.

This product is classified as a component and must be used in a suitable enclosure.

1. **There is no isolation between the Power and Control Circuits. ALL connections to the Drive are HAZARDOUS. Mount the drive in an earthed enclosure.**
2. **The Installer MUST provide Protection for the End User** by using Double or Re-inforced Insulation. The drive's Control signal terminals operate at the output voltage of the drive. Therefore, User controls **MUST** be made safe by the use of suitably insulated components, i.e. Potentiometer, Run Switch.
3. **DO NOT** connect these Control signal terminals to low voltage equipment or any non-isolated potential as this will cause significant damage to both the Drive and attached equipment.

Contents:

Disposal

This product contains materials that are consignable waste under the Hazardous Waste Regulations 2005. Metal and plastic materials can be recycled, however, disposal of the printed circuit board requires compliance with all valid environmental control laws.

Products that must be recycled in accordance with the WEEE Regulations are marked with the symbol opposite. Contact us when recyling the product.

1 Introduction

The 370 DC Drive is a non-isolated speed controller for small brushed shunt wound or permanent magnet DC motors.

This "non-isolated" drive has control signals that are NOT isolated from the mains supply, therefore, do not connect any of the terminals to earth or to other non-isolated equipment as when power is applied to the drive ALL terminals are at dangerous line potential.

To control the motor speed the drive uses speed feedback derived from either the armature voltage or a shaft-mounted tachogenerator. It incorporates an accurate current control loop to protect itself and the motor.

Current loop:	full P+I current shunt feedback
Speed loop:	full P+I armature voltage or tach feedback
Speed range:	0-100% (motor dependent)
Load regulation:	typically 0.1% Tacho, 2% Armature Volts

The LV suffix, for example 370 LV60, denotes a low voltage version.

This component is hazardous. Please obtain expert help if you are not qualified to install this equipment. Make safety a priority.

Read about the general risks and warnings at the front of this manual.

CE This apparatus complies with the protection requirements of the relevant EU Directives.

WARNING!

PERSONAL INJURY HAZARD

This product is non-isolated and so, when power is applied to the drive, ALL terminals are at dangerous line potential.

Ensure that connected items (e.g. speed potentiometer, Tacho, etc.) are NOT earthed, and have sufficient dielectric strength to avoid breakdown.

2 Mechanical dimensions

WARNING!
PERSONAL INJURY AND/OR
EQUIPMENT DAMAGE HAZARD
The drives are NON-ISOLATED.
Do not allow contact of the enclosure with the drive card electronics.

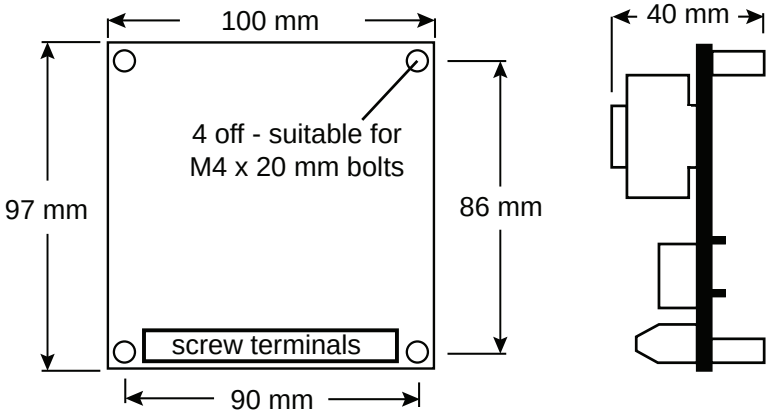


Figure 1 Mechanical dimensions

3 Guide for systems used in the EU

Special consideration must be given to installations in member states of the European Union regarding noise suppression and immunity. According to IEC 1800-3 (EN61800-3) the drive units are classified as complex components only for professional assemblers, with no CE marking for EMC.

The drive manufacturer is responsible for the provision of installation guidelines. The resulting EMC behaviour is the responsibility of the manufacturer of the system or installation. The units are subject to the LOW VOLTAGE DIRECTIVE 73/23/EEC and are CE marked accordingly.

Following the procedures outlined below will normally be required for the drive system to comply with the European regulations, some systems may require different measures. Installers must have a level of technical competence to correctly install. Although the drive unit itself is not subject to the EMC directive, considerable development work has been undertaken to ensure that the noise emissions and immunity are optimised.

* EN61800-3 specifies two alternative operating environments. These are the Domestic (1st environment) and Industrial (2nd environment). There are no limits specified for conducted or radiated emissions in the industrial environment, hence it is usual for the AC supply filter to be omitted in Industrial systems.

Definition of an industrial environment: all establishments, other than those directly connected to a low-voltage power supply network that supplies buildings used for domestic purposes.

4 Multiple drives

The arrangement shown below is for multiple drives with one filter, showing the star point earthing method.

The filter should be rated for the worst case total armature current load. The drive units are designed to function normally on unfiltered AC supplies shared with other thyristor DC drives. (Not AC drives).

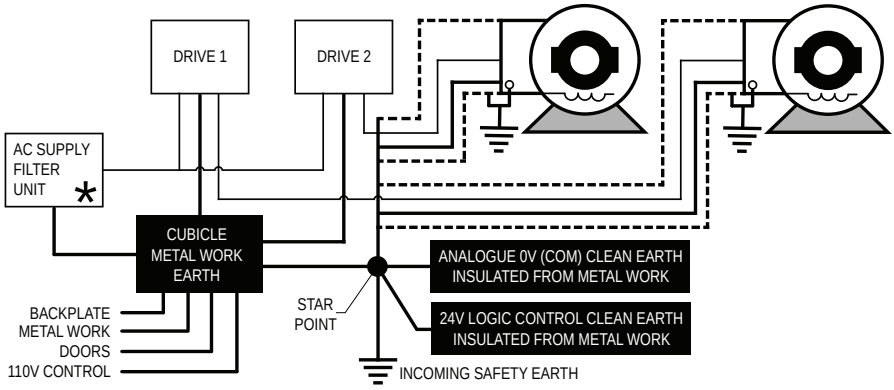


Figure 2 Star point connections for multiple drives

5 Requirements for EMC compliance

- Keep parallel runs of power and control cables at least 0.3 metres apart. Cross-overs must be at right angles.
- Keep sensitive components at least 0.3 metres from the drive and power supply cables.
- The AC connections from the filter to the drive must be less than 0.3 metres or, if longer, correctly screened.
- Do not run filtered and unfiltered AC supply cables together.
- Control signals must be filtered or suppressed, e.g. control relay coils and current carrying contacts. The drive module has built-in filters on signal outputs.
- The AC supply filter must have a good earth connection to the enclosure back plane. Take care with painted metal to ensure good conductivity.
- The AC input filter has earth leakage currents. Earth RCD devices may need to be set at 5% of rated current.
- The metal enclosure will be RF ground. The AC filter, drive earth and motor cable screen should connect directly to the metal cabinet for best performance.
- Linear control signal cables must be screened, with the screen earthed at the drive end only. Minimise the length of screen stripped back and connect it to an analogue earth point.
- **(1)** The motor cable must be screened or armoured with 360 degree screen terminations to earth at each end. The cable must have an internal earth cable and the screen must extend into the enclosure and motor terminal box to form a Faraday cage without gaps.
- **(2)** The internal earth cable must be earthed at each end. The incoming earth must be effective at RF. **WARNING! The earth safety must always take precedence.**

WARNING!
ELECTRIC SHOCK HAZARD

AC supply filters must not be used on supplies that are unbalanced or float with respect to earth.

The drive and AC filter must only be used with a permanent earth connection. No plugs/sockets are allowed in the AC supply.

The AC supply filter contains high voltage capacitors and should not be touched for a period of at least 20 seconds after the removal of the AC supply.

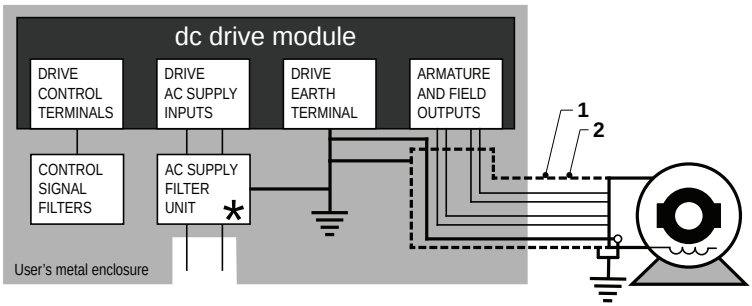


Figure 3 Connections for EMC compliance

6 Installation

6.1 Motor installation

- Foot-mounted motors must be level and secure.
- Ensure accurate alignment of the motor shaft and couplings.
- Do not hammer pulleys or couplings onto the motor shaft.
- Protect the motor from ingress of foreign matter during installation.

NOTE: This drive does not provide motor over-temperature protection. If required, fit an external thermal sensor device to the motor that will remove the supply when activated by over-temperature.

Earthing: Connect the motor to the system enclosure earth.

6.2 Drive installation

Requirements during installation and operation:

- Avoid vibration.
- Protect the drive from pollutants.
- Avoid ambient temperatures below –10°C and above +40°C.
- The heat dissipation of the drive is 11 W at rated current. Ensure there is an adequate supply of clean cool air to ventilate the unit and the enclosure it is mounted in.

6.2.1 Electrical installation

WARNING!
PERSONAL INJURY AND/OR EQUIPMENT DAMAGE HAZARD

Never work on any control equipment without first isolating all power supplies from the equipment.

Protection must be provided by a correctly rated semi-conductor fuse, fitted upstream of the drive. The fuse must have an I^2t rating of less than 50 A^2s at the applied supply voltage. Refer to page 11 for recommended fuse and fuse holder.

The built-in line fuse is rated at 6.3 A HRC ceramic. DO NOT replace with a glass-fuse type.

Control cable	1.5 mm^2	
External control options:	Speed setpoint from external 10K potentiometer *	External RUN contact (Terminal 5) for electronic STOP/START
* Potentiometer, graduated dial and knob - Sprint Electric part number: POTKIT		

EMC wiring: If the unit is to be used in the domestic environment, then for installations in the EU a supply filter is recommended in order to comply with EN6800-3. Sprint Electric part number: FRLN16.

WARNING!

PERSONAL INJURY HAZARD

Terminals A+, A-, F-, F+, N & L are at high potential.
Do not touch the terminals or any connected conductor.

RUN is an electronic inhibit function. The field remains energised, and all power terminals 'live'. During hazardous operations remove the power source to the system. **RUN must not be relied on to ensure the machine is stationary.** The motor FIELD output remains energised with RUN open, please beware of overheating the motor when stopped (does not apply to permanent magnet motors).

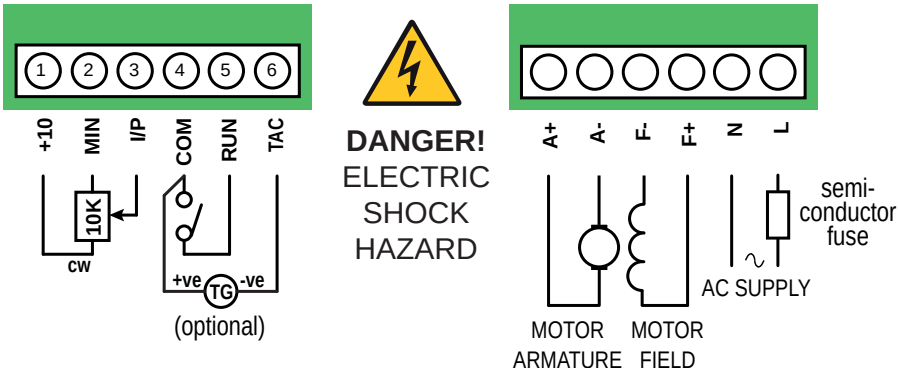


Figure 4 Terminal connections

L1/L2/L3, A+/A-	Use correctly rated cable - minimum 600 Vac, 1.5 x armature current

Earthing: All control inputs to the drive are NON-ISOLATED. Do not connect any of the terminals to earth or to other non-isolated equipment. **A common cause of damage is accidental earthing of the external potentiometer or RUN contact wiring.**

TERMINAL LISTING - tightening torque: 0.5 Nm (4.4 lbf.in)			
1	**+10** +10 V output, 2 mA maximum. Use a 10K potentiometer for external speed reference. **cw**.	**A+**	Motor armature +
2	**MIN** Minimum Speed: connect to minimum end of internal speed potentiometer 10K preset to common. **acw**.	**A-**	Motor armature –
3	**IP** Speed Input: 0 to +10 V speed input from the potentiometer wiper. It has a 39K internal pull-down resistor.	**F-**	***** Motor field – For half wave field Volts 0.45 x AC, connect field to F– and N.
4	**COM** Common. 0 V (zero).	**F+**	***** Motor field +
5	**RUN** Internal 12K pull-up resistor to +10 V. Open to stop; close to COMMON to run. **See the WARNING below.** Reset release time 0.1 to 0.5 s.	**N**	NEUTRAL/RETURN : AC supply
6	**TACH** When using Tach feedback, the tach feedback polarity must be negative with respect to COMMON, Terminal 4.	**L**	LIVE : AC supply

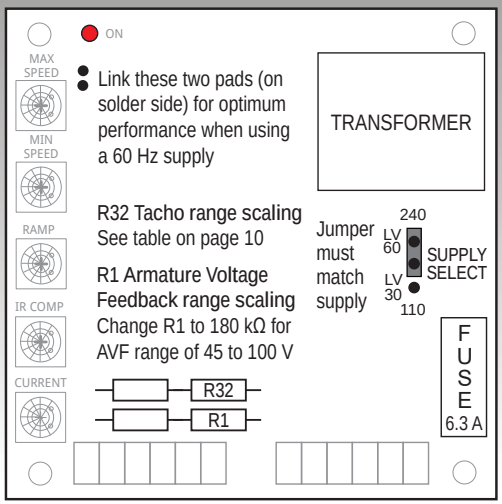
***** No connection required for permanent magnet motors.

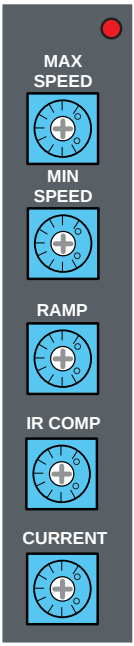
USER ADJUSTMENTS

The suggested Commissioning strategy starts in the safest possible mode of operation and progressively exercises each element of the system to achieve full functionality.

WARNING!

When power is applied to the drive, ALWAYS use an insulated tool when adjusting the presets.





ON: Power is present when lit.

Maximum speed: rotate clockwise to increase speed, 90 V to 200 V (armature or tach feedback Volts).
LV model has Avf range 24 V to 48 V.

* Minimum speed: rotate clockwise to increase minimum speed.
0 to 30% of maximum speed.

Ramp: Rotate clockwise for a faster response. 20 to 1 seconds up ramp rate.

IR compensation: rotate clockwise to increase level of armature voltage droop compensation. 0 to 25%. Excessive rotation may cause instability. Always set fully anti-clockwise in Tacho mode.

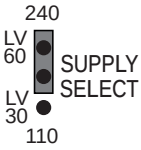
Maximum current: rotate clockwise to increase current limit.
0 to 100% current limit (0 to 3.7 A).

* *Assumes using a 10K speed reference potentiometer*

Figure 5 User adjustments

7 Commissioning

7.1 Initial settings - without power



1. **To avoid damage, ensure the supply selection jumper on the drive matches the incoming ac supply: 240 Vac or 110 Vac, (60 Vac or 30 Vac for LV models).**
2. With the unit on the work bench, set the **CURRENT** preset to match the motor armature current rating as closely as possible:
   - fully anti-clockwise = 0%
   - fully clockwise = 100% of the drive rating, i.e. 3.7 A.
     For example, to adjust the preset for a motor with an armature current rating of 1.85 A, set it to 50%. Use a suitable current meter temporarily connected in series with the armature to achieve accurate settings.
3. Set **MAX SPEED**, **MIN SPEED**, **RAMP** and **IR COMP** presets to fully anti-clockwise.
4. The preferred strategy for initial commissioning is to use armature voltage feedback (AVF). The drive's default setting is to use armature voltage feedback. (Temporarily remove any tachogenerator connection made to Terminal 6. Make the wire end safe until later).
   - Resistor R1 scales the armature voltage. Depending on what armature voltage is needed at full speed, R1 is 510K (as fitted) for AVF 90 to 200 V or change R1 to 180K for AVF 45 to 100 V. Refer to "Figure 5 User adjustments" on page 7.

DO NOT use armature voltage feedback and a tachogenerator at the same time:

- **When using armature voltage feedback, DO NOT fit the TACH connection (T6).**
- **When using tacho feedback, ALWAYS remove resistor R1.**

7.2 Pre-operation motor check list

5. **With no power applied, complete the following check list:**
   - Check for the correct insulation between individual motor elements, and between these elements and the earthed motor frame. Disconnect all drive cables before testing. The motor elements are: armature winding, field winding*, temperature sensors*, tachogenerator* (* where applicable).
   - Check inside the motor connection box for foreign objects, damaged terminals etc.
   - Check that motor brushes are in good condition, correctly seated and free to move in brush boxes. Check for the correct action of brush springs.
   - Check that motor vents are free of any obstruction and that any protective covers have been removed.

WARNING!
PERSONAL INJURY HAZARD

This product is non-isolated and so, when power is applied to the drive, ALL terminals are at dangerous line potential.
Ensure that connected items (e.g. speed potentiometer, Tacho etc.) are NOT earthed, and have sufficient dielectric strength to avoid breakdown.

7.3 Operating the drive

WARNING!
PERSONAL INJURY HAZARD

RUN is an electronic inhibit function. The field remains energised, and all power terminals 'live'. During hazardous operations remove the power source to the system. RUN must not be relied on to ensure the machine is stationary. The motor FIELD output remains energised with RUN open, please beware of overheating the motor when stopped - this does not apply to permanent magnet motors.

6. **For this initial start, disconnect and insulate the (optional) Tacho connection to Terminal 6** as the drive will be using **Armature Voltage** feedback.
7. **Apply power to the drive.** The drive's power lamp (ON) will light.
8. Close RUN to Enable operation.
9. Slowly increase the external speed potentiometer setting to maximum. The motor will ramp up slowly to about 90 V on the motor armature (to about 25 V for LV units).
10. **Is the motor turning in the required direction?** If not, reverse the system by transposing the A+ and A- motor armature connections.

CAUTION!

When reversing the system: To prevent damage, do not transpose the motor armature connections until the motor has stopped rotating.

11. **MAX SPEED** Set the speed potentiometer to maximum. The drive will ramp up to full speed. Adjust the **MAX SPEED** preset as required. DO NOT exceed the armature voltage rating.

    NOTE: If the DC motor rated armature volts is 90 V, operating from a nominal 110 Vac supply, it may be necessary to change R1 to 180K.

12. **MIN SPEED** Set the speed potentiometer to minimum. The drive will coast down to zero. Adjust the **MAX SPEED** preset as required. The Min spd potentiometer can now adjust between 0% and 30%. (This assumes that a 10K potentiometer is being used to provide the speed setpoint at terminal 1, 2 and 3.)
13. **RAMP** Set the ramp up rate as required (from 20 seconds to 1 second).
14. **IR COMP** Speed droop on heavy loads may occur where armature voltage feedback is used. Compensate for this by clockwise adjustment of the **IR COMP** preset. Excessive rotation may lead to instability.

The drive is now commissioned to use Armature Voltage feedback.

8 Options

- **Speed Feedback selection:** If the system is to use **Tacho** feedback you can now adjust for the tachogenerator's output voltage, and hence the speed of the motor.

  Run the drive in **Armature Voltage** feedback mode and check the polarity of the tacho using a voltmeter. The tacho feedback polarity must be negative with respect to COMMON, Terminal 4.

NOTE: IR COMP must not be used with Tacho feedback - set the potentiometer fully anti-clockwise.

a. **To use Tacho feedback (Terminal 6), remove resistor R1 from the board -** refer to "Figure 5 User adjustments" on page 7.

b. If necessary, change the value of resistor R32 to accomodate the tacho voltage at full speed:

Full speed tacho voltage	Value of R32
110 to 270 V	1 MΩ - **fitted as standard**
55 to 135 V	500 kΩ (1 MΩ soldered in parallel with R32)
22 to 67 V	250 kΩ (330 kΩ soldered in parallel with R32)
10 to 25 V	91 kΩ (100 kΩ soldered in parallel with R32)

- **Jogging**: We recommend using the RUN input (Terminal 5) for stopping or jogging. If you use a mains contactor, connect a spare normally-open contact of the contactor in series with the RUN input.

  For frequent stopping or jogging it is not good practice to rely on switching the supply off and on to stop and start with the run contact permanently closed. This can result in an uncontrolled current pulse for one half mains cycle under certain conditions. For example, main contact bounce. This might lead to undesired motor movement or device damage. Use a spare NO contact on the main supply contactor in series with T5 and any other RUN contacts in rapid start-stop applications.

- **Terminal 6 (TAC) has an alternative use when using armature voltage feedback**:

  As an auxiliary speed input - it acts as an arithmetic summing junction with the main setpoint and has a strength of approximately 5% (+/-10 V input gives +/-5% speed change). This input bypasses the setpoint ramp stage and has a fast response.

  As an auxiliary speed trim - it acts as an auxiliary fast ± speed trim (approximately 5-10%).

9 Specifications

All specifications in this document are nominal.

RATINGS					
Drive model	**AC supply input 1 ph 50 or 60 Hz**	**Maximum output**			**Power rating**
		Armature voltage	**Armature current**	**Field current ****	
	(Vac ±10%)	**(Vdc)**	**(Adc)**	**(Adc max)**	**(kW / hp)**
370	90-120 or 200-264	90–180 (200 V max)	3.7	0.5	0.55 / 0.75
370 LV60	25-35 or 50-70	24–48 (50 V max)	3.7	0.5	*
kW / hp ratings are for typical motor ratings at or below the available terminal ratings of Watts = armature Volts x armature Amps. * Note that the power output of LV versions will be proportionately lower than is shown above. ** Volts DC = 0.9 x AC supply Volts (0.45 x AC supply Volts for field connected to F- and N) A+ / A- motor armature terminals have Form Factor typically 1.5 (load dependent).					

FUSE - Class aR Series semiconductor - fitted upstream of the drive				
Drive model	**Drive rating**	**Fuse rating**	**Sprint part number**	**Clearing I^2t**
370	3.7 A	8 A	CH00608A	35 A^2s
6 x 32 mm Panel-mount fuse holder - CP102071; DIN rail clip for fuse holder - FE101969				

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