Xtravert Series
Technical Manual

Part Number 4201-196 Revision G

IMPORTANT

Read and understand the procedures described in this manual before attempting to install or commission your drive.

If in doubt, before proceeding, please contact Bardac Drives at:

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Contents

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XTRAVERT SPECIFICATIONS

MODEL	INPUT VOLTS (V)	INPUT CURRENT (A)	RECOMMENDED INPUT FUSE (A)	OUTPUT CURRENT @ 50°C (A)	OVERLOAD CURRENT (A)	RECOMMENDED MAXIMUM CABLE LENGTH (m)	NOMINAL MOTOR SIZE (kW)	(hp)
							230V	230V
X302	230 1~	8	15	2.5	3.75	50	0.37	¾
X304	230 1~	12	20	4	6	50	0.75	1
X307	230 1~	20	35	7	10.5	150	1.5	2
X309	230 1~	22	35	9	13.5	150	2.2	3
							230V	230V
X502	230 3~	4	10	2.5	3.75	50	0.37	¾
X504	230 3~	7	15	4	6	50	0.75	1½
X507	230 3~	12	20	7	10.5	150	1.5	2
X509	230 3~	9	15	9	13.5	150	2.2	3
X512	230 3~	12	20	12	18	150	3	3
X516	230 3~	16	30	16	24	150	4	5
							400V	460V
X702	400 3~	4	10	2.5	3.75	50	0.75	1½
X704	400 3~	7	15	4	6	50	1.5	2
X707	400 3~	12	20	7	10.5	150	3	5
X709	400 3~	9	15	9	13.5	150	4	5
X712	400 3~	12	20	12	18	150	5.5	7½
X716	400 3~	16	30	16	24	150	7.5	10

Note 1: Nominal motor size applies to 4-pole motors only. Check your motor specification before selecting.
Note 2: Input fuses should be fitted - typed gG(distribution) or gR/UR (semiconductor) are suitable.
Note 3: UL requirements specify that UL class CC, T or J1 fuses must be fitted in-circuit with the input supply.

4202-186 RevG

INPUT

Input supply range	Nominal Actual 230V 1~ 200V to 250V ±0% 230V 3~ 200V to 250V ±0% 400V 3~ 200V to 480V ±0%
Configuration	Earthed neutral supply
Input frequency range	48–62 Hz
Input displacement factor	0.99
Power loss ride through	> 1 second at nominal voltage

Short circuit rating: Dependant on fusing. For UL requirements with UL class CC, T, or J1 fuses fitted, the Xtravert Series of AC Motor Controllers are suitable for use on a circuit capable of delivering up to a maximum of 200,000 rms symmetrical amperes, 480Vac maximum.

OUTPUT

Current overload capability	150% for 30 seconds
Efficiency (full load, 50Hz)	>97%
Power on delay	<1 sec
Suit motor rated voltages	10-500Vac
Suit motor rated frequencies	10–175 Hz
Output voltage	<Vin
Voltage regulation	<±3%
Frequency range	0 to ±150Hz

Frequency resolution	0.01Hz
Control method	Dynamic Flux Control
Carrier frequency	8kHz (5kHz selectable)

ENVIRONMENTAL

Protection standard	IP20; Pollution degree 2
Operating temperature	0–50°C
Storage temperature	-40°C to +80°C
Relative humidity	<90%, noncondensing
Altitude	1000m
Altitude derating (>1000m)	-1% per 100m; 3000m max

XTRAVERT PROTECTION

Supply loss	Input phase loss
Output current limit	Short circuited load
Ground fault detection	Regeneration limit
Low DC bus voltage	Motor overtemperature
Excessive DC bus voltage	Control PCB failure
Xtravert thermal model	

MOTOR PROTECTION

Stall avoidance	Stall protection
Shear pin mode	Combined overload alarm
Thermal model overtemperature trip	Motor overtemperature

LOCAL CONTROL OPTIONS

Selection:	
Start and Stop-Reset buttons	Stop-Reset button
Reset button	None (remote)

FREQUENCY CONTROL SOURCES

Local Keyboard	Inch 1, Inch 2

Analogue Input 1; Configurable as 0-10Vdc or ± 10Vdc
Analogue Input 2; 4-20mA
Maximum of Analogue Input 1 or Analogue Input 2
Sum of Analogue Input 1 and Analogue Input 2

Switch Control (7 preset)	Switch Control (3 preset)
Motorised Potentiometer	PID Process Control output
RS232/RS485 (Options)	Crane Control

SWITCH CONTROLS

1 x Dedicated external trip input, 4 x Multifunction inputs configurable as:

Stop	Start
Start-Reset	Stop-Reset
Inch	Alternative Stop-Reset
Direction Invert	Increase/Decrease Speed
Alternative Accel/Decel	Dual Button Crane Control

CONFIGURABLE RELAY OUTPUTS

2 relays; 250Vac/30Vdc/2A (non-inductive)
1 x changeover; 1 x normally open
Output selection:

Failsafe fault	Xtravert started
Xtravert running	Xtravert started or running
Xtravert overloaded	Motor overloaded
Frequency sense point	Current sense point
Direction	At set frequency
Combined overload alarm	Feedback sense
Power flow direction	
RS232/RS485 controlled (Options)	

ANALOGUE OUTPUT CONFIGURABLE AS 0-10VDC, ± 10VDC, OR 4-20mA

Output selection:

±50/± 60/±100/±120 Hz Output frequency	0–150% Output current
±50/± 60/±100/±120 Hz Reference frequency	±10V RS232/RS485 (Options)
0–500Vac Output voltage	0–150% Motor power
0–150% Torque component of current	±100% Process Control Error

CONTROL PANEL

32 Character alphanumeric LCD (may be mounted up to 3m away) with IP54 protection.
Xtravert status, current, frequency permanently displayed
Estimated motor temperature, reference frequency, DC bus voltage, output voltage optionally displayed
Multi-language capability
Direct status/level display of input and output control terminals
3 key input system with separate Start and Stop-Reset buttons.
Local/Remote control possible
LED status indication for Power On, Run and Fault

CONTROL FEATURES

Wide speed range up to 120Hz	7 switch selectable speed presets
Switch controlled speed inputs	Two skip frequencies
Programmable to suit almost any motor	Programmable thermal model of motor
Dynaflux optimising system	Anti-condensation motor heater
Spinning start mode	Spinning stop mode
DC injection braking	PID process controller
Configurable switch controls	Programmable reaction to mains loss
Automatic restart	Smooth current limit
Shearpin mode	Showering arc noise immunity tested
Serial communication options	Reverse lock out

Very low motor noise – WhisperWave or Fixed frequency (normal) modulation
Programmable offset, gain and inversion of analogue reference signals
Two sets of acceleration and deceleration rates plus alternative stop rate
Wide acceleration and deceleration range – 0.02Hz/s to 500Hz/s
Programmable S-curve acceleration/deceleration

THE XTRAVERT

The Xtravert is a fourth generation AC Motor Speed Controller developed by PDL Electronics Ltd. The 16 models in the range are designed to operate smaller three-phase induction motors, rated up to 7.5kW at 400Vac.

- Models are available for single-phase 230Vac, three-phase 230Vac, or three-phase 400Vac supplies. A wide tolerance in supply voltage and frequency is allowed for.
- A compact bookshelf style enclosure has been designed for this range, with IP20 ingress protection rating. This offers the advantage of reduced installation space, allowing for easy installation either in a switchboard or stand-alone in a switchroom.
- The Xtravert is fully compliant with appropriate European Safety and EMC directives and as such carries the CE Mark.
- Optimal thermal design and management enable construction of a compact enclosure, and allow the full output rating to be achieved in ambient temperatures up to 50°C.
- Surface mount technology on the circuit boards allows for sophisticated yet compact circuit design.
- The power electronics design uses the latest generation IGBT switching devices. These permit a high overload capacity (150% for 30 seconds minimum), and protection against output short circuits. Their high switching speed enables modulation up to 8kHz for low output harmonic currents and near silent motor operation.
- The Control PC Board uses an extremely powerful 16-bit microcontroller and waveform enhancement ASIC to generate the output waveform using space vector modulation techniques. The microcontroller also allows PDL Electronics to include many programmable features into the Xtravert yet retain simplicity of control.
- WhisperWave Modulation is incorporated in the waveform generation. This is a technique developed by PDL Electronics to remove the annoying motor tone usually associated with motors operating from AC Motor Speed Controllers, allowing the little remaining motor noise to be easily masked. This feature is especially valuable in applications requiring low noise – particularly for heating and ventilation applications.
- The output waveform may be controlled by the PDL Dynaflux Optimising System. Dynaflux is a form of automatic voltage regulation that optimises the flux within the motor according to load conditions. This leads to increased motor efficiency, particularly under reduced load conditions.
- Digital control means absolute precision and repeatability in settings with complete keyboard control. There are no internal adjustments or trimpots in the Xtravert. All information, including input terminal status and levels, is available on the Xtravert display.
- The Display Unit is normally mounted on the front of the Xtravert. However it can be removed, re-orientated, or mounted remotely up to three metres away. It can be fitted to an industry standard 56-series box to achieve an IP54 ingress protection rating.
- The Display Unit includes three status LEDs, a 32-character alphanumeric LCD, three screen control keys and START, STOP-RESET push-buttons. The functions of the push-buttons may be disabled by the user.

- Plug-in control terminals allow for speedy change-over of drives in the event of a need for service or relocation of the Xtravert.
- Digital (switch) inputs include four programmable inputs and one dedicated TRIP input. The functions of the programmable inputs can be selected from a list of thirteen different options, including stop, start, reset, direction invert, alternative reference selection, alternative ramp rate selection, inch, and multi-speed selection.
- Two analogue inputs are provided. One is configurable as 0 to 10Vdc, or -10V to +10Vdc. The other is designed for 4 to 20mA control signal. Either input can be configured as a reference source or a process controller feedback source.
- Two relay outputs are provided, each rated at 250Vac/30Vdc/2A. One relay has change-over contacts, the other is normally open. Each may be configured to perform one of seventeen different functions, including indication of start, run, overload and direction status, frequency and current sensing.
- One analogue output is provided, which may have its format configured to 0 to 10V, -10V to +10V, or 4 to 20mA. The function of the analogue output can be selected from a list of sixteen, including output current, voltage, frequency.
- An internal PID Process Controller is provided, to enable applications such as level control, constant pressure pumping etc., to be set up without the need for an external controller.
- A Serial Communications Card may be fitted in place of the display unit, to enable extensive control and monitoring of the Xtravert from a host controller, e.g., computer, PLC, DCS, etc. Available options include RS232 or RS485 MODBUS, Profibus or Serial Bus Interface format to communicate with standard PLCs. A stand alone interface is available to support Interbus format.
- A stand alone dynamic brake unit is available to dissipate regenerative energy from motors that are required to decelerate quickly.

The Xtravert with its long list of desirable features and flexibility is an outstanding choice for the broad industrial market.

SECTION 1: INSTALLING THE XTRAVERT

1.1 APPLICATION RECOMMENDATIONS

The Xtravert is suitable for controlling the speed of all standard three phase induction motors. Choose an Xtravert which is capable of supplying the full load current and voltage of the motor to be driven and is suitable for the mains supply voltage.

When the Xtravert is correctly adjusted, full torque can be obtained from the motor at up to rated speed. A standard motor may be operated above rated speed by using higher than rated frequency, but the torque that is able to be generated declines (1/f) as there is insufficient voltage to provide correct stator flux.

Operation below rated speed must take account of the reduced cooling efficiency of the motor. Because of thermal limitations, the continuous capability of the motor reduces from rated torque at rated speed, to the value defined by the “zero speed cooling value” at zero speed. The Xtravert thermal model (overload) takes these factors into account and provides safe protection from inadvertent overloads of this type.

The quality of the Xtravert current waveform is such that no derating of the motor torque due to harmonic heating is necessary.

In a safety situation motors may be switched on and off the Xtravert while it is running but this is not good control practice – it stresses the Xtravert and may lead to occasional tripping due to arcing of the isolating device's contact terminals. A more elegant control solution is to use the Xtravert control terminals.

Generally it is better practice to leave electronic equipment (including the Xtravert) permanently connected to the mains supply. Switching the mains on and off to control the Xtravert is bad practice and should be avoided (use the control terminals). If mains switching is insisted upon (!), it must not occur more often than once every 5 minutes or the Xtravert charging circuits may be damaged.

Several motors may be operated at once on the Xtravert, but individual thermal protection must be supplied. Be sure to choose an Xtravert which is capable of supplying the total current requirements of all of the motors. If you plan to start motors independently “direct-on-Xtravert” then you must also include the DOL starting current of the motors (this generally leads to gross oversizing of the Xtravert – a much better solution is to stop the Xtravert, connect the extra motors, and restart the Xtravert).

An advantage of the Xtravert is that non-standard motors (frequency, voltage) can be driven from standard mains. The Xtravert may be set to drive any motor with a rated voltage between 10 and 500Vac with a rated frequency between 10 and 175Hz.

When selecting the gearing of your system, be sure to operate the motor as near to rated speed as possible. Centring your speed range around rated speed (so that maximum speed actually overspeeds your motor) gives better motor cooling and utilisation.

OTHER USEFUL TECHNIQUES INCLUDE:

– The use of a six pole motor in a four pole application (Xtravert operates around 75Hz instead of 50Hz) – this gives better motor cooling (hence a wider useful speed range) and 50% better starting torque at very little extra motor cost.

– Small motors may often be connected in 230V (delta) connection. Using this connection with a 400V Xtravert (motor voltage set to 230V) on a 400V supply allows the motor to be operated with full flux up to 87Hz, thus providing a very wide constant torque speed range. Note that the motor in fact produces 1.7 times its rated power when operated at 87Hz. The penalty is that the motor draws 1.7 times more current (because of the delta connection), so a larger Xtravert may be required.

Other recommendations:

– Regardless of how good a thermal overload or model is, a PTC thermistor in the motor windings with the appropriate control relay provides the ultimate thermal protection and is recommended.
– Always specify motors with high temperature insulation – at least class F or better.

1.2 INSTALLATION

1.2.1 ENVIRONMENTAL CONSIDERATIONS

The Xtravert must be sited in a suitable environment. As with all equipment, the cleaner, cooler and more vibration free the environment, the longer and more trouble free will be the life of the Xtravert.

The ambient temperature must not be below 0°C, and must not exceed the Xtravert specification of 50°C; relative humidity should be less than 90% and there must be no condensation. Avoid mounting the Xtravert in direct sunlight.

The Xtravert has a protection rating of IP20 and must have a clean environment (Pollution degree 2), free of electrically conductive (wet or dry) dust (e.g., carbon fibre, salt, etc.), and free of spraying water.

In some applications it may be desirable to improve the conditions in which the Xtravert is to be fitted. The first choice in this case is to fit the Xtravert remotely in a clean location.

If mounting the Xtravert in a switchboard or protective box, be sure to allow for sufficient cooling. The enclosure interior air temperature must not exceed the Xtravert specification of 50°C. Calculate the correct sized cabinet by using the procedure below.

1. Determine the worst case localised ambient temperature (T_{MAX}) surrounding the cabinet on the hottest day of the year. T_{MAX} should typically not exceed 30°C to minimise the size of the cabinet.
2. Note the rated current (I_{RATED}) of the Xtravert in Amps and the total output cable length.
3. And hence determine the power losses (P_{LOSSES}) within the cabinet in Watts

   P_{LOSSES} [W] = (13W x I_{RATED})
   \+ 20W (fixed losses)
   \+ 0.2W/m (cable effect losses)
   \+ other equipment losses
4. And knowing this power loss value choose:

EITHER a fully enclosed cabinet with an exposed heat dissipating surface area (A) of: Exposed heat dissipating surface area (m^2)

Steel construction

$$A = \frac{P_{LOSSES}}{5.5 \times (50°C - T_{MAX})}$$

Polyester construction

$$A = \frac{P_{LOSSES}}{3.5 \times (50°C - T_{MAX})}$$

Always ignore the base of the cabinet and unless free standing, ignore the back of the cabinet. Where multiple cabinets are mounted side by side, discount common surfaces as heat dissipating surfaces. Ensure no other radiant or convection heat source is externally heating the cabinet.

If the Xtravert is not fitted with a heatsink fan, an internal stirring fan will be required to prevent hotspots.

OR if the cabinet is too large, forced ventilation cooling will be required. Calculate the appropriate flow of air as

$$\text{Airflow } (m^3/\text{minute}) = \frac{P_{LOSSES}}{20 \times (50°C - T_{MAX})}$$

Fit the inlet and outlet vents such that the airflow circulates around the complete cabinet. Remember to still follow the guidelines on mounting the Xtravert within the cabinet as per Section 1.2.2.

A suitable convection or forced air system must be provided to ensure the inside air temperature does not exceed 50°C.

Note: The Xtravert display unit has a protection rating of IP54 (front and sides only) when mounted correctly against a hard flat surface. This allows the display unit to be fitted on the front of a protective cabinet or switchboard. When remotely mounting the display unit, the protective screw caps must be fitted to maintain the IP54 rating.

1.2.2 MOUNTING THE XTRAVERT

The Xtravert must be mounted vertically to ensure proper cooling. Allow 150mm of free air space vertically top and bottom and mount no closer than 150mm centre to centre between adjacent Xtraverts to provide adequate ventilation. Avoid mounting Xtraverts inline above other units to prevent accumulated air heating. Ensure dirt does not form on the heatsinks by occasionally clearing the fins with compressed air.

1.2.3 MANUFACTURER'S RECOMMENDATIONS

Failure to adhere to the manufacturer's recommendations for installation, environmental conditions and electrical specifications may result in damage to the Xtravert (and/or external equipment) and may void the warranty.

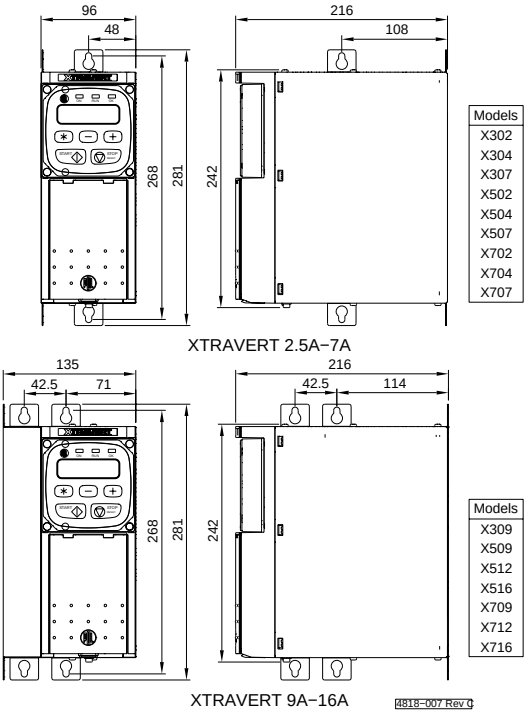


Figure 1.1: Xtravert Dimensions

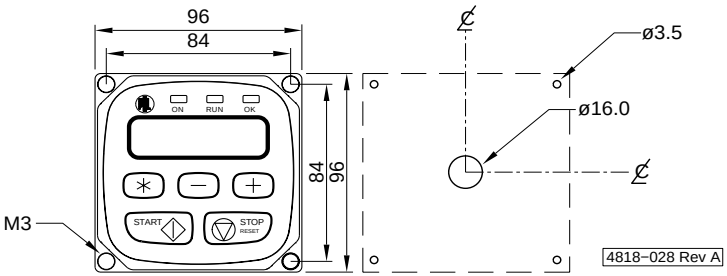


Figure 1.2: Remote Dimensions & Cutout Pattern

1.2.4 CONNECTING THE XTRAVERT

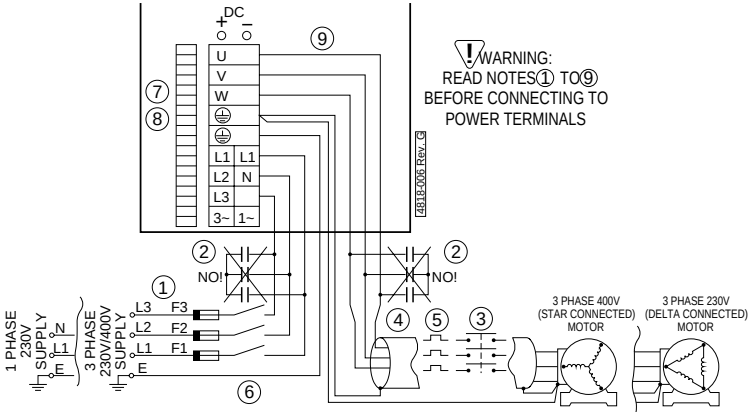


Figure 1.3: Xtravert Power Connections

1. Wiring Details: Refer to Specifications for fuse ratings.
2. Power factor capacitors are not required on the Xtravert input (Xtravert displacement factor = 0.99), and must not be connected to the Xtravert output.
3. A motor isolator or contactor may be used on the Xtravert output, but its use should be restricted to emergencies.
4. To reduce radio frequency interference (RFI), screened cable (e.g., neutral screen, steel conduit) must be used on the Xtravert output. Bond the screen solidly to the Xtravert and motor chassis. The output cables should be run separate from the input cables (especially if not screened). Refer to Specifications for recommended maximum output cable lengths. Where multiple motors are attached, the recommended maximum cable length is the combined cable length.
5. The Xtravert protects the motor with an electronic overload, so an external overload relay is unnecessary. Where multiple motors are attached, separate overload protection should be located at each motor. Where fitting at the motor is not possible, contact PDL electronics or its agent for application advice. The Xtravert or the motor must be isolated before operating on the motor terminals.
6. The Xtravert output switching voltage waveform can give rise to high (capacitive) earth leakage currents. Permanent earth connection of both the motor and the Xtravert is essential before connection to the supply.
7. The control input circuit is configurable from the keyboard. Be sure that you are using the correct configuration and circuit before wiring up. Good control circuit wiring practice should be observed. Control wiring must be screened and run physically separate from power wiring (at least 300mm distance and crossing only at right angles).
8. The control terminal strip is constructed of cage clamp terminals. Recommendations for control terminal wiring connections:
   Recommended tightening torque: 0.5Nm
   Maximum tightening torque: 1.0Nm

Maximum cable size: 1.5mm² appliance wire
Maximum number of cables/terminal: 2

9. For single phase supply connect to L1 and N. For three phase supply connect to L1, L2, L3.

Note: It is the responsibility for the installer to ensure that all the manufacturer's installation guidelines are followed and that any site specific, local and national electrical regulations are complied with.

1.3 CONTROL INPUT/OUTPUT FUNCTIONAL DESCRIPTION AND SPECIFICATION

Fig. 1.4 provides the complete electrical specification of all Xtravert control inputs and outputs and includes diagramatic descriptions. Each input is individually described below.

TERMINALS D1–D3 — DISPLAY UNIT

The display unit may be mounted remotely (maximum distance 3m) by an extension lead of 3 core plus shield cable. Connect the shield (and drain wire) to 0V (Terminal D3).

TERMINALS T1–T5 — CONFIGURABLE RELAY OUTPUTS

Two voltage free 250Vac/30Vdc(referenced to protective earth -PE), 2A (non-inductive) rated relay outputs are provided for process interfacing. Each relay may be programmed (Screens O3 and O4) to switch according to one of several possible output controls.

One changeover contact pair (Terminals T1 to T3) and one normally open contact (Terminals T4 and T5) are provided.

TERMINALS T6–T9 — CONFIGURABLE (MULTI-FUNCTION) DIGITAL INPUTS

The switch (digital) input control lines of the Xtravert may be configured to provide many alternative functions. Refer to the detailed description of Screen I9 for a full description of the inputs and their alternative configurations. The level status of each of these inputs may be directly examined by viewing Screen Z6 at any time. Supply for control of active high inputs may be sourced from Terminal T11 or alternatively an external 24Vdc supply. Do not exceed 24Vdc on these terminals.

TERMINAL T10 — EXTERNAL TRIP INPUT (XTRIP)

If an external trip feature is not required, this input must be closed (linked to +24V). Provides a dedicated input to trip the Xtravert and immediately disables the output. Do not exceed 24Vdc on this input.

TERMINAL T11 — +24V SUPPLY, 20mA MAX.

Supply that may used for the Multi-function digital inputs (Terminals T6–T9) and the External Trip input (Terminal T10).

TERMINALS T12, T15, T17 — 0V CONNECTIONS

For safety reasons the Xtravert control PCB should be linked to earth at some point in a control system. When supplied the control PCB common point (0V) is connected to earth via a link from Terminal T12. Where control wiring is run to external control equipment (or other Xtraverts) there should be only one earth connection for the complete control system (to prevent earth loops). If necessary, remove this earth link.

TERMINAL T13 — +10V SUPPLY

Voltage reference signal for (1 kOhm) potentiometer control.

TERMINAL T14 — ANALOGUE INPUT 1 (AIN1)

Voltage control input for reference frequency adjustment or as a feedback source. It may be used for voltage control or as potentiometer input source. The input signal level may be observed on Screen Z3.

TERMINAL T16 — ANALOGUE INPUT 2 (AIN2)

Current loop control input for reference frequency adjustment or as a feedback source. Note that the current return (-connection) is common with the control PCB circuit 0V connection. The input signal level may be observed on Screen Z4.

TERMINAL T18 — CONFIGURABLE ANALOGUE OUTPUT

An analogue output which may be configured (Screen O1) to represent several different internal signals. Suitable for driving industrial voltmeters or further process controls. The format is selectable from 0-10V, ± 10V or 4-20mA via Screen O2. The output signal level may be observed on Screen Z5.

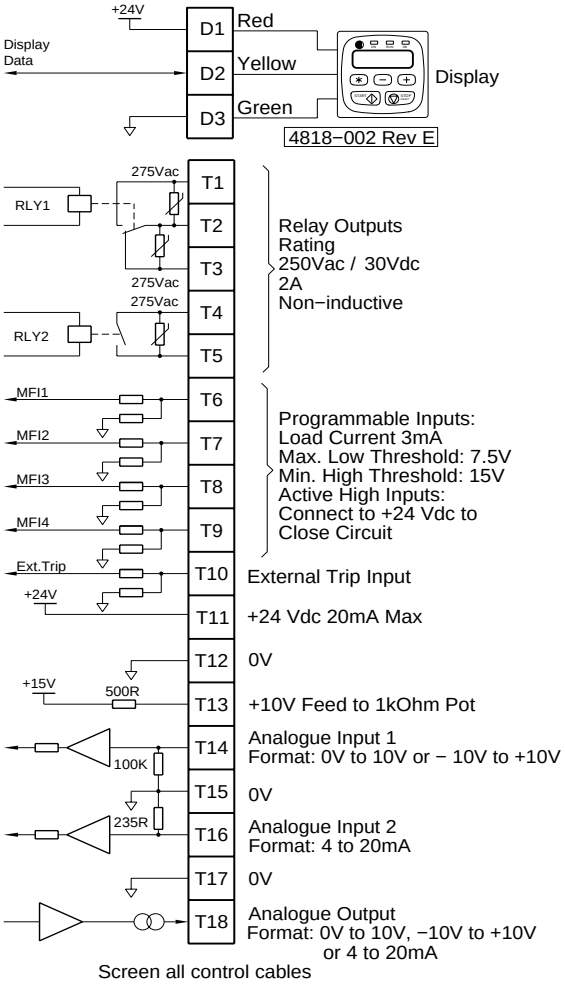


Figure 1.4: The Xtravert Control Inputs and Outputs

1.4 THE DISPLAY UNIT

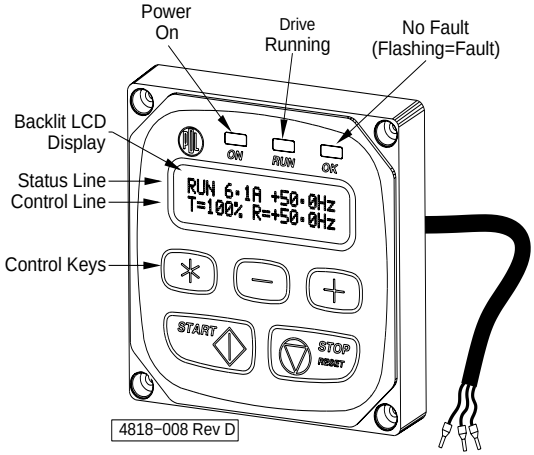


Figure 1.5: The Display Unit

1.4.1 THE LED INDICATORS

The LED indicators are a useful service tool once their exact function is understood.

LED	**ON**
Functional Indication	Mains power is supplied or stored charge is present.
Actual indication	Display Unit is functioning.
Implication	Control PCB receives power from supply.
LED	**RUN**
Functional Indication	Xtravert is running.
Actual indication	Output devices enabled.
Implication	Xtravert is functional.
LED	**OK**
Functional Indication	Xtravert is operating normally.
Actual indication	Drive ready to operate.
Implication	No fault is present.
LED	**OK (Flashing)**
Functional Indication	Fault trip.
Actual indication	Output disable.
Implication	A fault (Screen F) has tripped the Xtravert.

1.4.2 USE OF THE DISPLAY UNIT

THE LCD DISPLAY

The Xtravert has a 16 character by two line LCD display. The lines each have different functions:

– The STATUS LINE is always present and shows the Xtravert status, the output current and the output frequency.
– The CONTROL LINE display is used to view and/or adjust the many parameters of the Xtravert.

USE OF THE CONTROL KEYS

The control keys are used to view and/or adjust the parameters of the Xtravert.

SCREEN SELECTION

– Use "+" and "–" to examine the displays.

Note: Only the bottom line changes.

CHANGING A VALUE

– Use "+" and "–" to locate the desired screen.
– Press and hold "∗" to allow adjustment to the value.
– Now use "+" and "–" to adjust the value.
– Release "∗" to enter new value.

Hint: For reasons of security the Xtravert must be in commission mode (Screen Z) before some adjustments can be made.

1.5 COMMISSIONING THE XTRAVERT

Before attempting commissioning, be sure you understand the operation of the Xtravert and have read this manual. Plan and define your wiring, controls and adjustments beforehand.

CHECK INSTALLATION:

Check that the Xtravert will not be subject to an unacceptable environment. Check that adequate airflow is available. For reliable operation, the operating ambient temperature must not exceed 50°C.

CHECK WIRING:

Check all wiring thoroughly according to the circuits (refer fig. 1.3 and 1.4). Check that all supply and motor cabling is correctly dimensioned for the application, the Xtravert is bonded to earth and electrical connections are secure. The cable connecting the Xtravert to the motor should be of screened construction with the screen (forming an earth connection) solidly bonded to the motor and the Xtravert chassis. Local regulations may require a separate protective earth between the Xtravert and the motor. Be particularly careful that power and motor wiring is not transposed or otherwise incorrect (or else irreversible damage will occur). Control wiring must be screened and run separately from power cables.

Note that the Xtravert does not have internal power fuses. Check that the correct fuses (refer Specifications) are fitted at the supply.

Ensure that power and control cabling are securely fastened by the cable clamp on the Xtravert. Extra holes are provided on the Xtravert cable clamp for using cable ties.

Note that the External Trip input (Terminal T10) must be closed before the Xtravert will start. Check control wiring conforms to the configuration selected.

TEST WITHOUT MOTOR:

Before proceeding, ISOLATE THE MOTOR. Switch the mains supply on to the Xtravert.

CHECK XTRAVERT OPERATION:

Check that the Xtravert operates normally and displays the status and control lines. Familiarise yourself with the keyboard displays.

If any faults are indicated at any time, refer to Screen F — Fault Messages.

SELECT SCREEN Z6:

Check the status and operation of all inputs.

WARNING: – THE XTRAVERT WILL STILL RESPOND TO THE INPUTS WHILE DISPLAYING SCREEN Z6.

SET THE ADJUSTMENTS:

Referring to Screen Groups A to Z, set all relevant Xtravert and motor parameters.

TEST RUN WITH MOTOR:

Stop the Xtravert if it is running.

WARNING:
CHECK THAT ALL PERSONNEL ARE CLEAR
OF THE MOTOR AND ATTACHED MACHINERY
AND THAT IT IS SAFE TO OPERATE THE MACHINE.

REMOVE THE MOTOR ISOLATION:

Set a low reference speed and start the Xtravert. Check immediately for correct direction of rotation (if incorrect, stop the Xtravert, isolate it and allow to discharge before reversing two motor phase wires). Use the Xtravert adjustments to achieve the desired operation of the Xtravert.

START AND RUN THE XTRAVERT:

Check that the Xtravert correctly responds to all control inputs without the motor drawing excessive current. Remember to measure motor current (Xtravert display), not the mains current.

TEST RUN:

Operate the Xtravert and drive system, making control adjustments as necessary.

For maximum reliability of operation, try to ensure your setting up does not cause the Xtravert to rely on its protective override features (ILT - current limit; VLT - voltage limit). These should be regarded as back-up features, not to be used to overcome inadequate set up. If ILT is displayed, your acceleration rate is probably too high or your boost setting is too low or too high. If VLT is displayed, your deceleration rate is probably too fast. Reduce the deceleration rate or fit a dynamic brake unit.

Once satisfactorily commissioned, be sure to record all settings on the Commissioning Configuration Record provided for this purpose in Section 3. This makes life a lot easier if unauthorised adjustment occurs or if Xtravert replacement is necessary.

1.6 SERVICE

Faults in the Xtravert will fall into one of three major categories:

– Incorrect settings, set-up or adjustment resulting in unsatisfactory performance.
– Protective fault operation with resulting display message.
– Electrical failure within the Xtravert.

If the Xtravert powered up and running, but has performance problems, try re-tuning the Xtravert from scratch (refer Screen Y2). If this fails to give satisfactory results, finer tuning may be required using Screen Group X.

In the event of a protective fault trip occurring (refer Screen F), attempt to remove the cause of the trip and then reset the Xtravert.

In the event of electrical failure within the Xtravert, do not attempt to repair the unit. Seek service from a qualified service agent or replace the unit. For processes critical to the operation of a plant; retain a spare unit. If the Xtravert will not power up; check supply fuses or circuit breakers (load side) for the appropriate voltage. If the motor does not appear to be running; check for a motor side isolator or contactor.

1.7 ELECTROMAGNETIC COMPATIBILITY (EMC) AND SAFETY

1.7.1 CONTROL CABLES

Screened control cables must be used for the Xtravert to comply with EMC regulations. The screen should be connected to 0V on the control board (irrespective of whether the control board is earthed or floating) as an RF return. Avoid using long twisted leads (pigtails) for the screen connection as this twisting increases the RF impedance (reducing the effectiveness of the screen). Control wiring screens should only be connected at one point in the control circuit to avoid earth loops.

For safety reasons, the control wiring 0V should be connected to earth at one point in the system. The Xtravert is supplied with an earth link from Terminal T12 (0V) to earth. This may be removed if required (e.g., control wiring is earthed by other control circuitry) allowing the control board 0V to float up to 50Vdc (clamped) from earth. This prevents earth loops in the control wiring. An example of where this is useful is where multiple drives are controlled using the same 4-20mA current source connected in series. Remove the earth link to prevent shorting out analogue input 2 (AIN2).

Avoid running control cables in parallel with power cables with a spacing less than 300mm. For longer runs (greater than 10m), increase this spacing in proportion to the length of the run. Cross control cables at right angles to power cables to avoid magnetically induced interference.

1.7.2 POWER CABLES

Screened output power cables must be used for the Xtravert to comply with EMC regulations. Connect the screen at both the drive and motor ends to provide an RF return path. This prevents the motor frame becoming an RF source, coupling into the local metalwork and the earthing system. Connect all earths (input, output and cabinet) together at one star point.

Local regulations may require that a separate earth be run to the motor for safety requirements. It is recommended that four core cable plus screen be used in these applications. Alternatively, use screened three core cable plus a separate safety earth to provide minimised common-mode stator voltage. The screen should be constructed from a minimum of neutral screen cable or steel armor/conduit although preferably copper tape and/or copper mesh for the best attenuation of high frequency emissions.

The Xtravert has been designed with input and output power filters to minimise radio frequency interference. The input common mode filter prevents conducted RF emission to the mains supply. The output filters on each phase reduce conducted RF emission to the motor by reducing dv/dt on the motor cables. Screened motor cables prevent any remaining noise from being radiated to the environment. Generally, it is better to keep motor cables as short as possible to reduce capacitive charging currents due to cable capacitance and limit the peak voltage at the motor terminals. Refer to Specifications.

Due to the use of an input common mode filter and RFI capacitors to earth, earth leakage current will be present.

If unscreened motor cables are used, EMC regulations may not be complied with.

EC Declaration of Conformity

Manufacturer:	PDL Electronics Ltd. 81 Austin Street, Napier, New Zealand
Authorised Representative:	PDL Elektronik Vertrieb Deutschland GmbH Industriestraße 13A, D-90592, Schwarzenbruck, Deutschland
Details of Equipment:	Xtravert
Model Number(s):	X302, X304, X307, X309 X502, X504, X507, X509, X512, X516 X702, X704, X707, X709, X712, X716
Description:	AC motor controller

Directives this equipment complies with: LVD 73/23/EEC, EMC 89/336/EEC

Standards applied in order to verify compliance with directives:

BS EN61010-1:1993.
Safety requirements for electrical equipment for measurement, control, and laboratory use, part 1: General requirements. Sicherheitsbestimmungen für elektrische Meß-, Steuer-, Regel- und Laborgeräte - Allgemeine Anforderrungen.

BS EN61800-3:1996.
Adjustable speed electrical power drive systems, part 3: EMC product standard including specific test methods. Drehzahlveränderbare elektrische Antriebe - EMV - Produktnorm einschließlich spezieller Prüfverfahren.

BS EN55011:1991.
Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment. Grenzwerte und Meßverfahren für Funkstörungen von industriellen, wissenschaftlichen und medizinischen Hochfrequenzgeräten (ISM - Geräten).

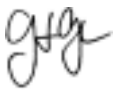
BS EN61000-4-2:1995.
Electrostatic discharge immunity. Prüfung der Störfestigkeit gegen die Entladung statischer Elektrizität.

BS EN61000-4-3:1995.
Radiated, radio-frequency, electromagnetic field immunity. Prüfung der Störfestigkeit gegen hochfrequente elektromagnetische Felder.

BS EN61000-4-4:1995.
Electrical fast transient/burst immunity. Prüfung und Störfestigkeit gegen schnelle transiente elektrische Störgrößen/Burst.

Year of affixing CE mark: 1997

Authorised Signatory: Manufacturer EU Authorised Representative



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Date of Issue:	2nd December 1997	
Place of Issue:	Napier, New Zealand	

SECTION 2: CONFIGURING THE XTRAVERT

2.1 INTRODUCTION TO THE FULL FEATURES OF THE XTRAVERT

When shipped from the factory the Xtravert is configured for local control.

Local control is just one selection setting of a large variety available in the Xtravert.

The process flexibility of the Xtravert only becomes evident when its programmable features are employed. This particularly refers to the ability to configure the Xtravert's operation in five specific areas (fig. 2.1):

- input frequency control source and format.
- analogue output source and format.
- process control, feedback
- relay outputs
- digital (switch) inputs

This configurability means that the Xtravert can often be employed as a complete stand-alone process control system.

To set up the Xtravert screens, the following procedure is typically used:

1. Set up the motor information of Screen Group N.
2. Set the limits of operation using Screen Group L. Set the minimum and maximum frequencies (Screens L1 and L2). The current limit on Screen L3 is typically set to 150% of the motor rated current (Screen N1). Use Screen L4 for current limit time-out (typically not required). Set Screen L5 to inhibit reverse direction being selected (typical for pumps).
3. Set up the control sources via Screen Group I. If local control is not required then disable the Display Unit's Start and Stop-Reset buttons via Screen I1. Select the speed reference source via Screen I2. If analogue input 1 (AIN1) is to be used then select the format (0-10V or ±10V) for Terminal T14. Set the span of the analogue inputs using Screens I5 to I8. Before setting the desired input mode at Screen I9, make certain that Terminal T10 is open to prevent inadvertent starting.
4. External monitoring of the Xtravert is achieved using analogue output 1 (AO1) at Terminal T18 and the two relays (RLY1 and RLY2) at Terminals T1 to T5. These are set up using Screen Group O. Start by setting analogue output 1 (AO1) to the required source using Screen O1. Set the analogue output format (0-10V, ±10V, 4-20mA) at Terminal T18 using Screen O2. Set the relay output selections using Screens O3 and O4. If using comparators as a relay source then set up using Screen Group C.
5. The ramp rates for accelerating and decelerating are then set using Screen Group R and the Start/Stop modes are set via Screen Group S.
6. Performance enhancements can now be set by applying voltage boost (Screen S3) if the motor has trouble starting the load. DC Stopping can be set up using Screens S4 and S5 to hold the motor near zero speed. For motors having problems with condensation, DC Heat (Screen S6) can be used to provide a small DC current to keep the motor warm.

More complex control schemes (e.g., pressure control using the internal PID process controller) will require the installer to fully read the manual to understand the wide range of features and flexibility within the Xtravert.

The following section provides full descriptions of the function and setting up of all Xtravert screen controls.

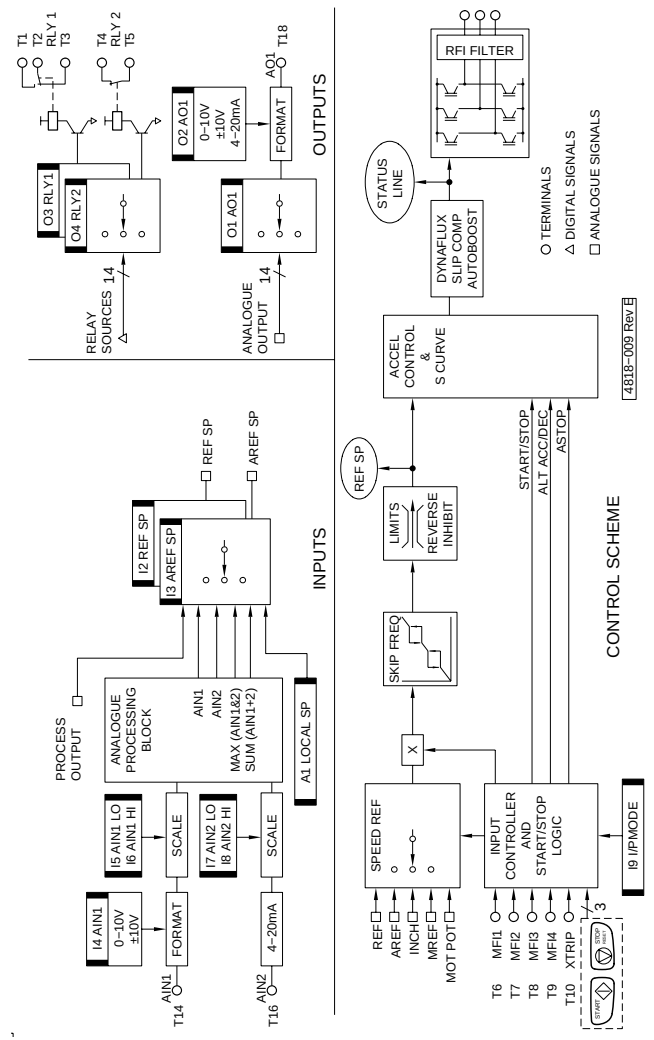

Figure 2.1: Structure of the Xtravert Control System

THE STATUS LINE

Screen **STP 0.0A +0.0Hz**
Description STATUS
Notes ALWAYS DISPLAYED

Function This is the top line of the display and is permanently displayed. The status line shows Xtravert status, motor current and output frequency according to the following:

STATUS MESSAGES:

Indication **STP**
Message STOPPED
Notes Xtravert stopped.

Indication **SPG**
Message STOPPING
Notes Xtravert is stopping.

Indication **RDY**
Message READY
Notes Xtravert is ready to run. A start command has been received but the speed demand does not exceed the minimum frequency or a automatically resetable fault is being reset.

Indication **RUN**
Message RUN
Notes Xtravert is running.

Indication **INC**
Message INCHING
Notes Xtravert is responding to an inch command.

Indication **ACC**
Message ACCELERATING
Notes Xtravert is accelerating from a lower frequency to a higher one.

Indication **DEC**
Message DECELERATING
Notes Xtravert is decelerating from a higher frequency to a lower one.

Indication **ILT**
Message CURRENT LIMITING
Notes Xtravert has reduced the output frequency to maintain the motor current at or below the current limit setting.

Indication **VLT**
Message VOLTAGE LIMITING
Notes Xtravert is limiting the deceleration rate to avoid excessive regeneration

Indication **HST**
Message HOST STOP (Serial Communications Option)
Notes Xtravert has stopped under a command via local control or host computer.

Indication **FLT**
Message FAULT TRIP
Notes Xtravert has tripped on a fault (refer to Screen F for detail).

DISPLAY STATUS, OVERLOADS:

The overload status is indicated by a flashing lower case letter while the overload is present.

Indication **i**
Message Current exceeds Xtravert rating.
WARNING: The Xtravert will eventually shut down to protect itself if this overload condition persists.

Indication **m**
Message Current exceeds motor capability.
WARNING: The thermal model of the motor indicates the motor will become too hot if this condition persists. The Xtravert will eventually stop to protect the motor if this condition persists.

OUTPUT CURRENT & FREQUENCY

Indication **0.0A**
Message Output current.
Notes The output current level supplied to the load.

Indication **+0.0Hz**
Message Output frequency.
Notes The frequency of the output voltage. The sign represents phase sequence; + is forward (U, V, W) phase sequence.

MOTOR ROTATION DIRECTION

According to IEC34–7, the motor rotates clockwise when:

– viewed from the drive (shaft) end,
– motor terminals U1, V1 and W1 (or U2, V2 and W2) are connected to Xtravert phases U, V, and W respectively,
– and the Xtravert is operating with “+” forward speed.

SCREEN GROUP A AUXILIARY SCREENS

A1

A2

A3

A4

A1 SET LOCAL SPEED SETPOINT

Screen **A1 LOCAL S= +50.0Hz**
Description LOCAL SPEED SETPOINT
Min/Max –150/+150
Units HERTZ

FUNCTION Local control of the set frequency.

SETTING UP Must be selected as the reference speed source (Screen I2) before it will take effect. Although this screen can be adjusted to ±120Hz, the Xtravert output frequency is constrained to Min Fr and Max Fr settings (Screens L1, L2).

A2, A3, A4 EXTENDED STATUS SCREENS

Screen **A2 T=100% R= +50.0Hz**
Description MOTOR TEMPERATURE; REFERENCE SPEED
Units %, HERTZ

FUNCTION Shows estimated motor temperature and the input reference speed.

Screen **A3 MOTOR RPM = 460**
Description MOTOR RPM
Units RPM (Revolutions per minute)

FUNCTION Shows motor reference speed in RPM. Screen N5 must be set appropriately for this value to be correct.

Screen **A4 Vdc=565V Vo=400V**
Description DC BUS VOLTAGE; OUTPUT VOLTAGE
Units V(DC);V(AC)

FUNCTION Shows the internal DC bus voltage of the Xtravert, and the AC voltage applied to the motor.

C1

SCREEN GROUP C COMPARATOR SCREENS

C1, C2 SPEED SENSE RELAY SETPOINTS

C2

Screen **C1 FR ON =12.0Hz**
Description FREQUENCY RELAY UPPER SET POINT
Min/Max RELAY OFF/150
Units HERTZ

C3

Screen **C2 FR OFF=10.0Hz**
Description FREQUENCY RELAY LOWER SET POINT
Min/Max 0.0/RELAY ON
Units HERTZ

FUNCTION To set the operating points of the frequency sensing relay controls.

SETTING UP Adjust the setpoints to the levels required by your process.
Configure the relay outputs using Screens O3, O4.

C3 CURRENT SENSE RELAY SETPOINT

Screen **C3 I SENSE=16.0A***
Description CURRENT RELAY SET POINT (5% HYST.)
Min/Max 0.00/1.50xI(Inv.)
Units AMPS

Notes * This value is dependent on Xtravert current rating.

FUNCTION To set the operating points of the current sensing relay control.

SETTING UP Adjust the set point to the level required by your process.
Configure the relay outputs using Screens O3, O4.

SCREEN GROUP F FAULT SCREENS

Fault messages are automatically displayed on Screen F. To reset fault indications, first determine and remove the cause of the fault, then operate the reset control (open a reset input control circuit or local keyboard control - Screen I1). Alternatively some faults may be reset automatically using the Xtravert auto-reset function. Refer to Screen S8 for further information.

At the time of a fault occurring, the Status Line (displaying output current and output frequency), Screen A3 (displaying the motor speed in RPM) and Screen A4 (displaying DC bus volts and output volts) have their values frozen. This provides additional diagnostic information.

Fault conditions, their interpretation, and suggested remedies are listed below:

Screen	**NO FAULT**
Description	FAULT DISPLAY
FUNCTION	Automatic display of fault information from the following list.
Fault	**01 LOW VDC**
Detail	Low DC Bus Volts; Mains voltage has dropped too low (= HV LOW TRIP - Screen S7).
Sense level	170Vac (240Vdc on DC bus)
Possible cause	Mains interruption, dip.
Action	Check supply conditions. Disable HV low trip (refer Screen S7).
Fault	**03 HIGH VDC**
Detail	High DC Bus Volts; DC bus voltage has risen to a dangerous level
Sense level	Internally Set.
Possible cause	Very high mains surge. Excessive regeneration from regenerative load or excessive deceleration rate (refer detailed description of Screen R2). Earth fault on motor.
Action	Reduce deceleration rate. Check motor circuit for earth fault. Apply S-curve (Screen R7).
Fault	**04 SUPPLY FLT**
Detail	Supply Fault; Input supply phase voltage imbalance.
Sense level	40Vac ripple voltage in Xtravert DC bus. Ripple is load dependent so phase imbalance will be most sensitive under heavy load conditions.
Possible cause	Loss of phase, fuse, motor phase loss, motor winding fault.
Action	Check supply conditions, check wiring to motor, check motor.
Fault	**05 S/W DL FLT**
Detail	Software Download Fault; Incorrect EPROM fitted.
Action	Seek service or replace Xtravert.
Fault	**06 EEPROM FLT**
Detail	EEPROM fault; Non-volatile memory (EEPROM) is faulty.
Possible cause	IC failure.
Action	Replace Xtravert.
Fault	**07 I TRIP FLT**
Detail	Current Trip Fault; Output current has reached a dangerous level.

Sense level 180% of Xtravert rated current.
Possible cause Short circuit; wiring fault; circuit fault; motor fault.
Action Check entire output circuit and motor for wiring or winding faults. Check output circuit contactors for correct operation.

Fault 15 XV O/L
Detail Xtravert Overload; The temperature calculated by the Xtravert inverter thermal model has reached a dangerous level.
Sense level 150% of Xtravert rated current for 30 seconds. Maximum continuous operation possible without trip is 105% of Xtravert rating.
Possible cause Continuous overload of Xtravert.
Action Check load requirements.

Fault 16 MOTOR O/L
Detail Motor Overload; The temperature calculated by the thermal model of the motor has reached a dangerous level.
Sense level 110%.
Possible cause Excessive load on motor (current draw too high); motor load exceeds cooling capacity at the operating speed; motor phase loss; motor winding fault; motor thermal model parameters incorrectly set.
Action Check load and thermal model settings (Screens N1–N6).

Fault 18 DATA FLT
Detail Data Fault; Non-volatile memory (EEPROM) reading error. The Xtravert will automatically RESET ALL DATA TO THE FACTORY SET VALUES upon reset of this fault. Be sure motor is isolated before resetting fault and entering correct data.
Sense level Checksum in memory.
Possible cause Spurious fault; faulty memory.
Action If fault recurs, replace Xtravert.

Fault 21 GROUND FLT
Detail Ground Fault detection; Excessive current flow to ground.
Sense level Internally set.
Possible cause Motor or cable insulation fault.
Action Check motor and cables (isolate from Xtravert first).
Note The ground fault detection system is not to be used for personnel earth fault protection.

Fault 22 EXT TRIP
Detail External Trip; External circuit (Terminal T10) has operated.
Sense level +12Vdc
Possible cause Operator, PLC, or external circuitry intervention.
Action Check external circuitry.

Fault 23 H/S TEMP
Detail Heatsink Temperature Trip; Xtravert heatsink too hot.
Sense level 90°C.
Possible cause Poor ventilation; obstructed ventilation path, local ambient temperature exceeds 50°C.
Action Check fan is operating; check ventilation and thermal conditions; improve cooling.

Fault	**25 COMMS TRIP**
Detail	Communications Trip; Host computer generated trip.
Possible cause	Trip generated by the host computer via serial communications.
Action	No action required.

Fault	**26 COMMS T/O**
Detail	Communications Timeout; Time since last valid serial communications data transfer has exceeded timeout period (Screen H2).
Sense level	Set by communications timeout value (Screen H2).
Possible cause	Serial Communications wiring fault; Xtravert RS232 or RS485 option board fault; host computer fault; incorrect settings (Screens H1, H2).
Action	Check complete serial communications system.

Fault	**29 ILT T/O**
Detail	Current Limit Timeout; Motor Stalled; Operation in current limit (Screen L3) has exceeded timeout period (Screen L4).
Sense level	User set current limit level and timeout period (Screens L3, L4).
Possible cause	Motor overload; incorrect settings.
Action	Check load and settings; refer to detailed descriptions of Screens L3, L4.

Fault	**31 CAL FLT**
Detail	Calibration Fault; Internal reference voltage levels are incorrect.
Possible cause	Xtravert fault.
Action	If persistent, replace the Xtravert.

Fault	**33 LVDC FLT**
Detail	Low Voltage DC Supply fault; Failure of +24V or ±15V supplies.
Sense level	24V supply falls below 22Vdc; 15V supplies fall below 12Vdc.
Possible cause	Internal Xtravert fault.
Action	If fault is persistent, replace Xtravert.

H1

SCREEN GROUP H HOST COMMUNICATION SCREENS

H1 SERIAL COMMUNICATIONS ADDRESS

H2

Screen **H1 COMMS ADR= 10**
Description SERIAL COMMUNICATIONS ADDRESS
Min/Max 1/240

FUNCTION Sets the serial communications address.

Serial communications with the Xtravert is available with the installation of the Xtravert serial communications option module (PDL Part No. X485). This allows the Xtravert to be controlled by a host controller such as a PLC or computer from a remote location via RS232 or RS485 using the industry standard Modbus protocol. All the controls, parameters, and modes available on the Xtravert can be monitored or adjusted by using the serial communications option module. For example, the Modbus host controller can start and stop the motor, control its speed, monitor the estimated motor temperature, and the status of the drive. In addition, the host controller can monitor and control a process by accessing unused digital and analogue I/O on the Xtravert.

SETTING UP The serial communications address has no effect if an Xtravert serial communications option module is not fitted. The serial communication option module (PDL Part No. X485) is connected to Terminals D1 to D3 replacing the display unit. Timeout protection is provided from Screen H2. The communication baudrate is fixed at 9600 Baud.

Notes: If input mode I3 is selected the communications address is set from the digital inputs.

H2 SERIAL COMMUNICATIONS TIMEOUT SELECTION

Screen **H2 COMMS T/O=OFF**
Description SERIAL COMMUNICATIONS TIMEOUT SELECTION
Options [OFF]/[1s]/[5s]/[25s]

FUNCTION Provides the option of tripping the Xtravert (indicating F26 COMMS T/O) if the time since the last valid serial communications data transfer has exceeded the communications timeout period.

SETTING UP If an Xtravert serial communications option module is not installed, leave this screen set to OFF (the timeout feature is active whether an Xtravert serial communications option module is fitted or not).

If an Xtravert serial communications option module is installed, select the required timeout period.

Notes: Select a timeout period which exceeds the time between valid serial communication data transfers.

SCREEN GROUP I INPUT SCREENS

I1 LOCAL START/STOP–RESET CONTROL

Screen **I1 LOCAL=STR/STP**
Description LOCAL CONTROL
Options
NONE: LOCAL CONTROL DISABLED
RESET: RESET ONLY
STP-RST: STOP–RESET ONLY
STR/STP: START/STOP–RESET ENABLED

FUNCTION Enables or disables the display unit Start/Stop–Reset.

I2 SPEED REFERENCE SOURCE

Screen **I2 REF SP=LOCAL**
Description SPEED REFERENCE SOURCE
Options REFER TABLE BELOW

FUNCTION Defines which input source (from the following list) is used to control the output frequency of the Xtravert.

SETTING UP Select the desired speed reference source to suit your requirements from the list below.

I3 ALTERNATIVE SPEED REFERENCE SOURCE

Screen **I3 AREF S=NULL**
Description ALTERNATIVE SPEED REFERENCE SOURCE
Options REFER TABLE BELOW

FUNCTION The alternative speed reference is selected using the programmable multifunction input as setup using Screen I9.

SETTING UP Select the desired alternative speed reference source to suit your requirements from the list below.

CODE	CONTROL SOURCE
NULL	NULL (ZERO)
LOCAL	SCREEN A1
AIN1	TERMINAL T14
AIN2	TERMINAL T16
AIN1&2	MAXIMUM OF AIN1 & AIN2
AIN1+2	SUM OF AIN1 + AIN2
MREF1	SCREEN M1
MREF2	SCREEN M2
INCH1	SCREEN M1
PR O/P	PROCESS CONTROL OUTPUT

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I4

I4 ANALOGUE INPUT 1 FORMAT

Screen **I4 AIN1 = 0-10V**
Description Selects the format of the Analogue Input 1 (AIN1)
Options 0-10V/±10V

I5

FUNCTION Provides the option of either 0-10V or ±10V input for Analogue Input 1

SETTING UP Select the required format for Analogue Input 1 at Terminal T14.

I6

I5-I8 ANALOGUE SCALING CONTROLS

Screen **I5 A1 LO =+0.0Hz**
Description ANALOGUE INPUT 1 LOW SETPOINT
Range –150/+150
Units HERTZ

I7

Screen **I6 A1 HI =+60.0Hz**
Description ANALOGUE INPUT 1 HIGH SETPOINT
Range –150/+150
Units HERTZ

I8

Screen **I7 A2 LO =+0.0Hz**
Description ANALOGUE INPUT 2 LOW SETPOINT
Range –150/+150
Units HERTZ

Screen **I8 A2 HI =+60.0Hz**
Description ANALOGUE INPUT 2 HIGH SETPOINT
Range –150/+150
Units HERTZ

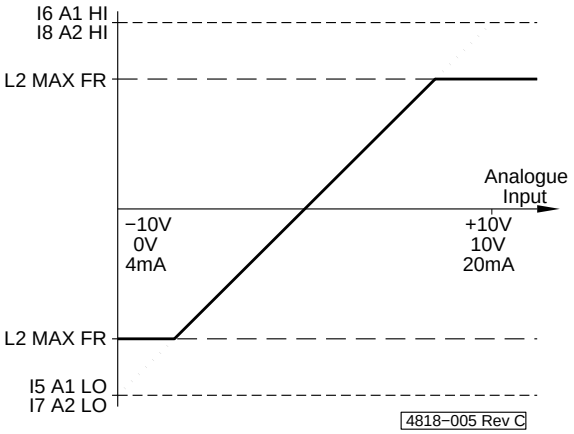
FUNCTION Provides controls for setting the Analogue Input spans (providing gain and offset).

A1 LO and A2 LO
Sets the reference when the minimum analogue level is applied to the analogue inputs.

A1 HI and A2 HI
Sets the reference when the maximum analogue level is applied to the analogue inputs.
The analogue inputs are linearly interpolated between the selected LO and HI settings.

SETTING UP If an analogue input is to be used for speed reference (Screens I2, I3) or process control (Screens P1, P2), it must first be selected as the source.
For Analogue Input 1, select the required format 0-10V or ±10V via Screen I4. Analogue Input 2 has a fixed format of 4-20mA.
Determine the range over which analogue control is desired. Adjust the LO setting (Screens I5, I7) to the reference required at the minimum analogue input. Adjust the HI setting (Screens I6, I8) to the reference required at the maximum analogue input.

At all times, the reference speed will be constrained by the maximum and minimum speed settings (Screens L1, L2).



I9 MULTIFUNCTION INPUT MODE

Screen **I9 I/P MODE =00**
Description MULTI-FUNCTION INPUT MODE SELECT
Options 00/13

FUNCTION The digital inputs of the Xtravert (Terminals T6 to T9) may be programmed to perform the many different control functions detailed on the following pages. The multi-function input mode screen defines which operating mode of the digital input controls is selected.

Detailed wiring and functional descriptions are presented in the following pages. The following are summary functional descriptions:

Option 0 **LOCAL CONTROL**
Message 00 LOCAL CONTROL
Notes Disables all multi-function inputs. Useful for commissioning by keyboard control without interference by external switch inputs.

Option 1 **3 WIRE STANDARD WITH DIRECTION**
Message 01 3W STANDARD
Notes The normal three wire configuration. Can also be wired for two wire control.

Option 2 **3 WIRE WITH ALTERNATIVE REFERENCE**
Message 02 3W ALTERN REF
Notes Provides normal three wire control plus provision to select an alternative speed reference source. The alternative speed reference source should be selected via Screen I3.

Option 3 **2 WIRE WITH DIRECTION AND ALTERNATIVE REFERENCE**
Message 03 2W ALTERN REF
Notes Provides two wire start/stop control with direction reversal plus provision to select an alternative speed reference source. The alternative speed reference source should be selected via Screen I3.

Option 4 **2 WIRE START-RESET WITH DIRECTION AND ALTERNATIVE REFERENCE**

Message 04 2W START–RST

Notes Provides a start-reset suitable for simple one wire control.

Option 5 **2 WIRE WITH DUAL ACCELERATION AND DECELERATION RATES**

Message 05 2W ACC/DEC

Notes Provides the ability to externally toggle the acceleration and deceleration rate set between Screens R1, R2 and Screens R3, R4. Works also in conjunction with Screen R5.

Option 6 **2 WIRE WITH INCH AND ALTERNATIVE REFERENCE**

Message 06 2W INCH AREF

Notes A dedicated inch input (INCH2) provides a start input while overriding the speed reference source to MREF2 (Screen M2). If the alternative reference is set to INCH1 and that input is closed then INCH3 (Screen M3 MREF3) is selected for the speed reference.

Option 7 **2 WIRE WITH DUAL ACCELERATION AND DECELERATION RATES, AND ALTERNATIVE REFERENCE.**

Message 07 2W ACC AREF

Notes Provides the ability to externally toggle the acceleration and deceleration rate set between Screens R1, R2 and Screens R3, R4. Works also in conjunction with Screen R5. The AREF input provides provision to select an alternative speed reference source. The alternative speed reference source should be selected via Screen I3.

Option 8 **MULTI-REFERENCE 3 WIRE**

Message 08 MREF 2W

Notes Provides seven selectable speed references (Screens M1–M7) plus zero speed according to the binary sequence of the three switch inputs X,Y,Z (Terminals T6, T7, T9).

Option 9 **MULTI-REFERENCE 2 WIRE**

Message 09 MREF 2W AREF

Notes Provides three selectable speed references (Screens M5–M7) plus zero speed according to the binary sequence of the two switch inputs Y,Z (Terminals T7, T9) plus an alternative reference input (Terminal T6). The alternative reference selection overrides the multi-reference selection.

Option 10 **MOTORISED POTENTIOMETER**

Message 10 MOTORISED POT

Notes Provides reference control by "increase reference" and "reduce reference" push buttons. Push buttons may be connected in series/ parallel to provide distributed control points. Reduce reference is defined as normally closed for fail safe operation. The motorised potentiometer switches all adjustment between the reference frequency set points MREF4 and MREF5 (Screen M4 and M5). The adjustment rate is scaled to allow full scale adjustment in 10s. The lowest absolute speed setting (or 0Hz if the range spans 0Hz) is set on power up.

Option 11 **MOTORISED POTENTIOMETER WITH DIRECTION**
Message 11 MOTOR POT DIR
Notes Similar to Option 10 but with start-reset and provides the ability to invert the speed reference direction.

Option 12 **CRANE DUAL BUTTON CONTROL**
Message 12 CRANE BUTTON
Notes A simple crane control system suited to long and cross travel. Speed and direction control by double detent (two stage action) push buttons. Limit switch control logic is provided slow down and stop at extremes of travel.
For operation, the Multi-reference screens are set up as follows:
M1 MREF1 = (slow speed)
M2 MREF2 = (maximum speed)
M3 MREF3 = (minimum hold speed)
Refer to Fig. 2.3. At closure of the early make (first) contact of the two stage action push button, the Xtravert is started and accelerates in the appropriate direction to the minimum hold speed (MREF3 Screen M3). Closure of the late make (second) contact of the same push button accelerates the Xtravert to the maximum speed (MREF2 Screen M2). If this contact is opened before this point, the Xtravert holds its present speed.
Releasing the two stage action push button will cause the Xtravert to decelerate to a stop. If the first contact is closed again before the Xtravert stops, it will hold its present speed. Opening of a slow limit switch in either direction will cause the Xtravert to run at the slow speed (MREF1 Screen M1). Opening of the respective working limit will cause the Xtravert to stop running in that direction enabling restart only in the opposite direction.
Crane brake control can be accomplished using the configurable relays operating on current and/or frequency (Refer Screens C1 to C3).

Option 13 **COMMS ADDRESS SELECT**
Message 13 COMMS ADDRESS
Notes Provides two wire start/stop with alternative stop-reset and selection of 1 of 4 Modbus communications addresses. With this option selected screen H1 can no longer be modified.

Comms Address	Terminal T7	Terminal T9
1	Open	Open
2	Closed	Open
3	Open	Closed
4	Closed	Closed

SETTING UP **WARNING**: Altering the multi-function input mode of the Xtravert completely reconfigures the control input terminals and the logic of their operation. Be quite sure that you understand the operating mode you require, and that any inputs already connected will not cause the Xtravert to automatically start once your mode is selected.

Hints: Local Control mode is a special “safe” multi-function mode in which all inputs are disabled (the Xtravert will not start from external terminal inputs), but will still show the state and operation of the analogue and digital inputs on the Commissioning Screens (Screens

Z3 to Z5). Before finally selecting your desired operating multi-function mode, use this mode to safely inspect the status and operation of all of your inputs.

The Xtravert will, however, still start from keyboard and serial communications inputs when local control is selected. To prevent starting from any source, the External Trip input (Terminal T10) should be opened.

Refer to the following table to determine which input mode your application requires. Ensuring Terminal T10 is open, so that the Xtravert will not automatically start, select your desired input mode.

SCREEN	DESCRIPTION	CONTROL SWITCH INPUTS				
		MFI 1	MFI 2	MFI 3	MFI 4	XTRIP
		T6	T7	T8	T9	T10
00 LOCAL CONTROL	LOCAL	DISABLED	DISABLED	DISABLED	DISABLED	EXT. TRIP
01 3W STANDARD	3 WIRE, DIRECTION INVERT	STOP	START	ASTOP-RST	INV DIRN	EXT. TRIP
02 3W ALTERN REF	3 WIRE, ALTERNATIVE REF	STOP	START	ASTOP-RST	AREF	EXT. TRIP
03 2W ALTERN REF	2 WIRE, DIRECTION, AREF	STR/STP	INV DIRN	ASTOP-RST	AREF	EXT. TRIP
04 2W START-RST	2 WIRE, START-RST, AREF	START/RST	INV DIRN	ASTOP	AREF	EXT. TRIP
05 2W ACC/DEC	2 WIRE, START-RST, ALT ACC	ALT. ACC/DEC	INV DIRN	START-RST	AREF	EXT. TRIP
06 2W INCH AREF	2 WIRE, INCH	STR/STP	INCH2	ASTOP-RST	AREF	EXT. TRIP
07 2W ACC AREF	2 WIRE, ALT ACC/DEC	STR/STP	ALT ACC/DEC	ASTOP-RST	AREF	EXT. TRIP
08 MREF 3W	MULTI-REF 3 WIRE	X	Y	ASTOP-RST	Z	EXT. TRIP
09 MREF 2W AREF	MULTI-REF 2WIRE, AREF	AREF	Y	ASTOP-RST	Z	EXT. TRIP
10 MOTORISED POT	MOTORISED POTENTIOMETER	STR/STP	UP	ASTOP-RST	DOWN	EXT. TRIP
11 MOTOR POT DIR	MOTORISED POT, DIRECTION	INV DIRN	UP	START-RST	DOWN	EXT. TRIP
12 CRANE BUTTON	DUAL BUTTON CONTROL	-HOLD	+HOLD	ADJUST	SLOW	EXT. TRIP
13 COMMS ADDRESS	COMMS ADDRESS	STR/STP	COMMS 0	ASTOP-RST	COMMS 1	EXT. TRIP

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Figure. 2.1: Multi-function Digital Input Configurations

Input **Start**
Active State Closed
Function Starts Xtravert; latching.
Conditions Stop closed, Alternative stop-reset closed; no faults.

Input **Stop**
Active State Open
Function Stops Xtravert.

Input	**Start–Reset**
Active State	Closed
Function	Resets fault; starts Xtravert; non-latching.
Conditions	Fault removed. Alternative stop-reset closed; no faults.

Input	**Start/Stop**
Active State	Closed
Function	Closed starts Xtravert; non-latching.
Conditions	Alternative stop-reset closed; no faults.

Input	**Invert Direction**
Active State	Closed
Function	Causes Xtravert to reverse (inverts reference frequency).

Input	**Alternative Stop-Reset**
Active State	Open
Function	Decelerates according to alternative stop rate (Screen R6); Resets fault; latching.
Conditions	Fault removed.

Input	**Inch 1**
Active State	Closed
Function	Starts Xtravert at Inch 1 speed (MREF1, Screen M1). Not latched.
Conditions	Stop or Alternative stop-reset closed; no faults.
Notes	Inch 1 may be selected via the alternative reference (Screen I3).

Input	**Inch 2**
Active State	Closed
Function	Starts Xtravert at Inch 2 speed (MREF2, Screen M2). Not latched.
Conditions	Alternative stop-reset closed; no faults.

Input	**X, Y, Z**
Active State	Closed
Function	Starts Xtravert using the multi-reference setpoints. Refer Screens M1–M7.
Conditions	Alternative stop-reset closed; no faults.

Input	**Alternative Acceleration/Deceleration**
Active State	Closed
Function	Selects alternative acceleration/deceleration. Refer Screens R1–R4.

Input	**Alternative Reference**
Active State	Closed
Function	Selects the alternative reference (Screen I3).

Input	**Increase Speed Reference**
Active State	Closed
Function	Increase the motorised potentiometer setpoint.
Conditions	Decrease speed reference closed.

Input	**Decrease Speed Reference**
Active State	Open
Function	Decrease the motorised potentiometer setpoint.
Conditions	Increase speed reference open.

Input	**-Hold, +Hold**
Active State	Closed
Function	Dual Button Control: Holds current speed in indicated direction when closed.

Input	**Adjust**
Active State	Closed
Function	Dual Button Control: Increases speed in direction according to -Hold, +Hold.
Conditions	-Hold or +Hold closed.

Input	**XTRIP**
Active State	Open
Function	When opened, trips the Xtravert displaying "F22 EXT TRIP" and disables the output. The XTRIP input must be closed for the Xtravert to start and run.

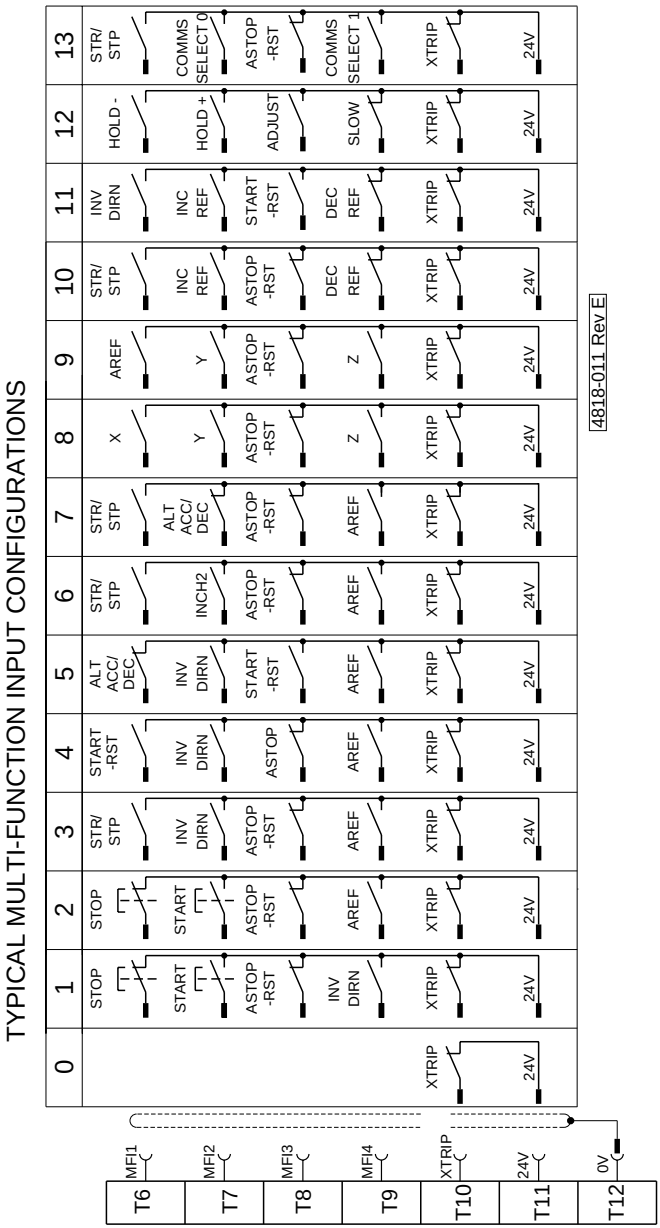
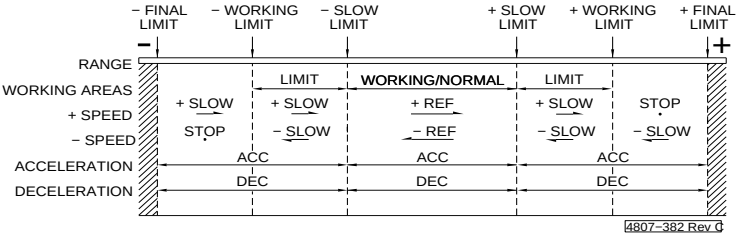


Figure 2.2: Multi-Function Input Configurations



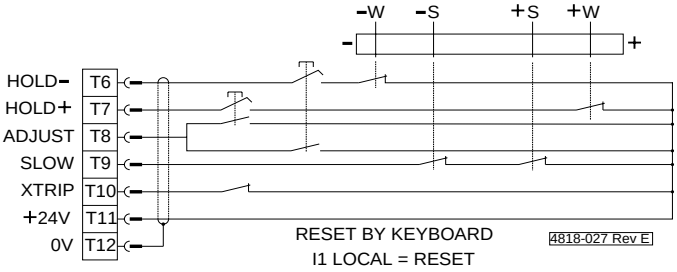


Figure 2.3: Multifunction Input Mode 12 - Dual Button Crane control wiring

SCREEN GROUP L LIMIT SCREENS

L1

L2

L3

L4

L1, L2 MINIMUM/MAXIMUM SPEEDS

Screen **L1 MIN FR= 0.0Hz**
Description MINIMUM FREQUENCY
Min/Max 0.0/MAX FREQUENCY
Units HERTZ

Screen **L2 MAX FR= 60.0Hz**
Description MAXIMUM FREQUENCY
Min/Max MIN FREQ/150
Units HERTZ

FUNCTION **Minimum Frequency:** Sets a minimum frequency below which the Xtravert cannot be set to run. If run at minimum frequency (Screen L9) is enabled (Y) then the Xtravert will operate at the minimum frequency if the absolute value of the reference is set below the minimum. If run at minimum frequency is disabled (N), then the Xtravert will stop under the above conditions. Inch controls allow operation below the minimum frequency.

Maximum Frequency: Sets a maximum frequency above which the Xtravert cannot be instructed to run. Demand by any control input of an absolute value greater than this frequency will be clamped to this frequency.

SETTING UP The particular arrangement of limits and set points on the Xtravert offers a great degree of flexibility, depending upon the values chosen. Refer also to Screens I5 to I9.

L3, L4 CURRENT LIMIT CONTROLS

Screen **L3 I LIMIT=16A**
Description CURRENT LIMIT
Min/Max 0.05/1.50 of I(Inverter)
Units AMPS

Screen **L4 ILT T/O=NONE**
Description CURRENT LIMIT TIMEOUT
Min/Max 0.0/25.0/NONE
Units SECONDS

FUNCTION To actively reduce the Xtravert frequency or acceleration to maintain load current within controllable bounds (status = ILT). Current limit timeout provides a setable maximum time of active current limit, beyond which the Xtravert will automatically trip (Fault status = 29 ILT T/O).

If the current limit timeout period is set at, or near zero, the current limit function effectively acts as a “SHEARPIN”, providing rapid over-torque protection.

SETTING UP Current limit: Where not strictly part of the required set-up for the particular application leave this set at 1.2 x Xtravert rated current.

If there is a particular requirement for this function (e.g., for torque

L5

limiting or to ensure the motor cannot approach the overload setting, and thus will not trip out regardless of the demanded frequency) set the current limit to the desired value.

L6

Hints: For normal operation, avoid choosing values much below the motor's rated current as various effects (boost, rapid acceleration or deceleration) can lead to confusing results.

Current limit timeout: Where not required adjust to “NONE”. Adjust as appropriate for your application. For “SHEARPIN” action, set to 0.0.

L7

Hints: In a well set up application current limit should never be required. Current limit acts to override incorrect Xtravert set up or load problems. If current limit action is observed during normal operation of the Xtravert or process, check that the set-up is correct - particularly check acceleration, deceleration, motor parameters and boost settings.

L8

L5 REVERSE DIRECTION INHIBIT

Screen **L5 REV INHIBIT=N**
Description REVERSE LOCK OUT
Options [Y]ES/[N]O

FUNCTION Provides, as a mechanical safety function, the ability to stop the Xtravert from operating in reverse, regardless of input command or selected negative frequency.

SETTING UP If reverse operation is to be a normal function of the process set reverse inhibit to NO.

If reverse operation is not required set reverse inhibit to YES.

L6, L7, L8 SKIP FREQUENCIES

Screen **L6 SKIP 1 =+0.0Hz**
Description SKIP FREQUENCY 1
Min/Max –150/+150
Units HERTZ

Screen **L7 SKIP 2 =+0.0Hz**
Description SKIP FREQUENCY 2
Min/Max –150/+150
Units HERTZ

Screen **L8 SK BW= 10.0Hz**
Description SKIP BANDWIDTH
Min/Max 0.0/10.0
Units HERTZ

FUNCTION To provide two zones of reference frequencies that cannot be set. The object is to provide “keep out” areas of operation which may be selected so that natural mechanical system resonances can be avoided.

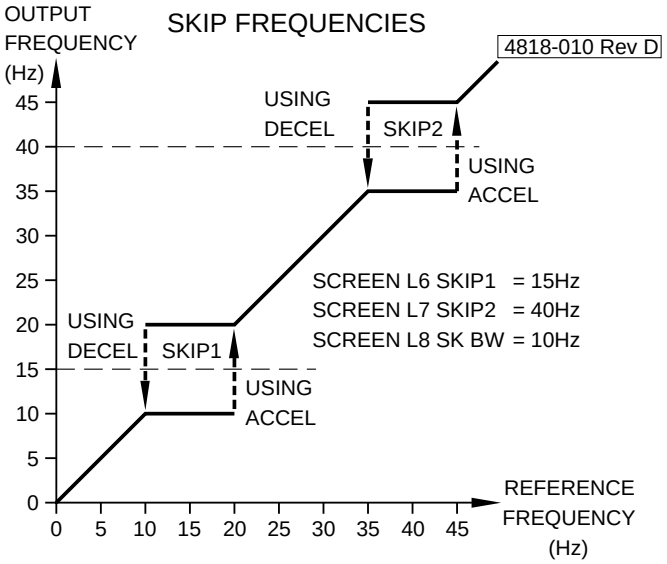
Skip frequencies 1 and 2 define the middle of each skip zone. The skip bandwidth defines the width of the zones.

SETTING UP Complete other commissioning first. Determine points, and

breadths of any (two) mechanical resonances in your system. Enter skip frequencies and desired bandwidth. Do not overlap skip zones unless only one zone is required. If only one skip zone is required, define the same frequency for both zones.

To turn off skip frequencies set SK BW to 0.0.

Check operation and readjust as necessary



L9 RUN AT MINIMUM FREQUENCY

Screen **L9 MIN FR RUN = N**
Description RUN AT MINIMUM FREQUENCY MODE SELECT
Options [Y]ES/[N]O

FUNCTION When run at minimum frequency is enabled (Y), the Xtravert will continue to run even when the reference frequency is set below the minimum frequency level (MIN FR - refer to Screen L1). However, the Xtravert will operate at the minimum frequency. If run at minimum frequency is disabled (N) then the Xtravert will stop and wait in the ready mode if the reference frequency is reduced below the minimum frequency.

The inch command will override the minimum frequency limitations.

SETTING UP If the Xtravert is required to run (at the minimum frequency) when the reference frequency is below the minimum frequency then select [Y]ES.

If the Xtravert is required to stop and wait in the ready mode when the reference frequency is below the minimum frequency then select [N]O.

M1

SCREEN GROUP M MULTI-REFERENCE SCREENS

M2

M1–M7 MULTI-SPEED REFERENCES

Screen M1 MREF1= +0.0Hz
Screen M2 MREF2= +0.0Hz
Screen M3 MREF3= +0.0Hz
Screen M4 MREF4= +0.0Hz
Screen M5 MREF5= +0.0Hz
Screen M6 MREF6= +0.0Hz
Screen M7 MREF7= +0.0Hz

M3

Description MULTI-SPEED REFERENCES
Min/Max –150/+150
Units HERTZ

M4

FUNCTION These are frequency set points for use with the following modes:

Inch 1	(MREF1)	Refer Screen I9, Options 2-7,9,12
Inch 2	(MREF2)	Refer Screen I9, Option 6,12
Inch 3	(MREF3)	Refer Screen I9, Option 6,12
Multi-reference	(MREF1 to MREF7)	Refer Screen I9, Options 8,9
Motorised Potentiometer	(MREF4 and MREF5)	Refer Screen I9, Option 9,10.

M5

The frequency set points may have negative values thus permitting reverse motor direction to be selected.

M6

SETTING UP Set each multi-speed setpoint to your desired value. Leave unused multi-speed frequencies set at zero in case these are inadvertently selected.

Configure the multi-function input mode (Screen I9) as necessary to use these inputs.

M7

SCREEN	TITLE	SPECIAL FUNCTIONS	MULTI-REFERENCE INPUTS		
			MFI1 (T6) X	MFI2 (T7) Y	MFI4 (T9) Z
	STOP		O	O	O
M1	MREF1	INCH1	O	O	X
M2	MREF2	INCH2	O	X	O
M3	MREF3	INCH3	O	X	X
M4	MREF4	MOTORPOT MIN SPEED	X	O	O
M5	MREF5	MOTORPOT MAX SPEED	X	O	X
M6	MREF6		X	X	O
M7	MREF7		X	X	X

O = Open, X = Closed

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SCREEN GROUP N MOTOR NAMEPLATE SCREENS

N1, N2, N3, N5, N6 MOTOR NAMEPLATE SCREENS

Screen **N1 MTR CUR=14.6A**
Description RATED (NAMEPLATE) MOTOR CURRENT
Min/Max 0.20/1.50 x I(Inverter)
Units AMPS

Screen **N2 MTR VOLT= 400V**
Description RATED (NAMEPLATE) MOTOR VOLTAGE
Min/Max 10/500
Units AC VOLTS

Screen **N3 MTR FR = 50Hz**
Description RATED (NAMEPLATE) MOTOR FREQUENCY
Min/Max 10/175
Units HERTZ

Screen **N5 MTR RPM = 1490**
Description RATED MOTOR RPM
Min/Max 0/8000
Units RPM

Screen **N6 MTR COOL= 40%**
Description MOTOR COOLING AT ZERO SPEED
Min/Max 5/100, OFF
Units %

FUNCTION To calibrate the Xtravert for the motor being driven. Sets the correct voltage and nominal operating frequency. Current, frequency and the motor cooling at zero speed parameters are used to define the thermal model. The thermal model performs a superior function to a thermal overload relay since it uses this data to compensate for differing cooling efficiencies when the motor is operated at other than rated frequency.

The thermal model is reset when power is removed from the Xtravert, therefore it is usually preferable to maintain power to the Xtravert at all times, and use the control inputs to stop and start the motor as required.

Where using multiple motors, each must have the same rated frequency and voltage. Each motor should be provided with its own thermal protection since it is not possible for the Xtravert to protect individual motors. Enter the total current.

SETTING UP Enter motor rated (nameplate) parameters - current, voltage, frequency, speed. Estimate the efficiency of cooling of your motor at zero speed and enter this figure (this is very application dependent - as a guide 40–60% is typical; where open frame, water or force cooled motors are used, a higher cooling efficiency will be achieved). The motor thermal model may be disabled by setting the motor colling to OFF. Independant external thermal protection should then be applied to the motor.

O1

SCREEN GROUP O OUTPUT SCREENS

O1 ANALOGUE OUTPUT 1 (AO1) SOURCE

Screen **O1 AO1 SRC =02**
Description ANALOGUE OUTPUT 1 (AO1) SOURCE
Options 00/15

FUNCTION Selects the analogue output function (Terminal T18) according to the following:

Option 00 **Null**
Notes Sets analogue output 1 (AO1) to 0V or 4mA as selected by Screen O2.
Option 01 **Full Scale**
Notes Sets analogue output 1 (AO1) to +10V or 20mA as selected by Screen O2.
Option 02 **Output Frequency ±50Hz**
Option 03 **Output Frequency ±60Hz**
Option 04 **Output Frequency ±100Hz**
Option 05 **Output Frequency ±150Hz**
Option 06 **Output Current**
Notes 0-150% of Xtravert rated current
Option 07 **Output Volts**
Notes 0-500Vac
Option 08 **Host Communications**
Notes -10 to +10V
Option 09 **Torque Current**
Notes 0-150% of Xtravert rated current Indicates the component of current in phase with the output voltage (i.e., real current). Owing to the high efficiency of the induction motor, this output is closely related to the motor torque under fixed V/Hz operation (X1 Min Flux = 100%).
Option 10 **Motor Power**
Notes 0-150% of motor rated power. Indicates power supplied to the motor. Useful for power control systems. A power factor of 0.9 is assumed. Accuracy is approximately ±10%
Option 11 **Reference Frequency ±50Hz**
Option 12 **Reference Frequency ±60Hz**
Option 13 **Reference Frequency ±100Hz**
Option 14 **Reference Frequency ±150Hz**
Option 15 **Process Control Error ±100%**
Notes When using unipolar formats (0-10V, 4-20mA) signed outputs will be converted to magnitude only.

SETTING UP Select the required option and set the format (0-10V, ±10V, 4-20mA) via Screen O2. The analogue output signal level may be observed on Screen Z5.

O2 ANALOGUE OUTPUT FORMAT

Screen **O2 AO1=0–10V**
Description ANALOGUE OUTPUT FORMAT
Options 0–10V / ±10V / 4–20mA

O2

FUNCTION Allows the format of the Analogue Output (Terminal T18) to be configured.
SETTING UP Select the desired output as required.

O3

O3, O4 DIGITAL OUPUTS

O4

Screen **O3 O/P RELAY 1 = 02**
Description OUTPUT RELAY 1 MODE SELECT
Options 0/16

Screen **O4 O/P RELAY 2 = 05**
Description OUTPUT RELAY 2 MODE SELECT
Options 0/16
FUNCTION Provides the ability to individually configure the state of each relay according to the following list. At power-up and during the reset interval all relays are in a de-energised state.

No. **00**
Name DE-ENERGISED
Notes This selection de-energises the relay.

No. **01**
Name ENERGISED
Notes This selection energises the relay.

No. **02**
Name NO FAULTS
Energised NO FAULT
De-Energised FAULT
Notes Indicates that the Xtravert is in an operational state. This relay is failsafe and will be energised on a fault free power-up or fault reset. A trip condition, power loss or Xtravert failure will cause the relay to de-energise.

No. **03**
Name START
Energised STARTED
De-Energised NOT STARTED
Notes Indicates that the Xtravert has received a START command. Relay will de-energise when the Xtravert receives a STOP command or if the Xtravert trips on a fault.

No. **04**
Name RUN
Energised RUNNING
De-Energised NOT RUNNING
Notes Indicates that the Xtravert is running the motor.

No. **05**
Name START OR RUN
Energised START OR RUN
De-Energised NOT START OR RUN
Notes Xtravert is started or is running

No. **06**
Name INVERTER O/L
Energised OVERLOADED

De-Energised	NOT OVERLOADED
Notes	Indicates that the Xtravert will eventually trip (or has already tripped) on "15 XV O/L" if left running at the present current. The overload will go inactive if the output current is reduced to the Xtravert rating or less. This is a predictive overload and the relay will pulse to warn of impending trip.

No.	**07**
Name	MOTOR O/L
Energised	OVERLOADED
De-Energised	NOT OVERLOADED
Notes	Indicates that the motor will eventually trip (or has already tripped) on "16 Motor O/L" if left running at the present current and speed. The overload will go inactive if the cooling is improved sufficiently (higher speed) or the current is reduced sufficiently. This is a predictive overload and the relay will pulse to warn of impending trip.

No.	**08**
Name	FREQ SENSE
Energised	ABOVE Fr ON
De-Energised	BELOW Fr OFF
Notes	See Screens C1, C2. Becomes energised when the inverter frequency has exceeded the upper frequency sense point (FR ON - Screen C1). Becomes de-energised when the frequency goes below the lower frequency sense point (FR-OFF - Screen C2). If the lower frequency sense point is set to zero, this signal will become de-energised only when the Xtravert stops (comes out of run). If the upper frequency sense point is 0 then it will become energised as soon as the Xtravert goes into run. The upper frequency sense point will always be higher than the lower frequency sense point.

No.	**09**
Name	CURRENT SENSE
Energised	ABOVE SENSE CURRENT
De-Energised	BELOW SENSE CURRENT
Notes	See Screen C3. Indicates that the current has exceeded the current sense point (Screen C3). This relay output exhibits 5% hysteresis.

No.	**10**
Name	INVERTER DIRECTION
Energised	REVERSE
De-Energised	FORWARD
Notes	The relay reflects the sign of the output frequency.

No.	**11**
Name	COMMS OUTPUT
Energised	SET
De-Energised	NOT SET
Notes	This signal can be toggled by the serial communications line and has no relation to the state of the Xtravert. It is intended purely for user convenience.

No.	**12**
Name	AT SET FREQ
Energised	AT FREQUENCY
De-Energised	NOT AT FREQUENCY
Notes	±0.5Hz. This signal indicates that the Xtravert is not accelerating or decelerating.

No.	**13**
Name	OVERLOAD ALARM
Energised	OVERLOADED
De-Energised	NOT OVERLOADED
Notes	Motor overloaded or inverter overloaded.

No.	**14**
Name	POWER FLOW
Energised	INVERTER REGENERATING
De-Energised	INVERTER SUPPLYING POWER

No.	**15**
Name	FEEDBACK SENSE
Energised	FEEDBACK BELOW REFERENCE
De-Energised	FEEDBACK ABOVE REFERENCE
Notes	Indicates that the feedback signal has exceeded the reference signal plus half the hysteresis (Screen P7)

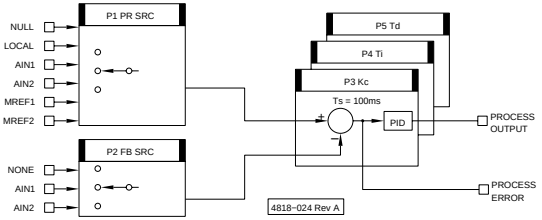
No.	**16**
Name	REFERENCE FREQUENCY DIRECTION
Energised	REVERSE
De-Energised	FORWARD
Notes	The relay reflects the sign of the reference frequency.

No.	**17**
Name	NO FAULTS LIMIT
Energised	NO FAULT OR A FAULT THAT CAN BE AUTOMATICALLY RESET
De-Energised	FAULT THAT CAN NOT BE AUTOMATICALLY RESET
Notes	See Screen S8. If automatic fault reetting is not enabled then this setting is the same as No. O2 NO FAULTS

P1

SCREEN GROUP P PROCESS CONTROL SCREENS

Introduction The Xtravert Series process controller is a fully featured PID regulator. The setpoint and feedback sources may be selected from a wide choice of options. If selected, the process output may be routed to the speed controller to provide a speed reference source (refer Screens I2, I3). The process controller may be disabled via a digital input to give auto/manual control by selecting an alternative speed reference (Refer Screen I9).



Tuning The process controller may be tuned using manual Zielger-Nichols techniques or by starting with the default values:
Increase the Controller Gains (Screen P3) until oscillation first occurs; then set to approximately 40% this setting.
Decrease the Integration Time (Screen P4) until oscillation occurs; then set back to approximately 150% this setting.
Increase the Differentiation Time (Screen P5) until minimal overshoot has been achieved but oscillation has not occured.
Typically the Differentiation Time would not exceed 25% of the Integration Time.

P1 PROCESS CONTROL SETPOINT SOURCE

Screen **P1 PR SRC=NULL**
Description PROCESS CONTROL SETPOINT SOURCE
Options REFER TABLE BELOW
FUNCTION Defines which input source is used as the setpoint source for process control:

CODE	PROCESS CONTROL SETPOINT SOURCE
NULL	NO SOURCE SELECTED
LOCAL	LOCAL SETPOINT CONTROL (SCREEN A1)
AIN1	ANALOGUE INPUT 1
AIN2	ANALOGUE INPUT 2
MREF1	MULTI-REFERENCE 1
MREF2	MULTI-REFERENCE 2

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SETTING UP Select the desired process control setpoint source to suit your requirements.

P2 PROCESS CONTROL FEEDBACK SOURCE

Screen **P2 FB SRC=NONE**
Description FEEDBACK SOURCE

FUNCTION Defines which input source (from the following list) is used as feedback source for process control.

CODE FEEDBACK SOURCE
NONE
AIN1 ANALOGUE INPUT 1 (TERMINAL T14)
AIN2 ANALOGUE INPUT 2 (TERMINAL T16)

SETTING UP Select the desired feedback source for your application.

For obvious reasons, do not select the reference and feedback from the same source.

Use the process error (Screen P6) and/or the feedback sense relay hysteresis (Screen P7) to monitor the feedback status.

P3, P4, P5 PROCESS CONTROL PID SETTINGS

Screen **P3 Kc= 1.0**
Description CONTROLLER GAIN (Kc)
Range 0.1 TO 10.0

FUNCTION Defines the controller gain (Kc) of the process controller.

SETTING UP Select the desired controller gain to suit your requirements.

Screen **P4 Ti= INF**
Description INTEGRATION TIME (Ti)
Range 1s TO 1000s, INF

FUNCTION Defines the integration time of the process controller.

SETTING UP Select the desired integration time to suit your requirements.

When the process controller is disabled, anti-windup protection limits the process controller intregrator.

Setting the integration time too small leads to faster error correction but the possibility of overshoot or instability.

Note: The process controller has a sampling period (Ts) of 100ms.

Screen **P5 Td= 0.0s**
Description DIFFERENTIATION TIME (Td)
Range 0.0s TO 250s

FUNCTION Defines the differentation time of the process controller.

SETTING UP Select the desired differentation time to suit your requirements. Typically left at the default value of 0.0s for pump and HEVAC applications.

Screen **P6 ERROR = +0.0%**
Description PROCESS ERROR
Units %

FUNCTION Displays the difference between the process reference (screen P1) and the process feedback (screen P2).

P5

P6

P7

P7 FEEDBACK SENSE RELAY HYSTERESIS

Screen **P7 FB RLY=10.0Hz**
Description FEEDBACK SENSE RELAY HYSTERESIS
Min/Max 0.0/150
Units HERTZ

FUNCTION To set the operating points of the feedback sensing relay. This relay is useful to show that a feedback process is operating correctly and is at its setpoint.

A feedback input signal higher than the reference setpoint plus half the hysteresis frequency set in this function will de-energise the selected relay.

When the feedback drops below the reference minus half the hysteresis frequency the relay will re-energise.

Equations for relay output:

Relay de-energised:
Feedback > reference + ½ hysteresis

Relay energised:
Feedback < reference – ½ hysteresis

SETTING UP The feedback sense relay hysteresis is not used unless the Xtravert is configured for process control (feedback) operation.

Set the relay hysteresis to the value required by your feedback process.

Configure the relay output using Screens O3, O4.

EXAMPLE Reference = 50 Hz

Hysteresis = 10 Hz

Relay open
Feedback > 50 Hz + 5 Hz

Relay closed
Feedback < 50 Hz – 5 Hz

SCREEN GROUP R RATE SCREENS

R1, R2 ACCELERATION/DECELERATION RATE (NORMAL)

Screen **R1 ACC=5.0Hz/s**
Description ACCELERATION RATE (NORMAL)
Min/Max 0.02/500
Units HERTZ/SEC

Screen **R2 DEC=5.0Hz/s**
Description DECELERATION RATE (NORMAL)
Min/Max 0.02/500
Units HERTZ/SEC

FUNCTION Control the rate of acceleration and deceleration of the motor.

SETTING UP Use the slowest settings acceptable for your application. An acceleration rate which is too fast may cause the Xtravert to overload (status ILT) and automatically override your setting with a slower one. A deceleration rate which is too fast can cause the motor to regenerate (status VLT) into the Xtravert and automatically override your setting with a slower one.

Being realistic with these settings generally leads to a more successful commissioning. Where fast accelerations/decelerations are called for, it is often best to use slower settings initially, until all other operations are proven (also refer Screens L3, L4, X4).

Freewheel to stop (instead of controlled deceleration) can be achieved by setting the stop mode (Screen S2) to spin.

R3, R4, R5 ALTERNATIVE ACCELERATION/DECELERATION RATES

Screen **R3 AACC=10.0Hz/s**
Description ALTERNATIVE ACCELERATION RATE
Min/Max 0.02/500
Units HERTZ/SEC

Screen **R4 ADEC=10.0Hz/s**
Description ALTERNATIVE DECELERATION RATE
Min/Max 0.02/500
Units HERTZ/SEC

Screen **R5 BRK FR= 0.0Hz**
Description BREAK FREQUENCY FOR ACCEL/DECEL
Min/Max 0.0/150
Units HERTZ

FUNCTION To provide the option of having two acceleration and deceleration rates which can be programmed to change over at a specified break frequency.

The normal acceleration rate (Screen R1) and deceleration rate (Screen R2) are active above the break frequency. The alternative acceleration rate and deceleration rate are active below the break frequency.

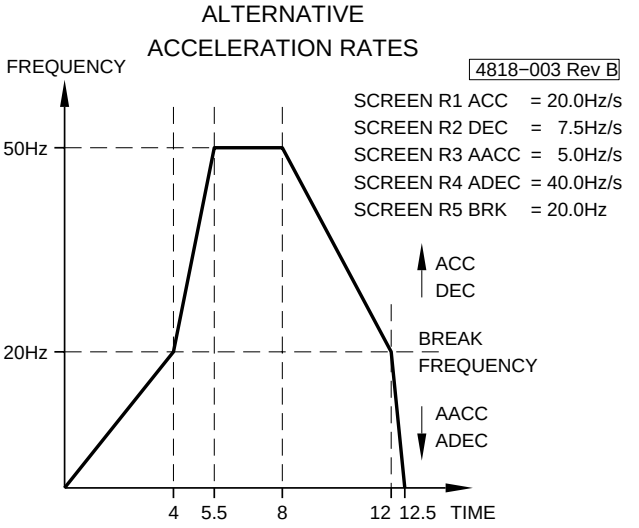
R6

The break frequency is normally set to zero, thus effectively disabling the alternative rates.

SETTING UP If alternative accelerations are not required, leave the break frequency at 0.0Hz.

Set the alternative acceleration and deceleration as desired. Set the breakpoint to the point above which normal acceleration/ deceleration are required to be active, and below which alternative rates are required. The alternative acceleration and deceleration rates may also be selected by using a multi-function input (refer Screen I9).

Being realistic with these settings generally leads to a more successful commissioning. Where fast accelerations/decelerations are called for, it is often best to use slower settings initially, until all other operations are proven.



R6 ALTERNATIVE STOP DECELERATION RATE

Screen	**R6 ASTP=10.0Hz/s**
Description	ALERNATIVE STOP DECELERATION RATE
Min/Max	0.02/500
Units	HERTZ/SEC

FUNCTION To provide a third deceleration rate which is used when the alternative stop (ASTOP) input is activated.

SETTING UP Adjust ASTOP to the level of deceleration required. Be sensible about choosing this value - choosing a very high rate will be of no use if the Xtravert loses control of the load while trying to stop it. Be sure to check the operation of this control while commissioning.

R7 S–CURVE TIME CONSTANT

R7

Screen	**R7 S-CURVE=0.20s**
Description	S-CURVE TIME CONSTANT
Min/Max	0.00/0.50
Units	SECS

FUNCTION

S-curve is used to provide a soft change in torque during acceleration or deceleration. Use S-curve to reduce harshness of acceleration. Typical uses include reducing the effects of slackness in chains or couplings and the soft acceleration of high inertia loads (flywheels, large fans and pumps). S-curve is also useful for improving the Xtravert's ability to operate with voltage limiting.

SETTING UP

Set the S-Curve Time Constant to 0.0 seconds for fastest response.

Set the S-Curve Time Constant to achieve the degree of acceleration softening required. Choose a setting consistent with the acceleration/deceleration settings (the S-curve time would typically equal 5–20% of the acceleration/deceleration time).

S-curve may be used as an alternative to a lower deceleration rate to help avoid voltage limiting problems when decelerating loads with high inertia (Refer Screen X8).

S1

SCREEN GROUP S START/STOP SCREENS

S1 STARTING MODE

S2

Screen **S1 STR MODE=RAMP**
Description STARTING MODE
Options NORMAL [RAMP] / [SPINNING]

FUNCTION Provides the option of a special starting mode for motor loads which may be spinning when started (e.g., freewheeling fans).

Problems can occur if a spinning load is started conventionally (i.e., Xtravert turns on at zero Hertz, before accelerating to the set frequency) as the load must first be stalled to near zero frequency, before being accelerated.

When spinning start is selected, the Xtravert starts at the maximum frequency, instead of zero Hertz. If the set frequency does not match the spinning frequency of the load, an over current situation arises, causing the Xtravert to operate in current limit and reduce its output frequency until the frequency matches the speed of the load. Once the frequencies match, the current will be reduced and the load will be accelerated normally toward the set point.

Note: When spin starting from the maximum frequency, the direction is set to the same as the reference frequency. When the reference frequency is 0.0Hz the spin start will be in the positive direction.

SETTING UP If the Xtravert will not normally be required to start spinning loads, set the starting mode to (normal) ramp acceleration.

If starting into spinning loads is a specific requirement of your application, set the starting mode to SPIN. During a spin start, while the Xtravert is trying to match the output frequency with the motor speed, the output current will be controlled independently of the motor current limit (Screen L3) and the current limit timeout (Screen L4). For most reliable starting, set the current limit timeout to above 0.0s (or OFF) to prevent “Shearpin” tripping once the Xtravert matches the motor speed.

S2 STOPPING MODE

Screen **S2 STP MODE=RAMP**
Description STOPPING MODE
Options [RAMP] DECELERATION / [SPIN] - DC BRAKE

FUNCTION Sets the mode of stopping. When set to ramp deceleration, deceleration during stopping is controlled by the deceleration ramp rates (Screens R2, R4). When set to spin, the Xtravert immediately jumps to zero frequency when commanded to stop, allowing the motor to freewheel (spin) to stop.

The use of spin to stop in conjunction with DC Hold/Brake (Screens S4, S5) provides a DC injection brake stopping function which does not involve regeneration and therefore does not require a dynamic brake module. It is most effective at lower speeds.

SETTING UP Ramp deceleration is normally employed if a controlled stopping rate is required. If it is preferable that the motor freewheel to stop,

or if DC braking to stop is required, set to SPIN.

S3

S3 TORQUE BOOST VOLTAGE AT ZERO SPEED

S4

S5

Screen **S3 BOOST = 0.0%**
Description TORQUE BOOST VOLTAGE AT ZERO SPEED
Min/Max 0.0/15.0
Units %V(MOTOR)

FUNCTION To provide a compensating voltage to improve low speed torque.

SETTING UP Torque boost has two modes configured in Screen X2. With autoboost set to [Y]es (the default condition) the drive automatically adjusts the boost level (up to the set level) in accordance with load variations.

When set correctly the Xtravert should be capable of delivering rated torque at rated current under stall conditions (shaft stationary).

With autoboost set to [N]o the boost voltage follows standard V/Hz control.

Some experimentation is usually required to find the optimal level. Use only as much boost as is required to reliably start your motor. If you use too much boost the motor may draw excessive current, possibly overloading the Xtravert and the motor.

When several motors are run from the same inverter with differing loads, autoboost should be set to [N]o.

Pump and fan applications usually require no torque boost.

For either boost mode, a first estimate of the boost required is equal to the percent slip of the motor:

$$\text{Percent slip of Motor} = \frac{100 \times (\text{synchronous speed} - \text{rated speed})}{\text{synchronous speed}}$$

It is possible to use much higher levels of boost in autoboost mode (up to 2x percent slip of motor) and achieve better starting torque.

S4, S5 DC STOPPING CONTROLS

Screen **S4 DC LEVEL =0%**
Description DC (0Hz) HOLD/BRAKE VOLTAGE AT STOP
Min/Max 0/25
Units %V(MOTOR)

Screen **S5 DC TIME =0.0s**
Description PERIOD OF DC HOLD VOLTAGE AT STOP
Min/Max 0.0/25.0
Units SECS

FUNCTION DC level sets the amount of DC voltage (hence current) applied to the motor when the Xtravert frequency reaches zero when stopping. When applied, the DC current causes the motor to resist movement

S6

and is used to brake the motor.

DC Time sets the period of application of the DC level after the Xtravert has reached zero frequency, upon receiving a stop command.

S7

Using DC at stop together with the spin stop mode (Screen S2) can be useful in positioning control systems.

Notes: To achieve DC holding while the control frequency is at zero, but the Xtravert is not stopped, use the boost voltage (Screen S3).

SETTING UP If motor braking upon stopping is not required, leave both settings to zero (factory set values).

If braking at stop is required, set the DC time to a suitable value (e.g., 2 seconds). While repeatedly stopping the motor, adjust the DC level to provide the desired braking force (typically achieved when the motor current equals its rated current). You must be careful that you do not overheat the motor by operating for too long at zero frequency, with too much DC level, or without adequate cooling. Be careful not to set the DC level so high that it causes the Xtravert to current limit (status display - ILT).

S6 DC HEATING VOLTAGE

Screen **S6 DC HEAT =OFF**
Description DC HEATING VOLTAGE DURING STOP
Min/Max OFF/0.1/10
Units %V(MOTOR)

FUNCTION To provide standby (anti-condensation) heating of the motor by means of a small DC current. When enabled, a DC heating current flows in the motor whenever the Xtravert is stopped. Any fault causing a trip disables DC heat.

SETTING UP If not required, leave OFF. If required, adjust the DC heat level while the Xtravert is stopped, until approximately 10–25% of rated current flows in the motor.

WARNING: High voltage will be present on the motor terminals while DC heating is employed.

S7 LOW VOLTAGE TRIP ENABLE/DISABLE

Screen **S7 HV LOW TRIP=N**
Description MAINS POWER LOSS RESPONSE
Options [Y]ES/[N]O

FUNCTION The high voltage (mains supply) power loss function provides an optional response to a power loss situation.

Upon power loss or brown out conditions, the Xtravert continues to operate normally until the energy supplied to the motor load discharges the Xtravert high voltage DC bus. At this stage the output power from the Xtravert is disabled to prevent further energy consumption by the load, but otherwise the Xtravert continues to operate from the remaining energy in the DC bus. Depending on the size of the Xtravert (and hence the energy in its DC bus), the Xtravert can stay active for several seconds in such an event.

While in this state (before the DC bus discharges below the switch mode power supply (SMPS) operating voltage) and depending upon the setting mode of this screen, the Xtravert is able to restart and continue normal operation when the mains supply returns to normal.

If the high voltage (mains supply) power loss function is set to trip (Y), the Xtravert will register a mains low fault (Fault 01 LOW VDC) after a two second power loss and require resetting. If the mains returns to normal within the two seconds, the Xtravert will restart automatically and perform a spinning start at the set frequency.

If the high voltage (mains supply) power loss function is set to not trip (N), the Xtravert will stay active as long as there is sufficient DC supply (perhaps several seconds). If the mains returns to normal while the Xtravert is still active, the Xtravert will restart automatically at the current set frequency.

SETTING UP The decision of whether to trip or not is usually based upon questions of the safety of automatically restarting equipment after brief power outages, of the ability of associated equipment to continue normal operation and of the reliability required of a process.

You must assess these factors to make your decision.

S8 AUTO FAULT RESET

Screen **S8 AUTO RESET =N**
Description ENABLE AUTOMATIC FAULT RESETTING
Min/Max [Y]es/[N]o

FUNCTION If "AUTO RESET" is YES then the Xtravert will, after tripping on one of the fault listed below, reset after a period of "Reset Time" from when the fault causing condition is no longer present. It will do this a maximum of "Max Retries" times. After "Max Retries" attempts then the attempts to reset will stop and the Xtravert will remain in the fault state. This counter is cleared after "Clear Time" of fault free running or when an external reset is applied. If one of the faults that is not able to be automatically reset occurs during the "Reset Time" then the Xtravert will trip on the new fault.

The "NO FAULT LMT" relay option energises the relay unless there is a fault that can not be automatically reset or the retry counter has reached its limit. If "AUTO RESET" is NO then the action of the "NO FAULT LMT" relay option is the same as the "NO FAULT" option.

The Start Relay will remain active during the retries. The Run relay will be deactivated during the "Reset Time".
The Rest Time starts after the fault causing condition clears. This may be several minutes from the time of the trip (especially MOTOR O/L). During this time, and while the fault causing conditions is still present, the status display on the screen will be "RDY", indicating that the Xtravert is ready to start but waiting for the correct conditions.
Reset time: 5 seconds
Max retries: 5 retries
Clear time: 5 minutes

Faults that can be automatically reset:

01 LOW VDC	03 HIGN VDC
04 SUPPLY FAULT	07 CURRENT TRIP FAULT
15 XV O/L FAULT	16 MOTOR O/L
21 GROUND FAULT	23 H/S TEMP
29 ILT T/O	33 LVDC FAULT

All other faults can not be automatically reset.

See also: Relay output option 17 NO FAULT LMT.

SETTING UP: The decision of whether to automatically restart the motor is usually based upon questions of personnel and plant safety; of the ability of associated equipment to continue normal operation; and of reliability required of a process.

You must assess these factors to make your decision.

SCREEN GROUP X XTRAVERT TUNING SCREENS

X1

X2

X1 DYNAFLUX MINIMUM FLUX LEVEL

Screen **X1 MIN FLUX=100%**
Description DYNAFLUX MINIMUM FLUX LEVEL
Min/Max 40/100
Units %V(MOTOR)

FUNCTION Sets the minimum flux level that the motor will be operated at under reduced load conditions.

The Xtravert incorporates the Dynaflux (dynamic flux) automatic motor flux optimising system. This system is particularly useful for reducing noise and power loss by automatically reducing motor flux levels (and so losses and noise), in reduced load situations.

SETTING UP If the flux reducing feature is not required, leave set at 100% (factory set value)

Dynaflux is best suited for slowly varying loads (e.g. pump and fan). This is due to the possibility of motor stall, upon a rapid load increase at a time when there is insufficient fluxing.

For fan and pump (or similar) loads, set to the lowest value, consistent with reliable operation. Usually 40% will be suitable.

Using a value which is too low can lead to instability or surging. If this occurs, increase the minimum flux level.

Selecting intermediate levels of minimum fluxing caters for more dynamic loads with reduced amounts of Dynaflux action.

Set the minimum flux level to 100% for highly dynamic loads (e.g. servos and cranes).

X2 TORQUE BOOST MODE

Screen **X2 AUTOBOOST=Y**
Description SELECT TORQUE BOOST MODE
Options [Y]ES/[N]O

FUNCTION In order to obtain full torque at low frequency, voltage boost must be applied. This option permits configuration for automatic boost (Y) or fixed boost (N). Refer to Screen S3 for set-up of boost levels.

SETTING UP For normal single motor operation, Autoboost provides best performance and should be left set to [Y]ES. For multiple motor operation, set Autoboost to [N]O.

Autoboost automatically varies the boost level according to the load condition, as a ratio of the level set by Screen S3. Screen S3 must still be set to a level appropriate to the motor being used.

X3

X4

X3 SLIP FREQUENCY

Screen **X3 SLIP FR=0.0%**
Description FULL LOAD SLIP COMPENSATION
Min/Max 0.0/10
Units %

FUNCTION Provides improved speed regulation under conditions of varying load torque. Load current is sensed and used to provide a small proportional increase in frequency to compensate for the slip of the induction motor as load changes.

SETTING UP Leave slip compensation set to 0.0% unless you have a special requirement for improved speed regulation.

Calculate the full load slip frequency of the motor and enter this frequency

e.g., for a 1420 rpm, 50Hz, 4 pole motor:

synchronous speed	= 1500rpm
full load speed	= 1420rpm
slip speed	= 1500-1420 = 80rpm
slip %	= (slip speed x 100) / synchronous speed
	= (80 x 100)/1500 = 5.3%

Better speed regulation may possibly be achieved by actually measuring shaft speed under varying load and experimentally setting the slip compensation

X4 I LIMIT SLIP

Screen **X4 ILT SLIP=2.0%***
Description CURRENT LIMIT SLIP VALUE
Min/Max 0.0/9.9/OFF
Units %

Notes * This value is dependent on Xtravert current rating.

FUNCTION Current Limit Slip(ILT) is a variable used to enhance the stability of current limit control by entering a motor slip parameter.

Do not adjust this parameter unless current limit action is unstable. Nominally this value should be set to the rated percent slip of the motor (see Screen X3 to calculate this value). To improve stability of current limit use a lower figure (the penalty against this is that predictive current limit action will occur at an earlier stage, more severely limiting acceleration rates and possibly intruding more into the normal area of operation). Predictive current limit can be turned off by setting ILT Slip to “off”.

In applications requiring fast acceleration or deceleration current limit slip should be set to "off" and the current limit to maximum.

X5 VOLTAGE LIMIT SLIP

Screen **X5 VLT SLIP=2.0%***
Description VOLTAGE LIMIT SLIP
Min/Max 0.0/9.9
Units %
Notes * This value is dependent on Xtravert current rating.

FUNCTION If a motor is overdriven (e.g., by decelerating its attached load too fast) it will regenerate into the Xtravert. Too much regeneration will cause the Xtravert to take evasive action ("voltage limiting") by reducing the deceleration rate as regeneration occurs.

The voltage limit slip setting is an adjustment which is used to enhance the stability of voltage limiting control by providing a motor slip parameter.

SETTING UP Do not adjust this setting unless voltage limiting is unstable. Nominally this value should be set to the rated percent slip of the motor (see Screen X3 to calculate this value). To improve stability of voltage limit use a lower value. The penalty against this is that voltage limiting will occur at an earlier stage, thus affecting deceleration more.

The S-curve setting (Screen R7) may also be used to improve stability during voltage limiting.

X6 NO LOAD DAMPING

Screen **X6 DAMPING=0.4%***
Description NO LOAD DAMPING
Min/Max 0.0/5.0
Units %
Notes * This value is dependent on Xtravert current rating.

FUNCTION Some motors may become unstable and appear to surge when operated at light load and at certain speeds. The damping term may be introduced to eliminate this tendency.

SETTING UP Do not adjust this value unless light load stability problems exist.

Increase setting to improve stability. Increasing the setting too far may induce instability.

The setting is nominally equal to 20% of the calculated percentage motor slip (see Screen X3).

No load damping introduces very small output frequency variations (typically <0.1 Hz). If absolute fixed output frequency is a specific requirement of your application, set to 0.0%.

X7 MODULATION TYPE

Screen **X7 SWITCH FR =WW**
Description MODULATION FREQUENCY
Options

[NB]	NARROW BAND	8kHz
[WW]	WHISPERWAVE	8kHz
[NL]	NARROW BAND	5kHz
[WL]	WHISPERWAVE	5kHz

X8

FUNCTION Alters modulation mode and switching frequency. Alters the type of noise produced by the motor. Narrow band produces a conventional fixed frequency noise spectrum. WhisperWave is a special mode which distributes the noise over a wider frequency range. The noise produced in WhisperWave mode is usually found to be less annoying and easier to mask.

SETTING UP To allow for direct comparison of the motor acoustic noise level, this mode may be switched while the Xtravert is running. Choose the option that you find most suitable.

X8 REGENERATION MODE

Screen **X8 REGEN = VCLAMP**
Description REGENERATION MODE
Options [VCLAMP] Voltage Clamp
[DBRAKE] Dynamic Brake

FUNCTION If a motor is overdriven (e.g., by decelerating its attached load too fast) it will regenerate into the Xtravert. Too much regeneration will cause the Xtravert to trip out to protect itself (Fault 03 HIGH VDC). The regeneration mode setting controls the way in which the Xtravert responds to the onset of regeneration to avoid tripping out.

When set to voltage clamp mode, the Xtravert takes evasive action by reducing the deceleration rate as regeneration occurs. This is the normal setting.

If a dynamic brake is fitted, this will automatically absorb the regenerated energy. In this case the dynamic brake mode (which takes no evasive action) may be selected.

SETTING UP If your application does not use dynamic braking, leave set to voltage clamp. If you application uses dynamic braking, use dynamic brake mode only if acceptably fast response cannot be obtained using voltage clamping.

SCREEN GROUP Y MENU OPTION SCREENS

Y1

Y2

Y1 LANGUAGE SELECTION

Screen **Y1 ENGLISH**
Description LANGUAGE SELECTION
ENGLISH/DEUTSCH/ESPANOL

FUNCTION Determines the language displayed by the Xtravert.

SETTING UP Choose the appropriate language.

Y2 INITIALISATION

Screen **Y2 INITIALISE =N**
Description INITIALISE ALL SETTINGS
Options [Y]ES / [N]O

FUNCTION Resets all internal settings to the default (factory set) condition. The default settings are those shown in this section, the summary tables and the commissioning configuration records.

Initialisation is usually used to completely reset an Xtravert for use in a new application. It can also be useful to return the Xtravert to a known and defined state if you have become lost or confused about the settings that are entered.

SETTING UP Initialise as required.

WARNING: Initialising the Xtravert RESETS ALL SETTINGS to the default settings. Use the Commissioning Configuration Form to record any set up that you wish to retain for re-entry after initialising.

Enter YES [Y] to initialise the Xtravert. The display shows "INITIALISING..." while doing so.

Z1

SCREEN GROUP Z COMMISSIONING SCREENS

Z COMMISSIONING SCREENS

Z2

Screen **Z COMMISSION =Y**
Description COMMISSION MODE
Options [Y]ES/[N]O

Z3

FUNCTION Provides a means of preventing accidental adjustment of the control screens.
The Xtravert must be set to commission mode (Y) before adjustment can be made to any screen except local frequency.
Setting the commission screen to No prevents adjustment of any screen.

Z4

SETTING UP Set this parameter to Yes if you wish to adjust any parameter.
Reset the display to No when you have finished your adjustments to prevent inadvertent adjustment.

Z5

Z2 SOFTWARE AND HARDWARE REVISIONS

Screen **X504 3P 230V 4A**
Z2 S/W1.1 H/W1.1
Description SOFTWARE AND HARDWARE REVISION NUMBERS

FUNCTION Shows the Xtravert Model, and the revision numbers of the Xtravert software and hardware.

Z3 ANALOGUE INPUT 1 (AIN1) STATUS

Screen **Z3 AIN1=+10.0V**
Description STATUS OF ANALOGUE INPUT 1 (AIN1)
Range –10V TO +10V

FUNCTION Displays the status of Analogue Input 1 (Terminal T14)
For 0-10V input, 0V to +10V
For ±10V input, –10V to +10V

Z4 ANALOGUE INPUT 2 (AIN2) STATUS

Screen **Z4 AIN2=+20mA**
Description STATUS OF ANALOGUE INPUT 2 (AIN2)
Range 0mA to 20mA

FUNCTION Displays the status of Analogue Input 2 (Terminal T16)
For 4-20mA input, 0mA to 20mA

Z5 ANALOGUE OUTPUT 1 (AO1) STATUS

Screen **Z5 AO1=+10.0V**
Z5 AO1=+20mA
Description STATUS OF ANALOGUE OUTPUT 1 (AO1)
Range –10V TO +10V or 4–20mA

FUNCTION Displays the status of Analogue Output 1 (Terminal T18)

For 0-10Voutput, 0V to +10V
For ±10V output, –10V to +10V
For 4-20mA output, 4mA to 20mA

Z6

SETTING UP This screen automatically displays the output in the required format as set by Screen O2.

Z7

Z6 MULTIFUNCTION INPUT STATUS

Screen **Z6 MFI:OOOO X**
Description STATUS OF MULTI-FUNCTION INPUTS
Range O (OPEN) or X (CLOSED)

Screen **Z6 MFI:OOOO X**
Reference **0 1 2 3 4 5**

Reference 0: Screen number Z6

Reference 1: Status of Multi-function Input 1 (Terminal T6)
O - Open X - Closed

Reference 2: Status of Multi-function Input 2 (Terminal T7)
O - Open X - Closed

Reference 3: Status of Multi-function Input 3 (Terminal T8)
O - Open X - Closed

Reference 4: Status of Multi-function Input 4 (Terminal T9)
O - Open X - Closed

Reference 5: Status of External Trip Input (Terminal T10)
O - Open X - Closed (required for normal operation)

Note 1: Multi-function inputs - O or X represent an Open (circuit not connected to +24V) or a Closed (circuit connected to +24V) respectively.

Z7 OUTPUT RELAY STATUS

Screen **Z7 RLY:1=XO 2=O**
Description STATUS OF OUTPUT RELAYS;
Range O (OPEN) or X (CLOSED);

Screen **Z7 RLY:1=XO 2=O**
Reference **0 12 3**

Reference 0: Screen number Z7

Reference 1: Status of Output Relay 1 Terminals (T1/T2)
O (Open) X (Closed)

Reference 2: Status of Output Relay 1 Terminals (T2/T3)
O (Open) X (Closed)

Reference 3: Status of Output Relay 2 Terminals (T4/T5)
O (Open) X (Closed)

Note: RLY1 is normally open on Terminals (T1/T2)
RLY1 is normally closed on Terminals (T2/T3)
RLY2 is normally open on Terminals (T4/T5)

SECTION 3: COMMISSIONING CONFIGURATION RECORD

DRIVE Model: _____ Serial No.: _____

Location: _____

Application Type: _____

CABLE Manufacturer: _____

Size: _____mm^2

Type: Screened / Unscreened

Length: _____m

MOTOR Manufacturer: _____

Model: _____

kW: _____ V: _____ A: _____

Poles: _____ rpm: _____ Wiring: Star / Delta

		RECORD 1	RECORD 2
	Date:	___/__/___	___/__/___
	Commissioned by:	_____	_____
ADJUSTMENTS	(= default)		
A1 LOCAL SP	(= +50.0Hz)	_____	_____
C1 FR ON	(= 12.0Hz)	_____	_____
C2 FR OFF	(= 10.0Hz)	_____	_____
C3 I SENSE	(= 16.0A)	_____	_____
H1 COMMS ADR	(= 10)	_____	_____
H2 COMMS T/O	(= OFF)	_____	_____
I1 LOCAL	(= STR/STP)	_____	_____
I2 REF SP	(= LOCAL)	_____	_____
I3 AREF SP	(= NULL)	_____	_____
I4 AIN1	(= 0-10V)	_____	_____
I5 A1 LO	(= +0.0Hz)	_____	_____
I6 A1 HI	(= +60.0Hz)	_____	_____
I7 A2 LO	(= +0.0Hz)	_____	_____
I8 A2 HI	(= +60.0Hz	_____	_____

I9 I/P MODE	(= 00)	_____	_____
L1 MIN FR	(= 0.0Hz)	_____	_____
L2 MAX FR	(= 60.0Hz)	_____	_____
L3 I LIMIT	(=)	_____	_____
L4 ILT T/O	(= NONE)	_____	_____
L5 REV INHIBIT	(= N)	_____	_____
L6 SKIP1	(= 0.0Hz)	_____	_____
L7 SKIP2	(= 0.0Hz)	_____	_____
L8 SK BW	(= 0.0Hz)	_____	_____
L9 MIN FR RUN	(= N)	_____	_____
M1 MREF1	(= +5.0Hz)	_____	_____
M2 MREF2	(= +0.0Hz)	_____	_____
M3 MREF3	(= +0.0Hz)	_____	_____
M4 MREF4	(= +0.0Hz)	_____	_____
M5 MREF5	(= +0.0Hz)	_____	_____
M6 MREF6	(= +0.0Hz)	_____	_____
M7 MREF7	(= +0.0Hz)	_____	_____
N1 MTR CUR	(= 14.6A)	_____	_____
N2 MTR VOLT	(= 400V)	_____	_____
N3 MTR FR	(= 50Hz)	_____	_____
N5 MTR RPM	(=1450)	_____	_____
N6 MTR COOL	(= 40%)	_____	_____
O1 AO1 SRC	(= 02)	_____	_____
O2 AO1	(= 0-10V)	_____	_____
O3 O/P RELAY1	(= 02)	_____	_____
O4 O/P RELAY2	(= 05)	_____	_____
P1 PR SRC	(=NULL)	_____	_____
P2 FB SRC	(= NULL)	_____	_____
P3 Kc	(=1.0)	_____	_____
P4 Ti	(=INF)	_____	_____
P5 Td	(=0.0s)	_____	_____
P7 FB RLY	(= 10.0Hz)	_____	_____
R1 ACC	(= 5.0Hz/s)	_____	_____

R2 DEC	(= 5.0Hz/s)	_____	_____
R3 AACC	(= 10.0Hz/s)	_____	_____
R4 ADEC	(= 10.0Hz/s)	_____	_____
R5 BRK FR	(= 0.0Hz)	_____	_____
R6 ASTP	(= 10.0Hz/s)	_____	_____
R7 S-CURVE	(= 0.20s)	_____	_____
S1 STR MODE	(= RAMP)	_____	_____
S2 STP MODE	(= RAMP)	_____	_____
S3 BOOST	(= 0.0%)	_____	_____
S4 DC LEVEL	(= 0%)	_____	_____
S5 DC TIME	(= 0.0s)	_____	_____
S6 DC HEAT	(= OFF)	_____	_____
S7 HV LOW TRIP	(= N)	_____	_____
S8 AUTO RESET	(= N)	_____	_____
X1 MIN FLUX	(= 100%)	_____	_____
X2 AUTOBOOST	(= Y)	_____	_____
X3 SLIP FR	(= 0.0%)	_____	_____
X4 ILT SLIP	(= 4.0%)	_____	_____
X5 VLT SLIP	(= 4.0%)	_____	_____
X6 DAMPING	(= 0.8%)	_____	_____
X7 SWITCH FR	(= WW)	_____	_____
X8 REGEN	(=V-CLAMP)	_____	_____
Y1 LANGUAGE	(=ENGLISH)	_____	_____
Z2 S/W REVISION	(= x.x)	_____	_____
Z2 H/W REVISION	(= x.x)	_____	_____

SECTION 4: USING THE XTRAVERT FOR PROCESS CONTROL

4.1: GENERAL NOTES

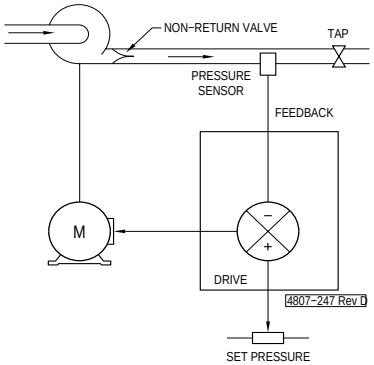
The Xtravert process controller is a fully featured PID regulator. The setpoint and feedback sources may be selected from a wide choice of options. If selected the Process Output may be routed to the speed reference source (refer Screens I2, I3). The process controller may be disabled via a digital input (selecting the alternative speed reference) to give auto/manual control.

4.2: APPLICATION EXAMPLE - CONSTANT PRESSURE PUMPING

Constant pressure pumping is a common application of AC Motor Speed Controllers. This section shows the configuration, wiring and adjustment of a typical example.

Constant pressure pumping systems maintain the pressure of the outgoing pipe by controlling the speed of the pump. If the demand increases (e.g., opening a tap) the pressure decreases and the pump has to wind up the speed. The system pressure is used as a feedback signal. The output pressure is selected with the setpoint potentiometer.

The example given is of a system of the following specification:



Setpoint Source	0-10V (Potentiometer)
Feedback Source	4-20mA pressure sensor
	0-4 bar
	24V supply, 2 wire
Motor	0.33kW, 1.1A, 415V 2700 rpm
Pump	Grundfos CH2-30
	Centrifugal pump
Xtravert	X702
Start/Stop Control	2 wire
Direction	Forward, Reverse inhibited

SETUP:

Using the simple setup procedure as outlined in Section 2.1:

Set up the motor information of Screen Group N.

N1 MTR CUR = 1.1A

N2 MTR VOLT = 415V

N3 MTR FR = 50.0Hz

N5 MTR RPM = 2700

Set up the limits of operation using Screen Group L.

L1 MIN FR = 0.0Hz

L2 MAX FR = 50.0Hz

L3 I LIMITS = 1.3A

L5 REV INHIBIT = Y

Set up the control sources via Screen Group I.

I1 LOCAL = NONE

I2 REF SP = PR O/P

I3 AREF S = LOCAL

I9 I/P MODE = 07 2W ACC AREF

External monitoring of speed is acheived via Screen Group O.

O1 AO1 SRC = 02 O/P FREQ 0-50Hz

O2 AO1 = 0-10V

The ramp rates are then set via Screen Group R.

R1 ACC = 20Hz/s

R2 DEC = 20Hz/s

R6 ASTP = 20Hz/s

The process controller is then set up using a combination of Screen Groups Pand I.

P1 PR SRC = AIN1

P2 FB SRC = AIN2

I4 AIN1 = 0-10V

I5 A1 LO = +0.0Hz

I6 A1 HI = +40.0Hz (representing 0-4.0 bar)

I7 A2 LO = +0.0Hz

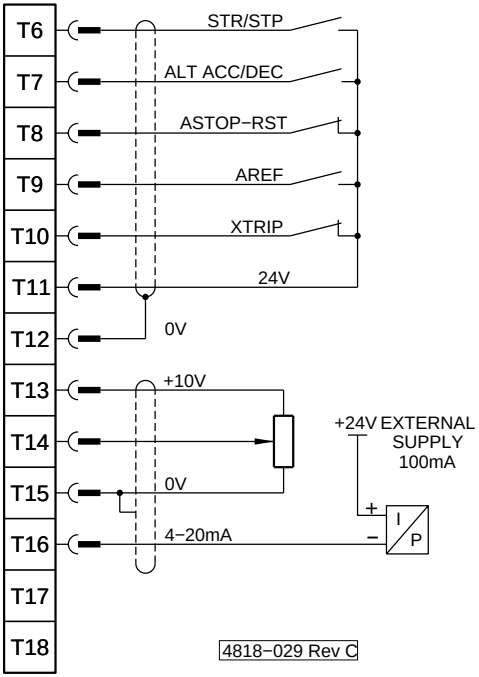
I8 A2 HI = +40.0Hz 1(representing 0-4.0 bar)

TUNING:

The process controller may be tuned using manual Zielger-Nichols techniques or by starting with the default values:
Increase the Controller Gains (Screen P3) until oscillation first occurs; then set to approximately 40% this setting.
Decrease the Integration Time (Screen P4) until oscillation occurs; then set back to approximately 150% this setting.
Increase the Differentiation Time (Screen P5) until minimal overshoot has been achieved but oscillation has not occured. Typically the Differentiation Time would not exceed 25% of the Integration Time.

In pump applications, the Differentiation Time (Screen P5) is not used and is left set to the default 0.0s .

The process error may be observed using Screen P6 to ensure process tracking occurs.



4.3: APPLICATION EXAMPLE - CONSTANT PRESSURE PUMPING WITH AUTOMATIC STOP/START CONTROL

Using Xtravert features the user can arrange to automatically stop a pump/motor for a period of no demand. Upper and lower pressure limits determine the turn off and the turn on point.

The start/stop input is wired up in such a way that the start/stop button and the feedback sense relay output are in series (to turn the Xtravert off when running on low demand).

EXAMPLE OF OPERATION OF CONSTANT PRESSURE PUMP

The corresponding process parameters of the Xtravert setup are:

Setpoint pressure	=	reference frequency level
Upper - lower pressure limit	=	feedback sense hysteresis (P7 FB RLY)
Minimum speed (25 Hz)	=	minimum output frequency Fmin (L1 MIN FR)

Using the example of Section 4.2, the configuration table has the following extra settings.

Adjustment	**L1 MIN FR**
(Default)	(= 0.0Hz)
Setting	25.0

Notes	Sets minimum output frequency.
Adjustment	**P7 FB RLY**
(Default)	(= 10.0Hz)
Setting	5.0
Notes	Hysteresis band around the reference frequency outside which the feedback sense relay changes state.
Mode	**O4 O/P RELAY 2**
(Default)	(= 05 START OR RUN)
Setting	15 FEEDBACK SENSE
Notes	Sets relay 2 to open when the feedback signal is higher than the reference plus half the hysteresis.
Mode	**L9 RUN AT MINIMUM FREQUENCY**
(Default)	(= N)
Setting	Y
Notes	Allows the drive to run at the minimum frequency (Screen L1) causing the pressure rise necessary to reach the upper hysteresis level.

DESCRIPTION OF OPERATION

This system is similar to that described in Section 4.2 except that use is made of additional features to overcome the following problem common in pressure control systems.

Problem

Under conditions of very low or no draw off, centrifugal pumps still maintain speed to maintain pressure. Due to this speed there may be high losses in the pump, even to the extent of boiling the fluid.

The normal solution to this problem is the addition of a non-return valve. This maintains pressure, however the pump may continue to run.

As a further solution to this problem the above system using feedback relays is implemented to automatically stop and start the pump. Key points are as follows:

i) A minimum speed is set which guarantees to provide a degree of over-pressure under the conditions that the pump is supposed to stop (i.e., under zero flow conditions).

ii) A feedback hysteresis level sets the over- pressure level (the amount above the set point) at which the hysteresis relay opens. Under zero flow conditions, the minimum speed setting must cause the pressure to exceed this level for this system to work.

iii) The feedback hysteresis relay opens (the stop/start circuit) under the above condition, and stops the drive. The non return valve maintains the system pressure.

iv) As flow resumes, the pressure drops. When the pressure drops below the set point minus hysteresis level, the feedback hysteresis relay closes, starting the drive again.

v) Apart from this automatic stop/start mechanism, the system operates as a normal pressure control system.

SECTION 5: APPLICATION EXAMPLE – SIMPLE FAN SPEED CONTROL

A typical application example is for simple fan speed control using a potentiometer to set 0-10V speed reference, and pushbuttons for start and stop-reset control. External speed monitoring is achieved using a simple 0-10V meter representing 0-100% speed. This section shows the configuration, wiring and adjustment of a typical example.

The example given is of a system of the following specification:

Control signal	0–10V (potentiometer)
Motor	5.5kW, 11.4A, 400V, 1450rpm
Xtravert model	X712
Stop/start control	3 wire
Direction control	None required

The configuration table (not including irrelevant and/or settings that have not been altered from factory set values) and wiring configurations follow:

SIMPLE FAN SPEED CONTROL EXAMPLE CONFIGURATION TABLE

DRIVE NO: _____ MODEL: X712

LOCATION: Fan Speed Control

MOTOR: kW: 5.5 A: 11.4 V: 400

POLES: 4 RPM: 1450

SETUP

Using the procedure as set up in Section 2.1:

Set up the motor information of Screen Group N.

N1 MTR CUR=11.4A

N2 MTR VOLT=400V

N3 MTR FR =50Hz

N3 MTR RPM =1450

N6 MTR COOL=40%

Set the limits of operation using Screen Group L.

L1 MIN FR = 0.0Hz

L2 MAX FR = 50.0Hz

L3 I LIMIT = 13.6A

L5 REV INHIBIT=Y

Set up the control sources via Screen Group I.

I1 LOCAL=NONE

I2 REF SP=AIN1

I4 AIN1 = 0–10V

I5 A1 LO=+0.0Hz

I6 A1 HI=+50.0Hz

I9 I/P MODE=01 3W STANDARD

External monitoring of speed is achieved via Screen Group O.

O1 AO1 SRC =02 Output Frequency 0-50Hz

O2 AO1 = 0-10V

The ramp rates are then set via Screen Group R.

R1 ACC = 5.0Hz/s

R2 DEC = 5.0Hz/s

R6 ASTP=10.0Hz/s

Wiring could be completed using a similar form to Fig. 5.1.

START is activated by momentarily closing the normally open pushbutton connected at Terminal T7. This starts the Xtravert accelerating the motor to the reference speed defined by the potentiometer connected at Terminal T14.

STOP is activated by momentarily opening the normally closed pushbutton connected at Terminal T6. This stops the Xtravert decelerating the motor to zero speed.

The acceleration and deceleration rates are defined by Screen R1 and R2.

By momentarily opening the normally closed XTRIP pushbutton connected at Terminal T10 the Xtravert will trip, displaying the fault condition “22 EXT TRIP”.

By opening the normally closed switch connected at Terminal T8, the Xtravert will stop, decelerating the motor using the alternative stop rate defined by Screen R6 (This overrides the deceleration rate defined by Screen R2). If any internal or external fault should occur, then the Xtravert may be reset (once the fault condition has been removed) upon the opening edge of the ASTOP-RESET switch.

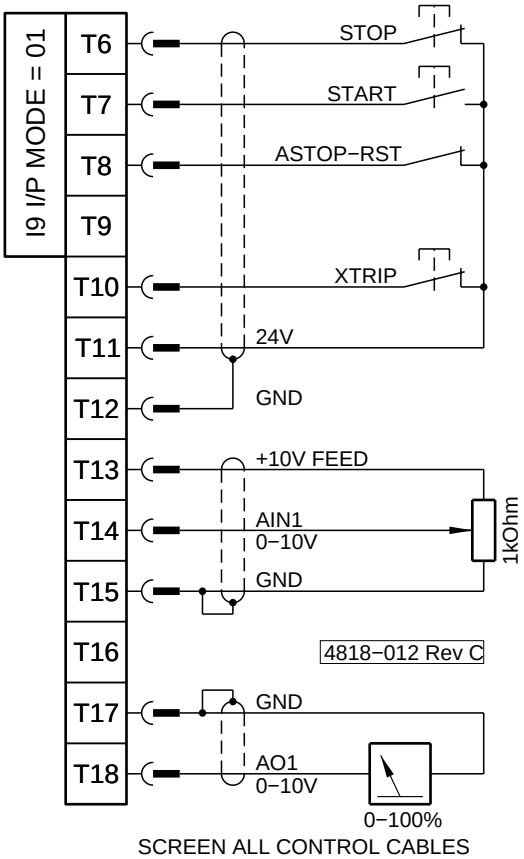


Fig. 5.1: Example Fan Speed Control

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