Instruction Manual

PRO-360 Series Controllers

PRO-360-S/HV

Firmware Version 2.4.4

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1. Introduction

The Pro-360 is an advanced digital PWM motor controller for currents up to 360A. It uses a specialist microprocessor to control a full H-bridge design that does not require relays for reversing. The display provides key information to the operator, and can be mounted separately to the controller if required. It has a full range of features and is easy to configure as required.

2. Do's and Don’ts

Warning – the Pro-360 does not have reverse polarity protection. Connecting the battery wires incorrectly WILL destroy the controller.

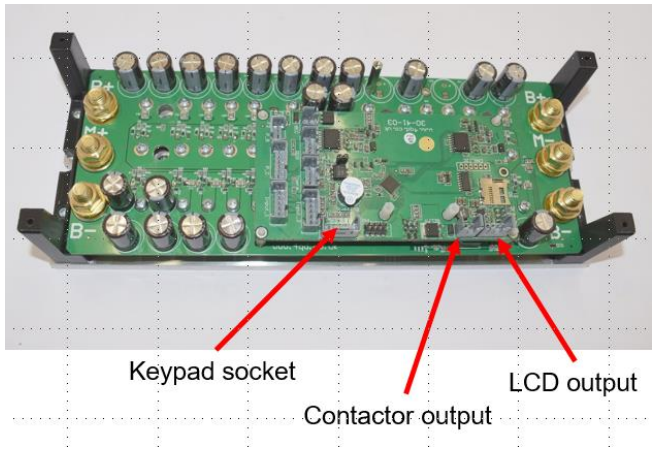
Do

- **Do r**ead the instructions fully before installing.
- **Do** take care to connect the battery wires with the correct polarity.
- **Do** fit a motor suppression capacitor, and ferrite rings.
- **Do** twist the motor wires together if possible.
- **Do** contact 4QD if you are uncertain about something.

Do not

- **Do not** loosen the locknuts on the brass terminal posts. If this does happen accidentally carry out the checks in this service bulletin. https://www.4qd.co.uk/docs/pro-360-locknut-service-bulletin/
- **Do not** allow water to get onto the circuit boards.
- **Do not use with lithium batteries without reading our website article about BMSs.** https://www.4qd.co.uk/docs/using-a-bms-with-a-motor-controller/

3. Getting Started

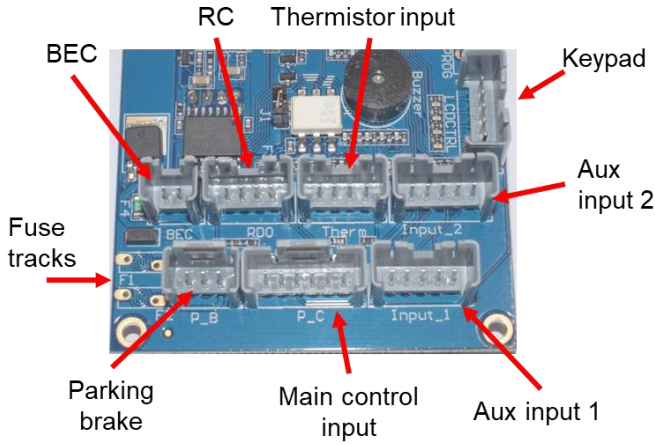


- Remove the four screws that hold the cover to the end plates and lift off the cover.

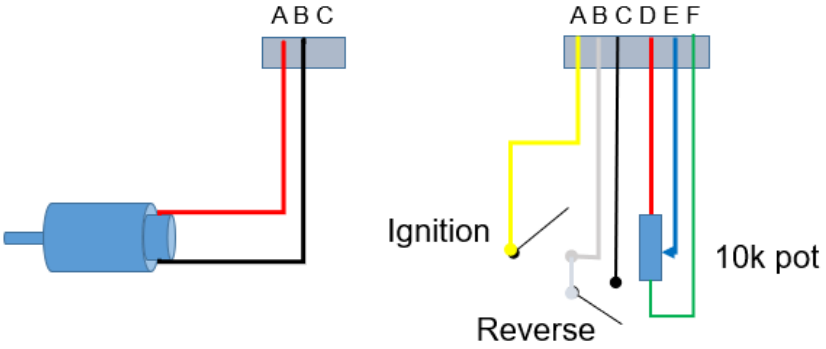
- The Pro-360 is supplied with the keypad and / or display cables not connected to their sockets. These should be plugged in once the Pro-360 has been fixed in position, the control and power connections made, and you are ready to start operation. The keypad socket in marked LCDCTRL.

4. Control Connections

The control input sockets are shown below.



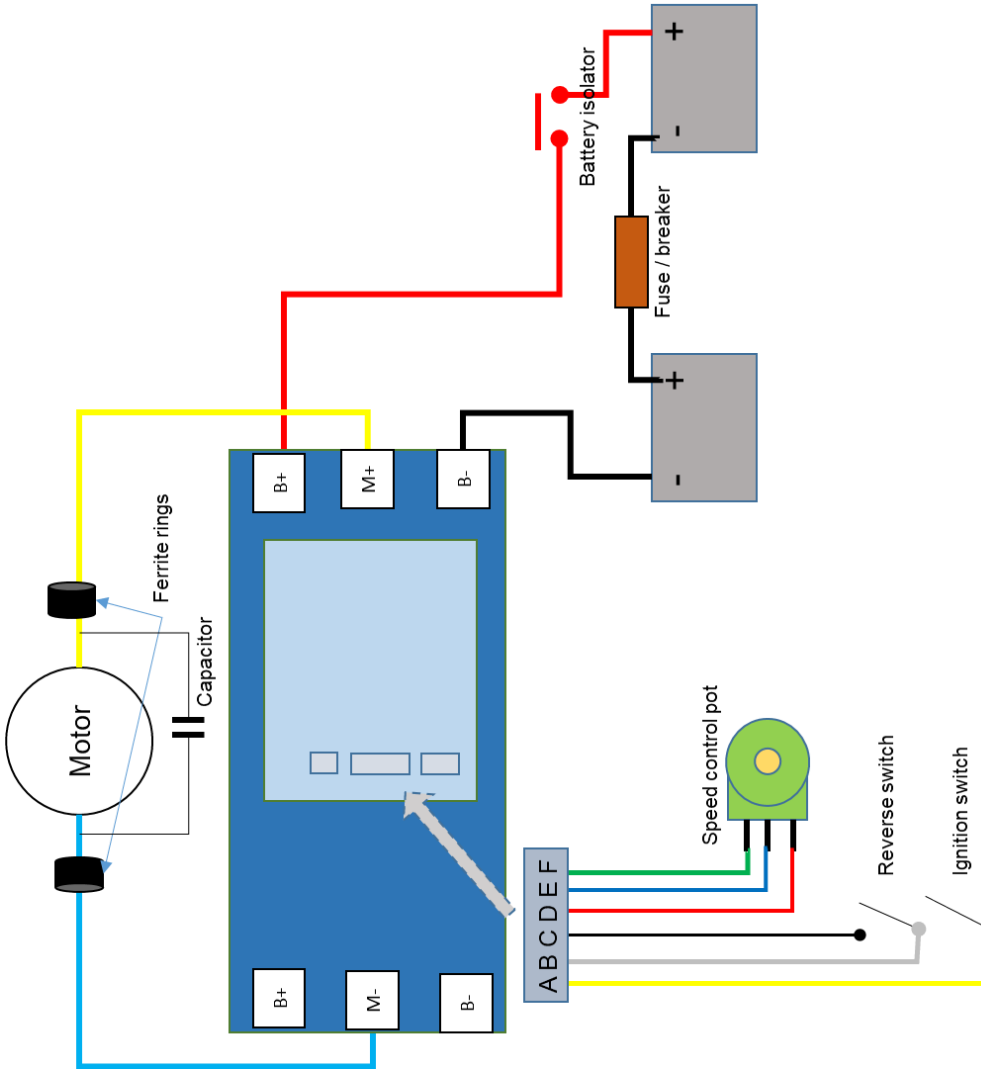
The main control input and brake should be wired as shown below [they are compatible with Pro-120/150 and DNO/VTX installations].



On the main control input Pin A provides the B+ voltage out to the ignition switch. Pin B looks for B+ as the signal to switch on. Pin C looks for B+ as the signal for reverse. Pin D provides a 5V feed to a potentiometer. Pin E is for the wiper of the pot or a voltage input [0 – 5V]. Pin F is ground.

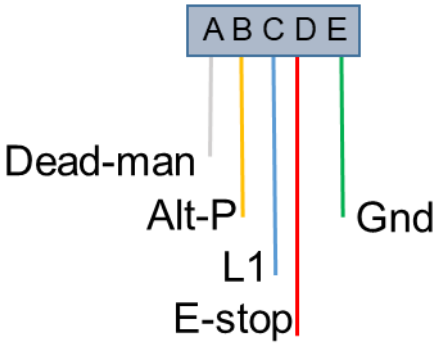
5. Simple wiring diagram

This diagram shows the basic connections needed to get the Pro-360 running.



6. Auxiliary Input 1

Has the following functions.



A - Deadman's handle. There are 2 modes of deadman operation. In "std" if this pin is connected to Gnd then the Pro-360 will follow the active profile ramp down to zero, it will ramp up again when Gnd is removed. In "safe" this pin must be connected to Gnd for operation to start.

B - Alternate profile. If this pin is connected to Gnd the Pro-360 will start up in the alternate profile defined in the profile that was operating without the Gnd present. This allows easy switching between any two profiles.

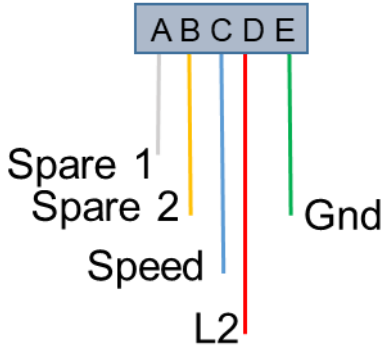
C - L1. If this pin is connected to Gnd then the Pro-360 will behave as follows…

- If push button operation is selected as the throttle input mode, grounding L1 will start forward operation up to the speed set by the throttle setting.
- If limit switch operation is selected [advanced settings] grounding L1 will select forward operation.

D - Emergency stop. If this pin is connected to Gnd then the Pro-360 will stop immediately. It will not start up again until the Gnd is removed, and the ignition has been turned off / on.

7. Auxiliary Input 2

Has the following functions.



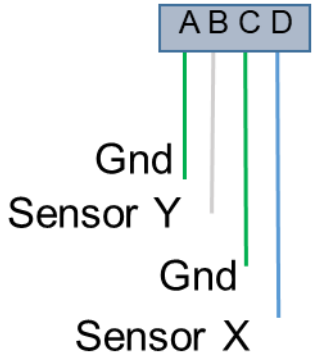
C - Speed. This pin can be used with our speed sensor kit [part number SEN-SPD] for top speed limiting. The sensor is powered by the BEC supply and delivers a 5V pulse proportional to the speed of the shaft that the magnet is attached to.

D-L2. If this pin is connected to Gnd then the Pro-360 will behave as follows…

- If push button operation is selected as throttle input mode, grounding L2 will start reverse operation up to the speed set by the throttle setting.
- If limit switch operation is selected [advanced settings] grounding L2 will select reverse operation.

8. Thermistor input

Can be used to connect 1 or 2 sensors to monitor external temperatures.



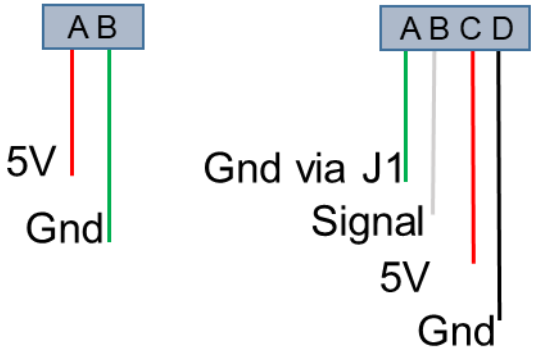
Sensors X and Y should be 4QD part number SEN-TMP.

Sensor X is connected to C and D, Sensor Y to A and B.

Once the sensors have been installed they must be enabled in the profile menu.

9. Radio Control Input and BEC

The Pro-360 will accept a standard hobbyist radio control servo signal directly from a receiver. The receiver should be connected to pins B, C, and D. Pin D is linked to pin A by Lk1, this can be removed if a 4 wire radio connection is required.



The Pro-360 is pre-programmed to work with the majority of radio receivers. Profiles 7 and 8 are configured for RC single ended and RC joystick use. Depending on your radio system you may need to use the RC learn function to properly match the Pro-360 to your receiver output.

The RDO port can act as a BEC for currents up to 1A. Pin B of the adjacent BEC port can be used in parallel to increase this to 2A if required.

If you wish to just use RC control, you still need to connect pins A & B on the main control input.

Fail safe operation

The Pro-360 will detect a break in the connection between itself and the radio receiver, or if the signal from the receiver goes out of limits, and will ramp down to zero.

To guard against radio transmitter failure or out of range situations it will be necessary to configure the failsafe facility in the radio receiver.

10. Power Connections

The power connections are M8 diameter threaded posts. The wire used should be of a diameter appropriate for the load envisaged.

Battery Wiring

Keep the battery wiring as short as possible to reduce the load on the main capacitors.

Motor Wiring

To reduce electrical noise the motor wires should be kept close to each other and twisted together if possible. A 10nF 100V disc ceramic motor suppression capacitor should be fitted across the brushes of the motor. Ferrite rings should be fitted on the motor wires. See the knowledgebase on our website for more information on noise suppression.

If the motor rotates in the wrong direction, swap over the M+ and M- wires.

Battery Circuit Breaker

A circuit breaker or fuse should be fitted in the battery wiring. The rating should be above that of the motors normal operating current.

A battery isolator switch should also be fitted to provide an emergency disconnection capability. In some applications such an isolator is a legal requirement.

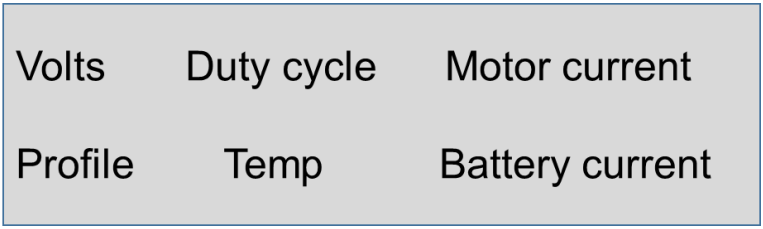
Contactor

The Pro-360 has provision to drive a failsafe contactor which can provide an emergency disconnection in the event of a controller failure. Details of how to implement this feature are in the knowledgebase on our website.

11. Display

The Pro-360 has a 2 line display to display useful information during operation and programming.

During operation the display will show information in this format:



Volts = battery voltage.

Duty cycle = % of battery voltage being applied to the motor.

Motor current[1] = instantaneous motor current in amps [- = reverse].

Profile = profile currently selected [suffix R indicates reverse].

Temp = temperature in ‘C or ‘F. Prefix X / Y denotes sensor X / Y temp, and are only shown if switched on in software. Temperatures below 0’C are shown as “Lo”.

Battery current[3] = average current being drawn from the battery in amps. Note the difference between this and motor current.

The display also shows any alert or fault information.

Notes:

[1] This part of the display can be set to show RPM or speed in mph or kph [Up button].

[2] This part of the display can be set to show power in W or HP [Down button].

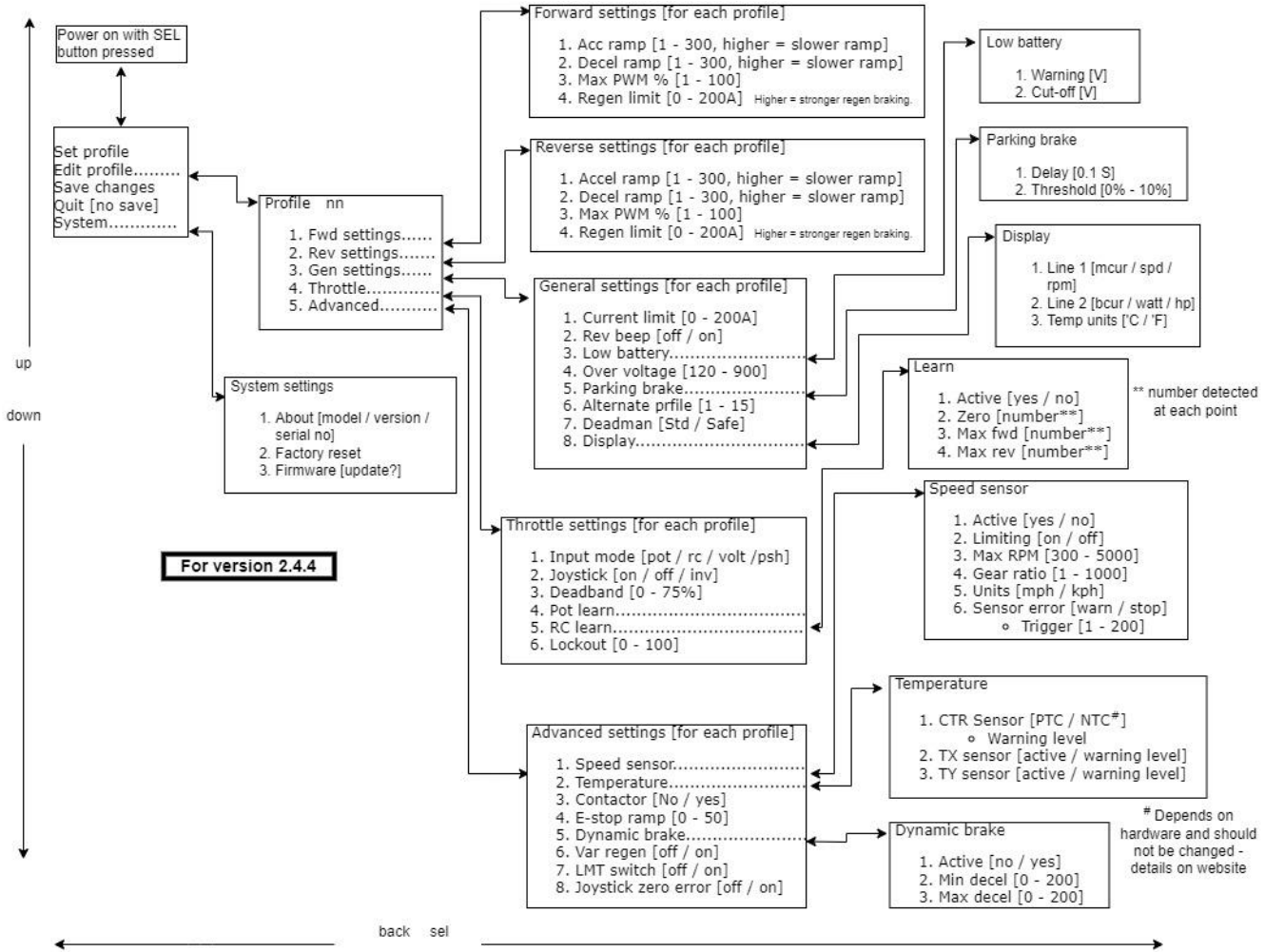
Display adaptors are available that allows the display and / or keypad to be mounted remotely from the Pro-360.

12. Programming

The Pro-360 has 15 profiles, 14 of which can be edited to suit the user. Each profile has a number of settings which control various aspects of the controller’s behavior. We have configured the first 9 profiles with values that are a good starting point for the most popular applications, full details are in the table at the end of the manual.

It is not possible to make changes to profile 01, to save changes you must first select another profile.

To edit the settings the SEL button should be held down while turning on the ignition, you can then navigate through the options and settings as shown in the menu structure below. Remember to use the menu option to save changes.


Power on with SEL button pressed
Set profile
Edit profile.....
Save changes
Quit [no save]
System.....
Profile nn
1. Fwd settings.....
2. Rev settings.....
3. Gen settings.....
4. Throttle.....
5. Advanced.....
System settings
1. About [model / version / serial no]
2. Factory reset
3. Firmware [update?]
Forward settings [for each profile]
1. Acc ramp [1 - 300, higher = slower ramp]
2. Decel ramp [1 - 300, higher = slower ramp]
3. Max PWM % [1 - 100]
4. Regen limit [0 - 200A] Higher = stronger regen braking.
Reverse settings [for each profile]
1. Accel ramp [1 - 300, higher = slower ramp]
2. Decel ramp [1 - 300, higher = slower ramp]
3. Max PWM % [1 - 100]
4. Regen limit [0 - 200A] Higher = stronger regen braking.
General settings [for each profile]
1. Current limit [0 - 200A]
2. Rev beep [off / on]
3. Low battery.....
4. Over voltage [120 - 900]
5. Parking brake.....
6. Alternate prfile [1 - 15]
7. Deadman [Std / Safe]
8. Display.....
Throttle settings [for each profile]
1. Input mode [pot / rc / volt /psh]
2. Joystick [on / off / inv]
3. Deadband [0 - 75%]
4. Pot learn.....
5. RC learn.....
6. Lockout [0 - 100]
Advanced settings [for each profile]
1. Speed sensor.....
2. Temperature.....
3. Contactor [No / yes]
4. E-stop ramp [0 - 50]
5. Dynamic brake.....
6. Var regen [off / on]
7. LMT switch [off / on]
8. Joystick zero error [off / on]
Low battery
1. Warning [V]
2. Cut-off [V]
Parking brake
1. Delay [0.1 S]
2. Threshold [0% - 10%]
Display
1. Line 1 [mcur / spd / rpm]
2. Line 2 [bcur / watt / hp]
3. Temp units ['C / 'F]
Learn
1. Active [yes / no]
2. Zero [number**]
3. Max fwd [number**]
4. Max rev [number**]
** number detected at each point
Speed sensor
1. Active [yes / no]
2. Limiting [on / off]
3. Max RPM [300 - 5000]
4. Gear ratio [1 - 1000]
5. Units [mph / kph]
6. Sensor error [warn / stop]
o Trigger [1 - 200]
Temperature
1. CTR Sensor [PTC / NTC#]
o Warning level
2. TX sensor [active / warning level]
3. TY sensor [active / warning level]
Dynamic brake
1. Active [no / yes]
2. Min decel [0 - 200]
3. Max decel [0 - 200]
Depends on hardware and should not be changed - details on website
For version 2.4.4
up
down
back
sel

13. Forward / Reverse Settings

13.1 “Accel ramp”. Sets the time taken to reach Max PWM. 1 - 300 corresponds to 0.1 - 30 seconds.

13.2 “Decel ramp”. Sets the time taken to slow down to zero. 1 - 300 corresponds to 0.1 - 30 seconds.

13.3 “Max PWM”. Sets the maximum percentage of battery voltage that can be applied to the motor.

13.4 “Regen limit”. Sets the upper limit of the regen braking current. This works in conjunction with “Decel ramp” to control the braking effect.

A slow “Decel ramp” [high number] will generate low regen currents. A low “Regen limit” will allow the motor to coast more.

14. General Settings

14.1 “Current limit”. Sets the maximum motor current that the Pro-360 will allow. If the motor / load tries to exceed this value the PWM duty cycle will be reduced.This can be used to provide a torque limiting function.

14.2 “Reverse beep”. Switches the reversing beeper on or off.

14.3 “Low battery”. Allows the alert and cut-off voltages to be set. When the low battery alert activates, the Pro-360 will reduce its maximum speed by 50%.

14.4 “Over voltage”. Sets the maximum voltage that the controller will allow during regeneration. The deceleration ramp speed is automatically adjusted to keep the battery voltage below this setting. [120 – 900 = 12V – 90V].

14.5 “Parking brake”. Sets the time delay before the parking brake is applied, and the power threshold that must be reached before the parking brake is released.

14.6 “Alternate profile”. Sets the profile to be selected if the Alt-P input is activated, and the Pro-360 re-started.

14.7 “Deadman”. Switches between push to stop [std] and push to go [safe] modes.

14.8 “Display”. Selects what information is displayed on the right hand fields of the display. Line1 can show motor current, speed, or RPM. Line 2 can show battery current, power in Watts, or power in HP. These fields can also be scrolled during operation by pressing the up and down buttons. This section also allows the temperature to be displayed in ‘C or ‘F.

Note; There is also a “System current limit” which is not user adjustable. If the load tries to exceed this value a message is shown, and the controller will shut down to protect itself.

15. Throttle settings

15.1 “Input mode”. Selects the input to be used. POT is for a potentiometer connected to pins D, E, & F of the main control input. RC will use the RDO port. VOLT will use the signal on pin E of the main control input but the pot fault checks will be disabled. PSH will allow push button control via grounding the L1 or L2 inputs.

15.2 “Joystick”. Selects either single ended or joystick [center-off / wig-wag] mode. Joystick mode can be inverted if required.

15.3 “Deadband”. Sets the amount of input required before the output starts [joystick mode only].

15.4 “Pot learn”. See Section 17. [also used for Volt mode].

15.5 “RC learn.” See Section 17.

15.6 “Lockout”. Prevents the motor starting if the Pro-360 is switched on with the throttle not at zero. This setting defines the throttle position above which this occurs. Setting Lockout to 100 disables the check.

16. Advanced settings

16.1 “Speed sensor”.

- “Active” switches on the speed sensor input.
- “Limiting” activates the top speed limiting function.
- “MAX rpm” sets the limit beyond which the controller will reduce the power.
- “Gear ratio” defines the ratio between the RPM measured by the speed sensor and the actual vehicle speed. A worked example is on our website knowledge base.
- “Units” selects mph or kph.
- “Sensor error” sets what happens if the speed signal is lost. “Trigger” sets the number of lost speed readings before action is taken.

16.2 “Temperature”.

- “CTR Sensor” The Pro-160 is fitted with either a PTC or NTC sensor during production. This setting matches the software to the hardware and should not be changed by the user. More details are on our website.
- “Warning” temperature warning can be adjusted down from its default 75’C, this must be set in ‘C
- “TX / TY Sensor” activates the external temperature sensors X and / or Y. Each sensor can have its own warning level set. Once activated the Pro-160 will display each sensor temperature in turn. Note: the controller sensor [C] is calibrated differently to the X and Y sensors, they may not give exactly the same readings at start up.

16.3 “Contactor”. Allows use of a failsafe contactor. This can be in either the motor or battery line as required. See the knowledge base on our website for more details.

16.4 “E-stop ramp” Sets the time taken to slow down to zero when the E-stop input is activated. The default time is 0.5S.

16.5 “Dynamic brake” aka tram mode. Only works with joystick mode enabled. Moving the joystick forward gives acceleration, returning the joystick to the center off position causes the motor to slow down [or coast] according to the “max deceleration” time set. Moving the joystick further into the reverse sector will give an increasing braking effect up to the “min deceleration” time. D is displayed to indicate that dynamic braking is being applied. This mode will work in either direction, but the change from forward to reverse travel will only occur when the motor is stopped and the joystick is centered.

16.6 “Variable regen”. This allows the regen current to be varied on the fly by means of a 0V – 5V signal [e.g. from a pot fed from the BEC socket] applied to pin B of the thermistor input. Note that temperature sensor Y cannot be used at the same time.

16.7 “LMT switch” Allows the use of limit switches to toggle the direction of travel. The controller will initially start in the direction set by the reverse switch, grounding L1 will switch to forward travel, grounding L2 will switch to reverse travel.

16.8 “Joystick zero error”. This dictates the controller behaviour in the event of the input voltage going to 0V. Only applies when joystick and volt modes are active. If set on then an input <0.25V will cause a P6 error and a ramp down to zero.

17. Using the “learn” function

The “learn” function allow you to match zero speed, full forward, and full reverse from the Pro-360 to specific input signals from your pot, radio control receiver, or other input source.

17.1 Set either “Pot learn” or “RC learn” active [only one per profile].

17.2 Select “Learn zero” and press SEL, the Pro-360 will show a number related to the value detected from the pot [or other input].

17.3 Set the pot, transmitter stick, or other input to the position you want to have as zero, and press SEL to capture the associated number.

17.4 Repeat steps 15.2 – 15.3 for “Learn max forward” and “Learn max reverse”

17.5 Use BACK to return to the main menu and then save changes.

Notes:

- If you are not using “Joystick” mode, you should set “Learn max reverse” to the same value as “Learn max forward”. Reverse is then selected by the reverse switch.
- “Pot learn” – “Active” must be set to yes for the learnt values to be used.
- Volt mode uses the “Pot learn” function for learning.

- “Pot learn” must be done for each profile that is to be used, learnt values are not carried over.

18. Power-up options

Power on with SEL pressed enters set-up mode.

Power on with DOWN pressed will start up with profile 1. This is an emergency start option to be used should a system 'EEPROM' error occur.

19. System settings [inc reset]

19.1 About. Gives information on the model, software version, and serial number.

19.2 Factory reset. Allows the user to reset the Pro-360 to factory settings.

19.3 Firmware update. Allows new software to be installed via the uSD card reader.

Switch off the Pro-360, insert the uSD card containing the new software into the card holder, and switch on again with SEL pressed.

Navigate through the system settings menu to “Firmware” and then follow instructions. Remove the uSD card when finished.

20. Mounting

The Pro-360 has 2 6mm notches in the baseplate, use M6 bolts to secure to mountings.

If the operating temperature of the Pro-360 regularly gets above 65’C we recommend fitting either additional heatsinking and / or cooling. A cooling fan can be driven from the parking brake socket. Uprated air and water cooled heatsinks are available from our website.

21. Display mounting

The LCD display can be detached from its normal place on the control board and mounted in a more convenient location for the operator. There is an optional remote display box.

22. Fault finding

The Pro-360 has a set of fault codes and warning messages. These are listed in the Support / Knowledgebase / Pro-360 section of our website.

There are two fuse tracks in the connections to the main control input, these are adjacent to the parking brake socket and aim to restrict damage in the event of a wiring fault. If a fuse track is blown a self-resetting fuse may be fitted or a single strand of 1A fuse wire.

23. Service

The Pro-360 has a 12 month warranty. Please see the service section of our website for full details.

It is also worth checking the troubleshooting section of our website for advice on how to find common installation problems.

			Profile									
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11-15
Parameter	**Range**	**Default**	**Small loco**	**Large loco**	**Golf buggy**	**Go kart**	**Joystick**	**RC single end**	**RC joystick**	**12 V**	**Dynamic braking**	**Custom**
Forward acceleration ramp time	0.1 - 30 sec	50	50	70	50	20	50	50	50	50	50	50
Forward deceleration ramp time	0.1 - 30 sec	30	30	30	20	10	30	30	30	30	300	30
Maximum forward speed	1 - 100 %	100	100	100	100	100	100	100	100	100	100	100
Maximum forward regen current	0 - 200A	140A / 200A depending on model										
Reverse acceleration ramp time	0.1 - 30 sec	50	70	100	50	20	50	50	50	50	50	50
Reverse deceleration ramp time	0.1 - 30 sec	30	30	30	20	10	30	30	30	30	300	30
Maximum reverse speed	1 - 100 %	100	50	50	50	100	100	100	100	100	100	100
Maximum reverse regen current	0 - 200A	140A / 200A depending on model										
Current limit [fwd and rev]	0 - 140A / 200A	120A / 175A depending on model										
Reverse beeper on / off	On / off	on	off	off	on	off	off	off	off	on	Off	on
Low battery alert [50% max speed]	11 - 72 Volts	220	220	220	220	220	220	220	220	110	220	220
Low battery cut-off	11 - 72 Volts	210	210	210	210	210	210	210	210	105	210	210
Parking brake delay	0.1 - 9.9 sec	10	10	10	10	10	10	10	10	10	10	10

			Profile									
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11-15
Parameter	**Range**	**Default**	**Small loco**	**Large loco**	**Golf buggy**	**Go kart**	**Joystick**	**RC single end**	**RC joystick**	**12 V**	**Dynamic braking**	**Custom**
Parking brake threshold	0- 10%	1	1	1	1	1	1	1	1	1	1	1
Alternative profile	0 - 20	0	3	2	0	0	0	0	0	0	0	0
Deadman	Std / Safe	Std	Std	Std	Std	Std	Std	Std	Std	Std	Std	Std
Input method	Pot / RC / Volt	pot	pot	pot	pot	pot	pot	rc	rc	pot	Pot	pot
Joystick mode	On / off	off	off	off	off	off	on	off	on	off	on	off
Joystick throttle dead band %	0 -75%	10	10	10	10	10	10	10	10	10	10	10
High pot / RC lockout level	0 - 99%	5	5	5	5	5	5	5	5	5	5	5
Max RPM	300 - 5000	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
TX warning temperature	40 - 95'C	80	80	80	80	80	80	80	80	80	80	80
TY warning temperature	40 - 95'C	80	80	80	80	80	80	80	80	80	80	80

25. Specifications

Technical Specification		
	Pro-360	
	360-S	**360-HV**
Nominal voltage range	12 - 48	12 - 84
Minimum / max voltage	10.5 - 65	10.5 - 96
Motor current A [max]	360	360
Motor current A [1 minute]	300	300
Motor current A [continuous]	Depends on cooling	
Programmable parameters	See parameter table	
Dimensions [mm]	281 x 103 x 60	
Weight [g]	~1700g	
Power connections	M8 studs	
Input	5k – 25k pot, RC [PWM], 0 – 4.7V	
Reverse polarity protection	N	
Overvoltage protection	Y [65V]	Y [95V]
Pot fault protection	Y [50k]	
Thermal protection	Y @ 65'C [also for 2 external sensors]	
Joystick/Wig-wag input	Y	
Radio Control	Y	
Parking brake	1A max, delay and threshold programmable	
Inhibit function	Emergency stop input	
Other inputs	Deadman, alt profile, speed, 2 x thermistor, 2 x limit, 2 x spare	
Powerdown state	Diode bridge across motor	
Closed loop RPM control	Via software update	
Ignition, electronic	Y	
Safety contactor circuit	Y	

Technical Specification		
	Pro-360	
	360-S	360-HV
Heatsink	10mm plate standard. Advanced air cooled and water cooled available as options.	
Double heading	Y [also comms board coming soon]	
Switching frequency	20 kHz	
Quadrants	4	