CHERRY_XPS Permanent Magnet DC Motor Driver

Hardware Installation & User-Manual

H♥M

Heart Of Motion

Preface:

CHERRY_XPS Permanent Magnet DC (PMDC) motor drivers are products of ALTALAB company under the HOM brand name. we regularly review the content of this document and any suggestions or critics are highly welcomed. We keep the right for ourselves to modify the equipment and documentations without any prior notice.

We keep ourselves committed in maintaining our distributors updated with our most recent documentations so that our users can make sure they have the latest updates. For any further information or news, you can visit www.altalab.it

This document comes along with the product datasheet as well as a complementary but not replaceable document, so the users should make sure they have read and understood them based on the application they are intending to use CHERRY_XPS.

Attention symbols

i Note	Note – information for clarification of a process, operation or setups leading to better preparation of the product
! Notice	Notice - Required instruction necessary to ensure successful completion of a task or procedure.
! Caution	Caution - Instructs and directs you to avoid damaging equipment
! **Warning**	Warning – Instructs and directs you to avoid harming yourself.
! **D A N G E R**	Danger - Presents information you must highly pay attention to avoid serious injury or death.

Contents

1 Product and System Requirements

This document is intending to provide necessary information for selecting, installing and operating CHERRY_XPS PMDC motor driver form the family of CHERRY drivers.

1.1 CHERRY_XPS PMDC Motor Driver Overview

CHERRY_XPS Motor Driver is one of the members of CHERRY family of Permanent Magnet DC(PMDC) motor drivers offered by HOM. CHERRY_XPS which is basically refers to CHERRY_HPS and CHERRY_LPS that are respectively the high power and low power members of CHERRY family of DC motor speed controllers. These products are facilitated with smart Sensor-less Speed and Torque control of PMDC motors up to the power range of 1400W. CHERRY_XPS is designed to be simple and extremely easy to use while having the highest possible technologies embedded inside. The main goal of a product like CHERRY for its designers is making the motion control at the simplest and most approachable form for a vast majority of users to enhance the user experiences by maximizing the efficiency time-wise and cost-wise.

Using CHERRY_XPS, the speed control can be done in Open-loop or Closed-loop fashions based on the desire of the end user. The CHERRY_XPS products offer sensor-less speed control feature in Closed-loop mode which enables the users to take the maximum advantage of their Motors by fixing the speed under variation of load without the need to any external Encoder or mechanical speed sensors which reduces the cost and size of systems considerably.

To run and control PMDC motors with CHERRY_XPS, in the simplest form, the users don't need to connect anything but the Motor and a power supply, the speed can be controlled by a mechanical potentiometer existing on the driver. In case of other applications that a higher precision and smarter control is required, the users can input the desired speed through the other three inputs including one Analogue input of 10V, one PWM input of 10kHz or an external potentiometer which can be wired to the driver by a distance up to 10 meters.

1.2 Part Numbering and Product Codes

In our products covered by this document we use a specific part numbering which can be helpful for understanding the major features and characteristics of the driver the users are intending to provide as in Figure 1-1.
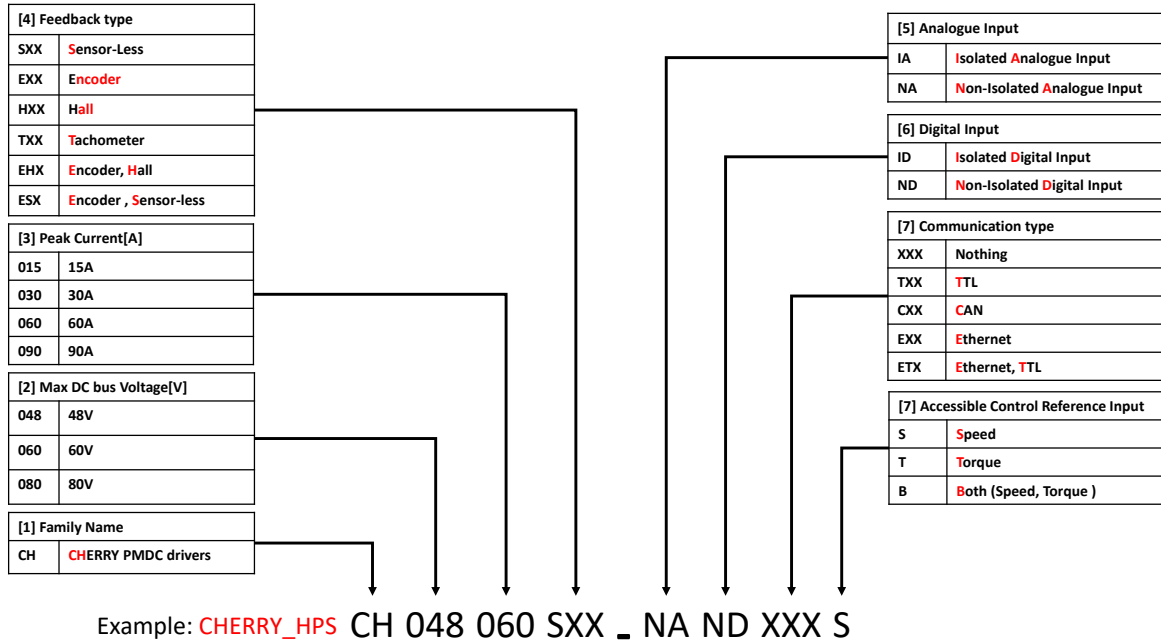
[4] Feedback type	
SXX	Sensor-Less
EXX	Encoder
HXX	Hall
TXX	Tachometer
EHX	Encoder, Hall
ESX	Encoder , Sensor-less

[3] Peak Current[A]	
015	15A
030	30A
060	60A
090	90A

[2] Max DC bus Voltage[V]	
048	48V
060	60V
080	80V

[1] Family Name	
CH	CHERRY PMDC drivers

[5] Analogue Input	
IA	Isolated Analogue Input
NA	Non-Isolated Analogue Input

[6] Digital Input	
ID	Isolated Digital Input
ND	Non-Isolated Digital Input

[7] Communication type	
XXX	Nothing
TXX	TTL
CXX	CAN
EXX	Ethernet
ETX	Ethernet, TTL

[7] Accessible Control Reference Input	
S	Speed
T	Torque
B	Both (Speed, Torque)

Example: CHERRY_HPS CH 048 060 SXX _ NA ND XXX S

Figure 1-1 - Part Numbering and Product Codes Encoding

The CHERRY family products can be categorized as in Table 1:

Table 1 – CHERRY family products

CHERRY Family Products					
Description	Units	CHERRY_HPS CH048060SXXNANDXXXS	CHERRY_LPS CH048030SXXNANDXXXS	CHERRY_HPT CH048060SXXNANDXXXT	CHERRY_LPT CH048030SXXNANDXXXT
DC Supply Voltage Range	VDC	12-48	12-48	12-48	12-48
DC Bus Over Voltage Limit	VDC	60	60	60	60
DC Bus Under Voltage Limit	VDC	12	12	12	12
Maximum Peak Output Current	A	60	30	60	30
Maximum Continuous Output Current	A	30	15	30	15
Maximum Continuous Output Power	W	1331	665	1331	665
Maximum Power Dissipation at Continuous Current	W	69	35	69	35
Internal Bus Capacitance	µF	6600	6600	6600	6600
Minimum Load Inductance	µH	50	50	50	50
Switching Frequency	kHz	20	30	20	30
Maximum Output PWM Duty Cycle	%	95	95	95	95

1.3 Drivers datasheet

Table 2 – Power Specifications

Description	Units	CHERRY_HPS CH048060SXXNANDXXXS	CHERRY_LPS CH048030SXXNANDXXXS
DC Supply Voltage Range	VDC	12-48	12-48
DC Bus Over Voltage Limit	VDC	60	60
DC Bus Under Voltage Limit	VDC	12	12
Maximum Peak Output Current	A	60	30
Maximum Continuous Output Current	A	30	15
Maximum Continuous Output Power	W	1331	665
Maximum Power Dissipation at Continuous Current	W	69	35
Internal Bus Capacitance	µF	6600	6600
Minimum Load Inductance	µH	50	50
Switching Frequency	kHz	20	30
Maximum Output PWM Duty Cycle	%	95	95

Table 3 – Control Specifications

Control Specifications		
Description	**Units**	**Value**
Command Sources	-	0-10V Analogue, PWM, Direction, Internal Potentiometer, External Potentiometer
Modes of Operation	-	Open-loop speed control, Closed loop sensor-less speed control
Motors Supported	-	Permanent magnet DC motors (PMDC)
Hardware Protection	-	Reverser Polarity, over-current, output short-circuit
Current Loop Sample Time	µs	40
Velocity Estimator Sample Time	µs	40
Velocity Loop Controller sample Time	µs	40

1.4 Modes of operation

CHERRY_XPS has two main modes of operation as below:

1.4.1 Open-loop mode

In this mode the driver outputs a certain fixed power to the motor in an open-loop fashion, which results a certain rotational speed on the shaft of the motor, this means the driver will not have any observation and control over the speed of the rotation of the motor, and the speed may be subjected to change if the load on the shaft of the motor varies.

This mode of operation is suitable for systems which are not sensitive to speed variation and specially applications that need fast and easy implementation.

i Note	This mode is suitable for fast system setups or systems that the users are certain the variation of the speed under variation of load on the motor is not a problem.

1.4.2 closed-loop sensor-less mode

This mode simply provides the users the possibility of fixing the motor speed under the variation of the load, which means after properly tuning the driver, for a certain amount of input either from SPEED Potentiometer or the Analogue or PWM input, the speed on the shaft of the motor will remain constant. This feature enables the users to have a valuable robustness in their systems when the load varies.

The sensor-less feature on the other side means, CHERRY_XPS will automatically detect the motor speed without the need to any external mechanical sensors such as Encoders, Tachometers or Hall sensors, this feature itself results in considerable reduction of the cost and size of the various applications.

The whole design of the closed-loop sensor-less mode stands on a nested Torque-Speed control loop with a speed estimator inside. To maximize the ease of use, CHERRY_XPS automatically tunes the Torque loop by identifying necessary parameter of the Motor and the users need only to tune the speed controller by two simple potentiometers which will be discussed in "Tuning CHERRY_XPS for Closed-loop Sensor-less Operation" section.

i Note	This mode is suitable for those application which the speed of motion should be constant during the operations. The driver in closed-loop sensor-less mode will adjust the output power to the motor in order to guarantee a fixed speed on the shaft of the motor during load variations up to the limited current defined by the user.

⚠ Notice	During the Closed-loop mode, the user has to make sure that the current limit switches are set correctly based on the datasheet. In case of the excessive load which results in higher current demand in the motor, the speed may get affected or reduced, in such cases the user has to increase the current limit to the next level.

⚠️ **Warning**	Make sure you have read and undrestood completely the tuning procedures for the closed-loop sensor-less mode. During the tuning the motor might start oscilating or it might get unstable if tunings are not done properly. Make sure the tuning is done in a safe place with proper clearances for you and your equipments to avoid harming yourself as well as other parts.

1.5 Command Sources

1.5.1   Speed Commands

CHERRY_XPS offers variety of methods for controlling the speed of a PMDC motor, it can be basically controlled by 4 main inputs:

1. **Mechanical Potentiometer mounted on the driver**, this mode is called stand-alone mode, in this mode the users can run the motor without any wiring except the wires for motor and the supply.

2. **Analogue 0-10V input**, this input enables the users to control the speed of the motors by an analogue input ranging from 0 to 10V which 0V stands for the zero speed and 10V stands for the maximum speed of the motor.

3. **PWM input of 10kHz with amplitude of 10V,** Thanks to this input the users can send a PWM command instead of an Analogue command to control the speed. These pulses should have frequency around 10Khz with amplitude of 10V, in this mode the duty cycle of 100% defines the maximum speed and subsequently the duty cycle of 0% maps into zero speed.

4. **External Potentiometers**, CHERRY_XPS offers for those who want to control their motors with an external potentiometer mounted far away from the driver a solution where they can connect their own potentiometer directly to the driver as far as 10 meters from the driver.

Caution

The maximum tolerable voltage on "ANALOGUE IN" pin for controlling the speed of the motor is 20V. Any voltage above that can cause permanent damage to the driver.

Caution

The user must ensure a safe and reliable ground connection between the power supply and the driver. The sudden loss of ground or Negative voltages on the inputs of the driver can harm the driver permanently.

1.5.2 Direction Command

The direction of the rotation of the Motor connected to CHERRY_XPS can be changed by pulling up or pulling down the "DIRECTION" pin. The action can be done in two different ways, the first one which is the simplest is by putting a switch between "+12V" pin and "DIRECTION" pin for simple systems in a fairly stable and not noisy environments as can be seen in Figure 1-2. The second method is by using a NPN or Open collector output according to the circuit mentioned in Figure 1-3 for PLC users whom work in industrial environments, in this configuration "R1" and "R2" can be selected as 15KΩ and 10KΩ respectively.

> ⚠️ **Caution**
>
> The maximum tolerable voltage on "DIRECTION" pin for setting the Direction of the motor is 20V. Any voltages above that, can cause permanent damage to the driver.
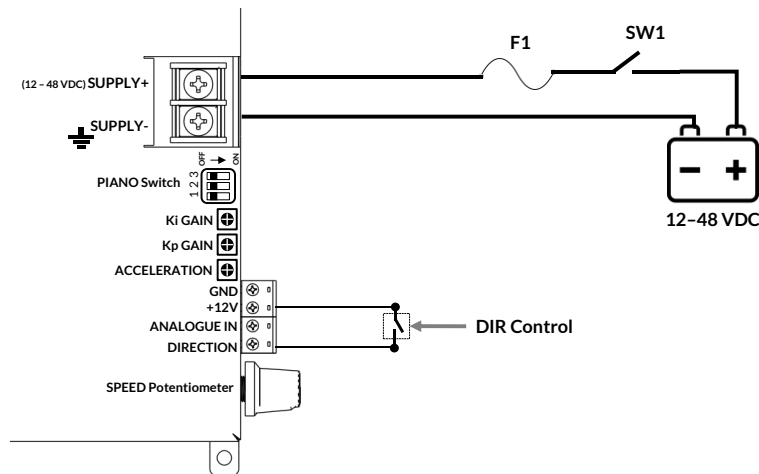

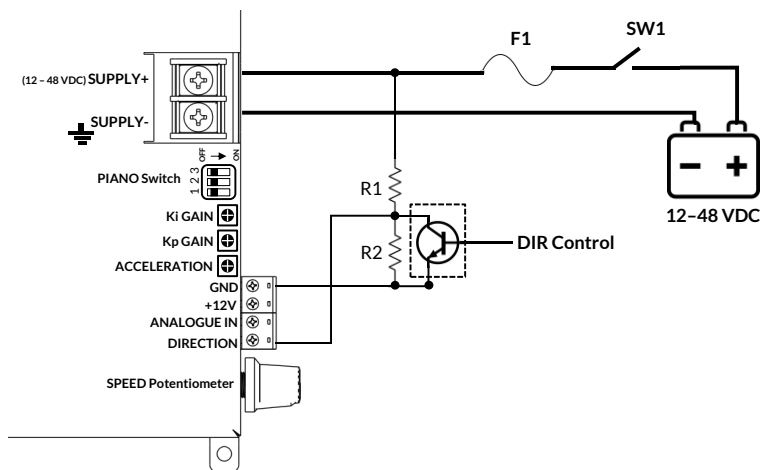Figure 1-2 – Simplest Form of Direction Control for stable Environments

Figure 1-3 – Direction control using NPN output for Noisy and harsh environments

During the Selection of the Motor direction based on the direction control switch shown in the Figure 1-2, the direction of the current floating into the Motor will be as in Figure 1-4 (when the Direction switch is open)
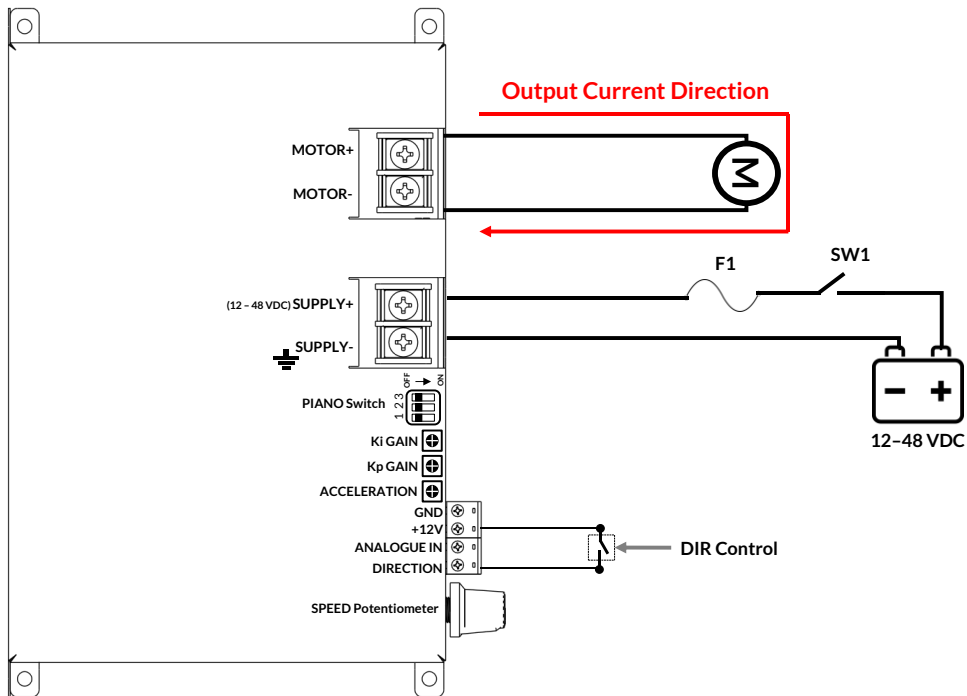

Figure 1-4 – Effect of Direction control on the Output Current Direction into the Motor

So, if the user closes the direction control switch in Figure 1-4 the direction of the current into the motor will be reversed.

| ⚠ Caution | Sudden changing of Direction may cause a mechanical shock to your system, since CHERRY_XPS has the Acceleration/Deceleration control feature foreseen into a potentiometer mounted on the driver, the users should tune this value in order to avoid damaging their systems due to shocks. |

1.5.3 Acceleration Command

The acceleration of the Motor connected to CHERRY_XPS can be tuned both in Open-loop and Closed-loop modes for those users who want a soft-start or soft-stop as well as Acceleration and Deceleration behavior when they alter the speed. Setting of the Acceleration will be done by turning the ACCELERATION potentiometer in CW direction (to increase Acceleration) as can be seen in Figure 1-5 until the desired acceleration is achieved. For having no acceleration, the users should turn the ACCELERATION potentiometer in CCW direction until it reaches to its end.
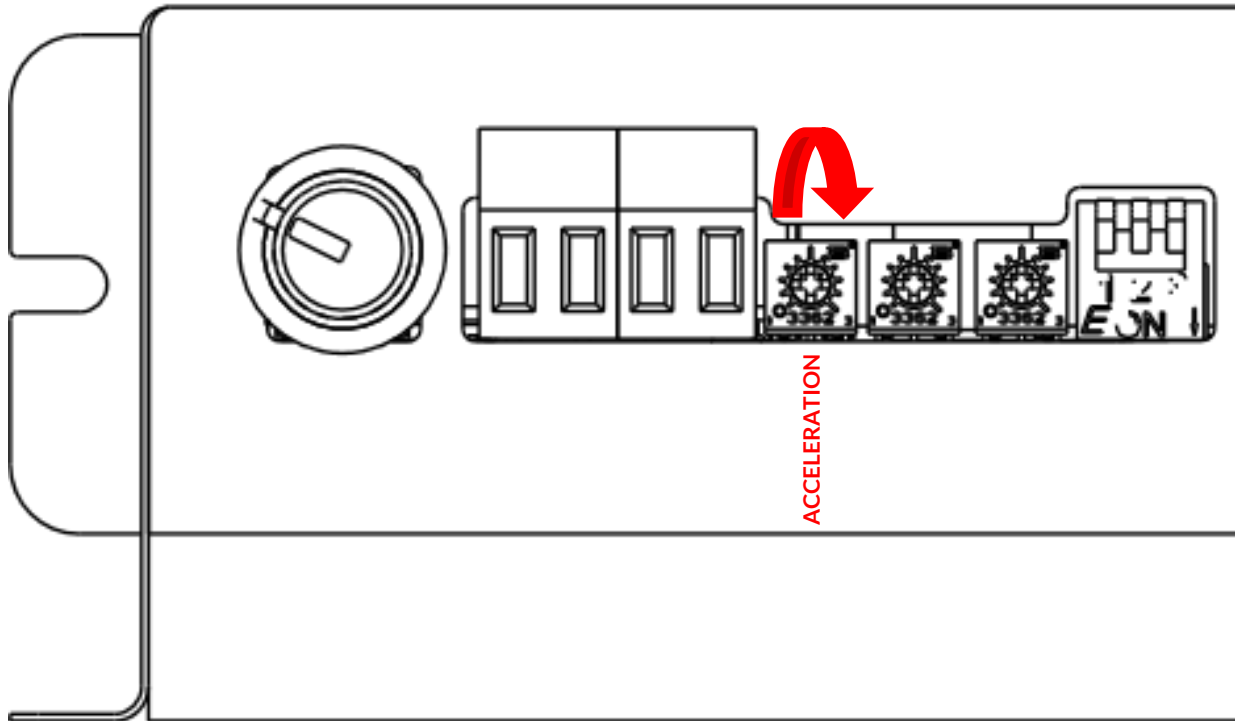

Figure 1-5 – Increase of Acceleration/Deceleration for soft-start/ soft-stop

1.5.4 Piano Switch Settings

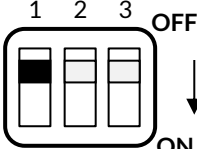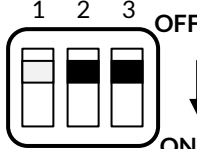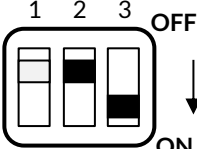The piano switch mounted on CHERRY_XPS has 3 switches for two main reasons:
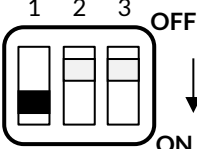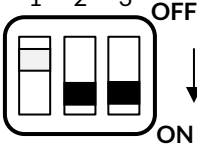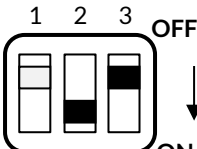
1. Mode selection between open-loop and Closed-loop
2. Current Limit value selection

As can be seen in Figure 1-6 the pinout of the Piano Switch has been shown.

Figure 1-6 – Piano Switch Pins

Table 4 – Piano Switch Table of Functionalities

MODE Selection[1]	CURRENT Limit	
Open-Loop Mode		30A Limit
		20A Limit
Closed-Loop Sensor-Less Mode (CLSL)		10A Limit
		5A Limit

[1] "MODE Selection" and "CURRENT Limit" functionalities are independent from each other

i Note	The current Limit pins are independent from the selected mode of the driver and both in open-loop and CLSL mode are valid and functional.
⚠ Caution	The user should take care of the value of the current limit selected for the driver so that the connected Motor to CHERRY_XPS will not get damaged or thermally stressed during various types of operations.

2 Getting Started

To start with your CHERRY_XPS motor driver, make sure you have read and understood the previous chapters in this manual as well as the driver datasheet. Ensure that all the system specifications and requirements are met.

2.1 Initial Setup and Configuration

For having a safe initiation, the user has to follow the steps below:

1. **Apply the essential wiring to the system** as shown below in Figure 2-1 , the user has to make sure that the value of "F1" (as well as "R1" and "R2" in case of using NPN output to DIRECTION pin as in Figure 1-3) is correctly selected based on the datasheet of the driver.
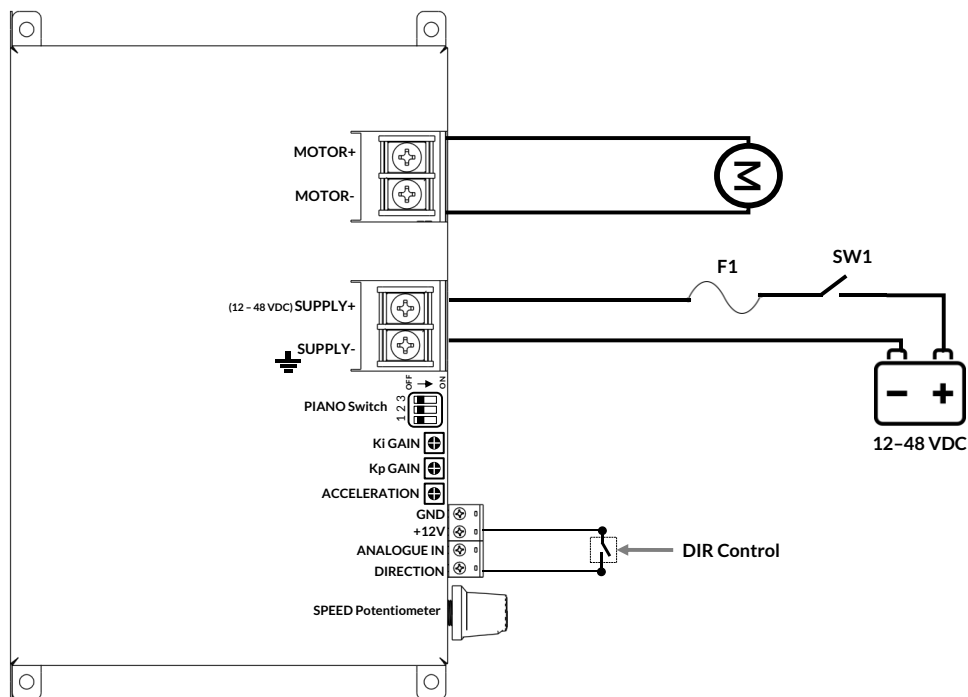

Figure 2-1- Minimum external wiring of CHERRY_XPS

2. **Set the amount of Current Limit,** at this stage the user has to Set the maximum allowable limit of the current floating to the motor by setting the "PIANO switch" considering the specification of the connected PMDC motor based on the datasheet of the CHERRY_XPS.
3. **Put the Driver on "Open-loop" Mode,** at this point the user has to set the Piano switch values according to the datasheet to activate the open-loop operation
4. **Close the switch "SW1" and connect the supply to the driver,** after this stage an internal LED near to the SUPPLY connector will turn on.
5. **Check the functionality of the driver,** at this stage without even connecting the "DIRECTION" circuitry you would be able to spin the Motor connected to the driver

by turning the SPEED Potentiometer clockwise, by doing so, the motor will speed up as you continue turning the potentiometer until it reaches the maximum speed.

6. **Tune the Driver for Closed-loop Sensor-less operation,** if the users want to use the closed-loop sensor-less (CLSL) mode, they can now move to "Closed-loop Sensor-less (CLSL) Setup and Configurations" chapter and then to "Tuning CHERRY_XPS for Closed-loop Sensor-less Operation" section in this manual to completely setup their systems for CLSL operation.

⚠️ Caution	The maximum allowable current depends on the ype of the use of the Motor in the systems and the Motors' nominal and allowable continuous power. The users by the knowledge of their system and used PMDC Motor must select an appropriate Current range to avoid firstly harming the Motor and secondly having the best performance of CHERRY_XPS.

3 Operational Configurations

3.1 Open-loop Configurations

3.1.1 Rapid Setup

For those users who want to rapidly setup the driver and spin their motors only in one direction, they can apply one of the wirings mentioned in Figure 3-1 or Figure 3-2, then follow the setup procedures mentioned on "

Initial Setup and Configuration" section. In this type of setup, the minimum wiring is represented to run CHERRY_XPS. As can be seen the direction pin is not connected, so for changing the direction of the motor the users must change manually the direction of motor wires as in Figure 3-2 in these configurations.
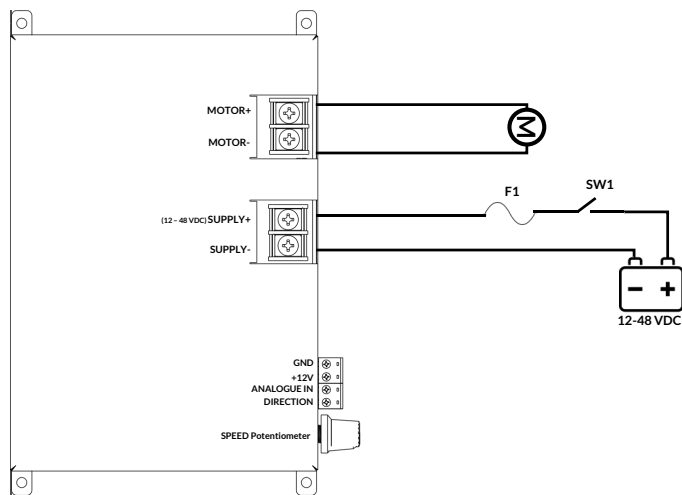

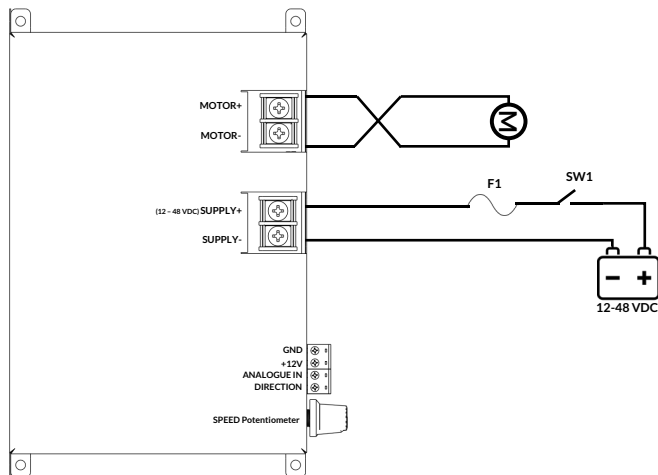Figure 3-1 Minimum Wiring to run CHERRY_XPS in Open-loop

Figure 3-2 Changing the Motor direction in Minimum wiring

3.1.2 Setup with Analog 0-10V Input Mode

This setup has a wiring like in   Figure 3-3 , but for making CHERRY_XPS ready to accept the Analogue voltages between 0V to 10V as the reference for the speed of the Motor, the users has to Rotate the SPEED Potentiometer in Counter Clockwise direction (CCW) as in Figure 3-4 until they can feel the switch of the potentiometer is turned off. Practically if the potentiometer reaches to its end, there would be a click-like sound and then the potentiometer will get blocked in CCW direction, by doing so, CHERRY_XPS will be ready to accept the speed commands as Analogue voltages.
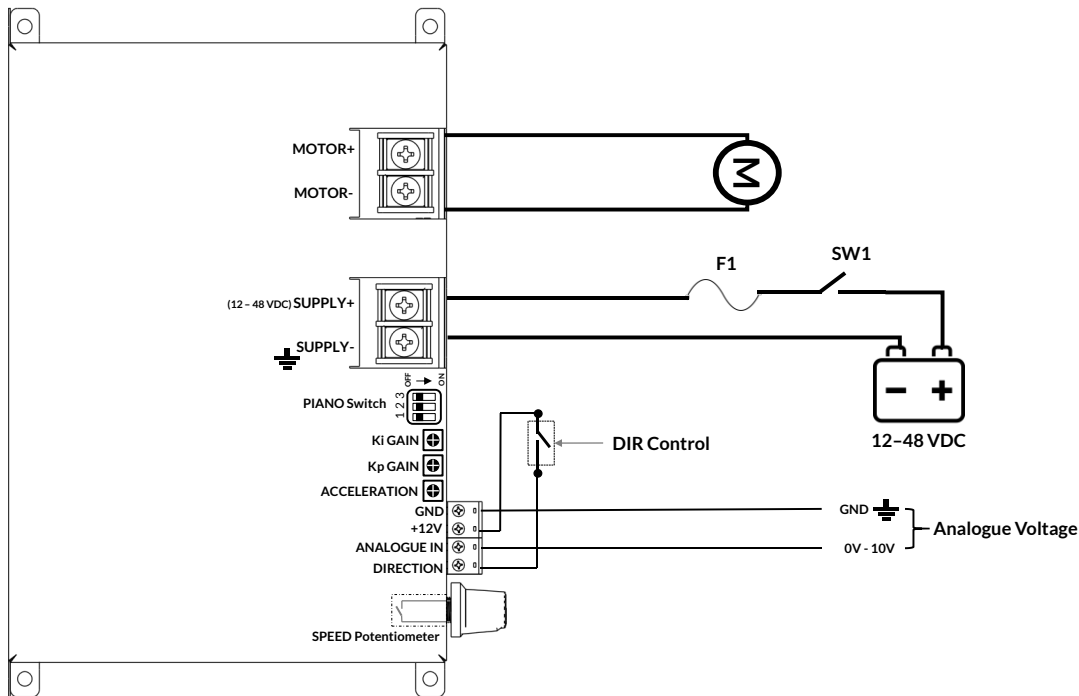

Figure 3-3 – CHERRY_XPS wiring in Analogue Voltage Input Mode
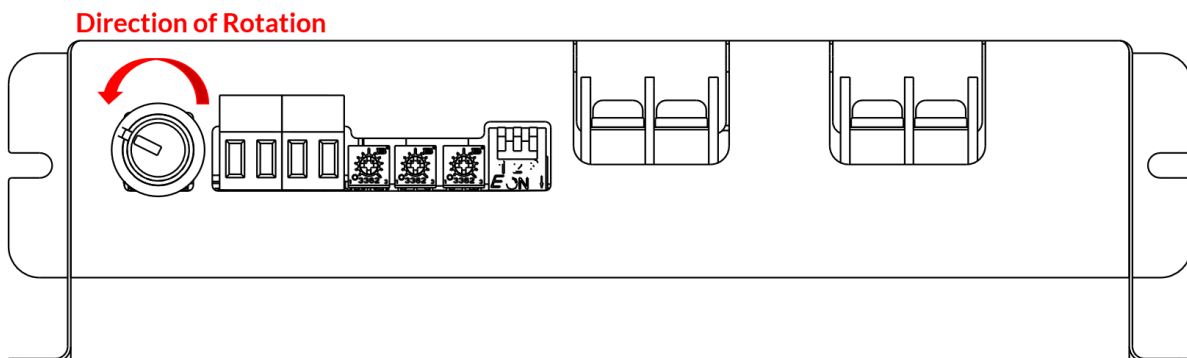
Figure 3-4 – Direction of rotation of SPEED Potentiometer to put CHERRY_XPS in Analogue Voltage input Mode

3.1.3 Setup with PWM input of 10kHz

This mode can be wired as in Figure 3-5, the whole initial setup in this mode is identical to the "Setup with Analog 0-10V Input Mode" section by turning completely the mechanical SPEED Potentiometer on the driver in CCW direction until its switch turns off as in Figure 3-4 . As it was mentioned before the PWM technique should be used with pulses with 0 to 10V known as Low state and High state respectively with a frequency of 10kHz. In this mode of operation, the duty cycle of the pulses will define the speed of the motor, so a pulse with 0% duty cycle stands for zero speed and a pulse with 100% duty cycle stands for maximum speed.

Figure 3-5- PWM input setup of CHERRY_XPS

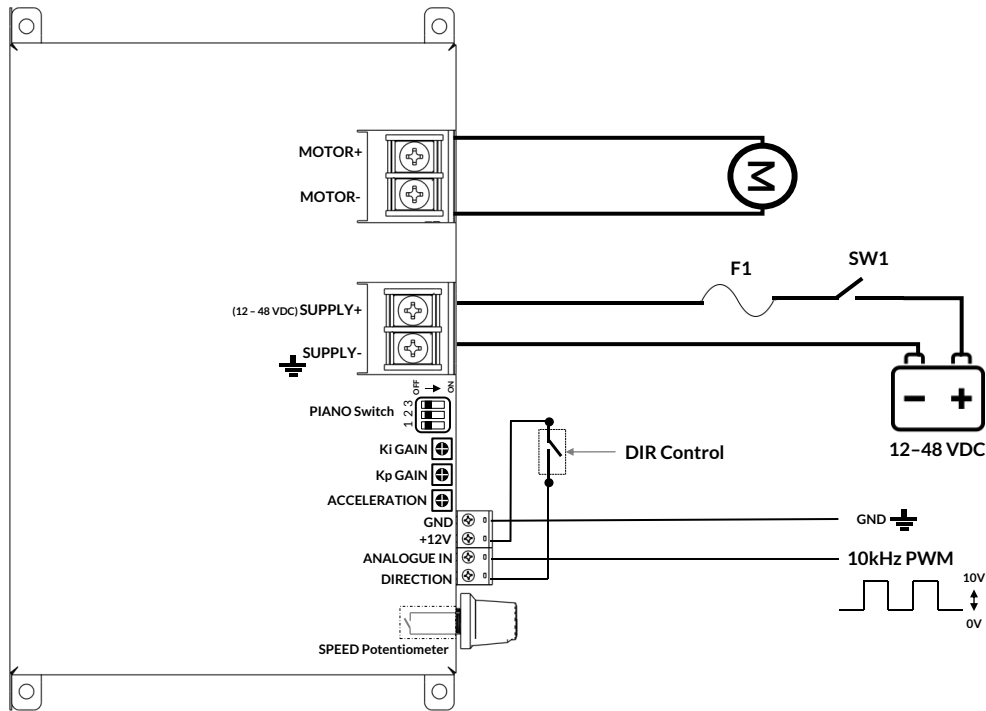### 3.1.4 Setup with External Potentiometer

This mode intends to address the needs of those users who want to control the speed of the Motor with a mechanical potentiometer but mounted far away from the Driver as far as 10 meters. To prepare CHERRY_XPS for operating in this mode the users must act like what has been said in previous section of "Setup with Analog 0-10V Input Mode" by rotating the SPEED Potentiometer CCW till the very end where the SPEED Potentiometer gets blocked in CCW direction like in Figure 3-4 (A click-like sound due to switching of the internal switch of SPEED Potentiometer will be heard). The configuration setup of the CHERRY_XPS will be as in Figure 3-6 for operating under External Potentiometer mode for controlling the speed.
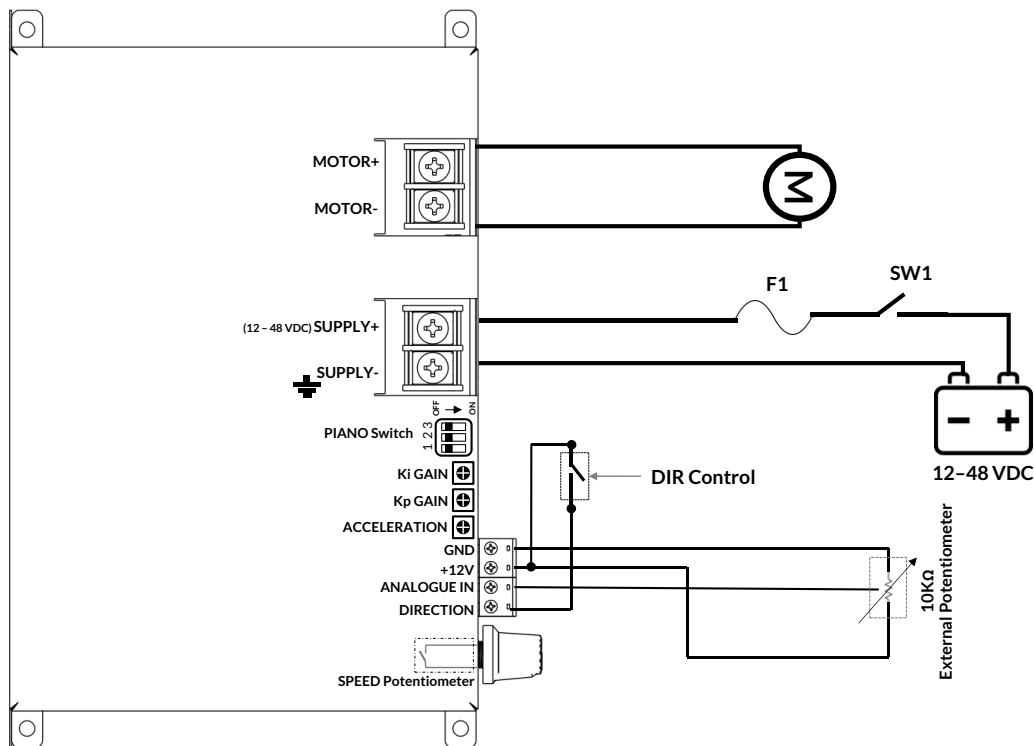

Figure 3-6- Setup of CHERRY_XPS in External Potentiometer Mode

As can be seen in Figure 3-6 the external potentiometer which should be used is 10KΩ with minimum power of 0.1 Watt.

3.2 Closed-loop Sensor-less (CLSL) Setup and Configurations

To setup the Closed-loop Sensor-less mode, the users can setup the system based on one of the configurations mentioned in previous sections as "Setup with External Potentiometer", "Setup with Analog 0-10V Input Mode " or "

Rapid Setup" configurations, in all these configurations the wiring of open-loop and closed-loop modes are the same and the only difference will be the difference on the PIANO switch settings. The procedure to setup the CLSL mode will be as following:

1. **Apply the essential wiring to the system,** the wiring can be done as one of the wirings in Figure 3-1, Figure 3-2, Figure 3-3 or Figure 3-6 based on the desire of users.
2. **Set the amount of Current Limit,** at this stage the user must Set the maximum allowable limit of the current floating to the motor by setting the "PIANO Switch" considering the specification of the connected PMDC motor based on the datasheet of the CHERRY_XPS.
3. **Put the Kp GAIN, Ki GAIN, ACCELERAION and SPEED Potentiometer on minimum,** at this point all the mentioned 4 potentiometers should be rotated in CCW direction up until they reach to their Minimum by getting blocked in CCW direction as in Figure 3-7.
4. **Put the Driver on "Closed-loop Sensor-less" Mode,** at this point the user has to set the Piano switch values according to the datasheet to activate the closed-loop sensor-less mode.
5. **Tune the CLSL Gains,** now the users must follow the procedure in next section mentioned for tuning the closed-loop sensor-less by tuning the Kp and Ki Gains for having a proper speed control in sensor-less mode.
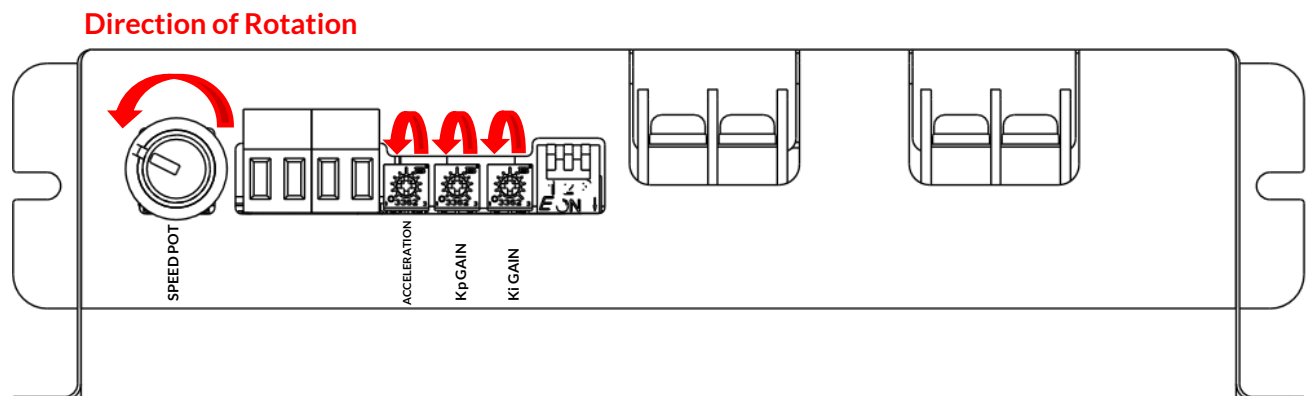

Figure 3-7 – Pre-Setting of Potentiometers for Tuning of CLSL mode

3.2.1 Tuning CHERRY_XPS for Closed-loop Sensor-less Operation

At this point the users after following the procedures mentioned in previous section of "Closed-loop Sensor-less (CLSL) Setup and Configurations" can proceed to tuning of the Closed-loop mode following the below steps:

1. **Prepare the System**, at this point, the system connected to CHERRY_XPS which will be a PMDC motor connected to some loads like wheels or etc. should be prepared for having some possible vibration or instability in case of bad tuning. To this end, for the users that their system is not sensitive to vibrations it is possible to leave the PMDC motor engaged inside of their system, but for those users whom their system is vibration sensitive, it is recommended to take the PMDC out only for one time and apply some external load to it, to firstly tune CHERRY_XPS externally and then after ensuring of no instability they can mount PMDC back and maybe doing some slight re-tuning while PMDC is engage inside in the real system to have the maximum performance.

2. **Apply Power to the System,** at this point the users can turn on CHERRY_XPS by activating supply to the driver by closing "SW1" in Figure 3-3.

3. **Wait 5 seconds until the Identification is done,** after suppling CHERRY_XPS, since the PIANO switch set on closed-loop mode, the driver will start identifying the connected PMDC (if previously not identified). At this point you might hear some noises from the motor while the shaft will stand still or may vibrate with very small amplitude. After this stage the Identified values will be saved on the memory of CHERRY_XPS until the next time you request for a new identification. (which will be discussed in "Repeating the Motor Identification")

4. **Tune Kp GAIN,** increase a little bit the Kp Gain first by rotating the Kp GAIN potentiometer in CW direction. Then increase a little bit the SPEED Potentiometer until the PMDC starts rotating with a very low speed. Now you can increase Kp further until you feel some vibrations on the shaft of the motor. This is the point you should stop rotating Kp GAIN potentiometer.

5. **Tune Ki GAIN,** now you can increase Ki GAIN by rotating its potentiometer in CW direction until the vibrations on the shaft of the motor disappears.

6. **Check the Tuned values,** now by changing the load on the shaft of the PMDC you can observe that the rotational speed of the PMDC will remain unaffected. In case by increasing the load on the shaft of the PMDC you observe the instability or vibration the reason could be one of the followings:

   - **The Current Limit is too Low,** if the current limit is not set properly, at moments when the current demand from the motor due to increase of the load on the shaft increases, the CHERRY_XPS will not allow for more currents, so you will observe jogging behavior or instability, in such a cases the users have to increase the Current Limit to the next level to avoid this.
   - **The Kp and Ki Gains are not tuned properly,** if this is the case try to find the best combination for Kp and Ki gains by adjusting them according to your system behavior, at a certain configuration of Kp and Ki you will have a desired behavior.

- **The Power supply cannot deliver enough power,** in some cases the power demand surpasses the maximum deliverable power from power supply in case the power supply is poorly selected for the application. In such cases the users should provide power supplies with enough power ratings for their system.

7. **Set the desired Acceleration,** at this point if the users want the acceleration or soft start in their systems, they can rotate the ACCELERAION potentiometer in CW direction till they have the desired acceleration.

Caution

Tuning of CLSL on CHERRY_XPS is very easy but it needs proper attention to the details, so the users must make sure they have enough training to deal with their systems during the tunings and possible vibrations.

Note

The Tuning is one-time job as long as the Motor remains the same, so once the best Ki and Kp gains are found they can remain the same.

Warning

For sensitive systems the tuning is better to be done Externally while the PMDC motor is not connected to the main system, so after some pre-tunings when the users make sure the instability is avoided they can put back PMDC in their systems and it might need some slight Kp and Ki tunings, so the users should pay attention to all the safety measures and avoid changing Kp and Ki Gains abruptly when PMDC is engaged in the system.

Warning

It is highly recommended that the Tuning is done with a power supply with control over current and not the batteries. In this case the users can avoid rushing huge current into CHERRY_XPS or PMDC due to bad tunings. After the tuning is done then the users can connect any kinds of DC supplies based on the "Power Supply Specification" section to CHERRY_XPS.

Caution

It is highly recommended that the users increase the Current Limit little by little and avoid putting the current limit on the maximum during the tunings. The users must put the Current limit firstly on the minimum possible range and increase it further when an initial tuning is done to check the performance for different loads.

3.2.2   Repeating the Motor Identification

CHERRY_XPS will memorize the results of the latest Identification on its non-volatile memory as long as the Piano Switch of Closed-loop mode is active, so that even after switching off the whole device, the values will be remembered. In one of the following cases the Identification is necessary to be repeated:

1. Changing the connected PMDC motor to CHERRY_XPS
2. Changing the wiring of PMDC connected to CHERRY_XPS
3. Activation of Open-loop Mode

To repeat the Identification process the users simply need to put back the Piano Switch settings on "Open-loop" mode while the power is applied to CHERRY_XPS, After this put the Piano Switch on "Closed-loop" mode (as can be seen in Figure 3-8), by doing so CHERRY_XPS will perform a new Identification and it will save the newly identified parameters as long as the piano switch remains on "Closed-loop mode".
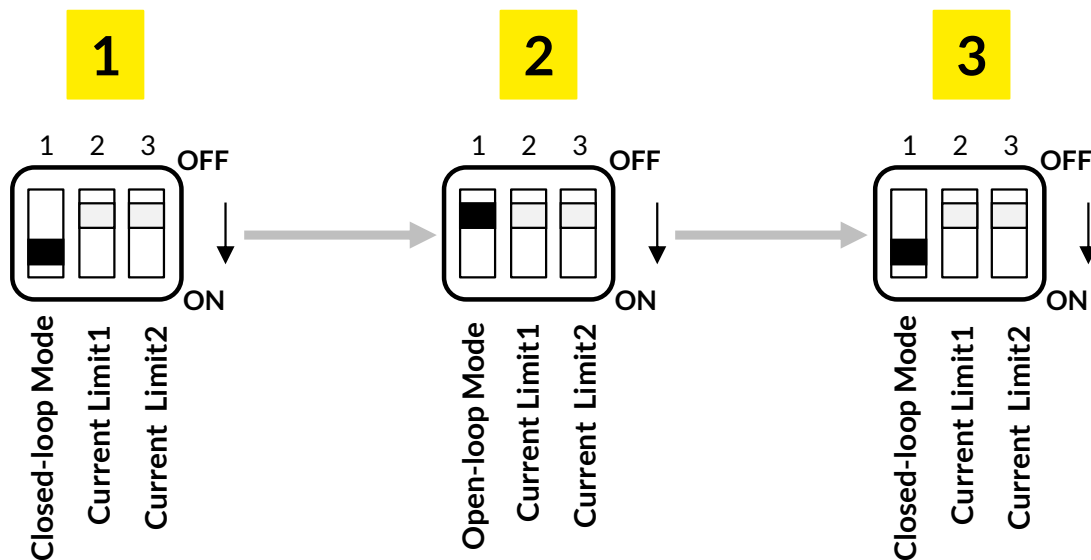

Figure 3-8 – Identification Repetition Procedure

3.3 Mounting and Mechanical Drawings

In this section a mechanical drawing of CHERRY_XPS is presented which indicates the size and mechanical dimensioning for mountings, CHERRY_XPS can be mounted both in wall-mount and panel-mount fashions as in Figure 3-9 .
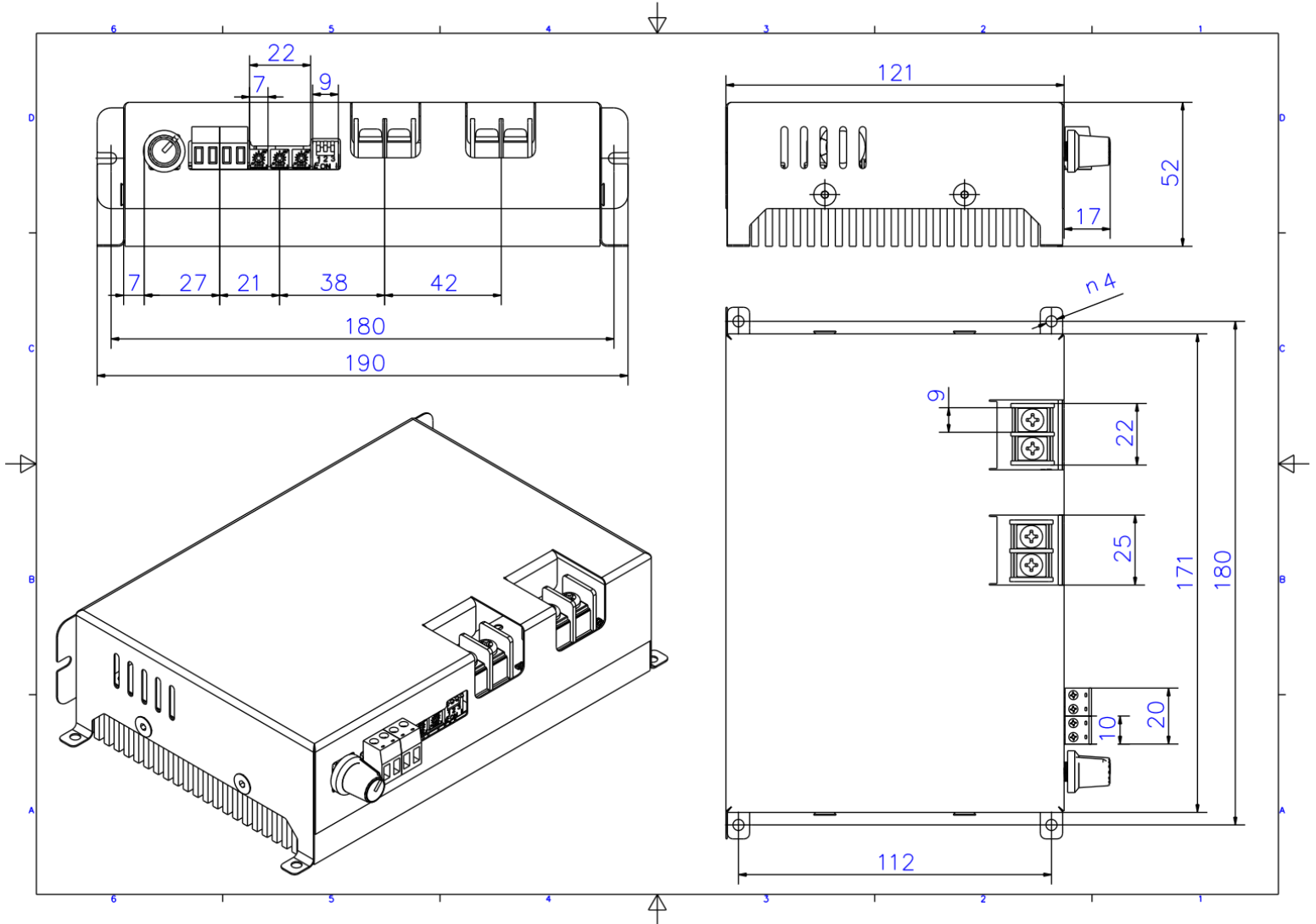
Figure 3-9 – Mechanical Drawings of CHERRY_XPS

⚠ Caution	Since the cooling system of the CHERRY_XPS is based on the natural convection through the mounted heatsink, after mounting, the users must make sure that there is enough space around and under CHERRY_XPS so that the air flux can move naturally. The users must avoid blocking the heatsink slots since it might negatively affect the natural thermal behavior and causes permanent damage to the driver.

3.4 CHERRY_XPS Features and Block Diagram

- Extremely easy to use
- Four Quadrant Regenerative Operation
- Configurable Speed and Current Limits
- Programmable Speed Gain settings
- Reverse Polarity Protection

- Over Current Protection
- Output Short Circuit Protection

- Open Loop and Closed Loop control
- Sensor-less PMDC speed control

- Nested Embedded Speed-Torque Loop
- Automatic Torque Loop Tuner
- Automatic Electrical Identifier of Motor Parameters
- Tunable Acceleration
- 32-bit Processing Unit
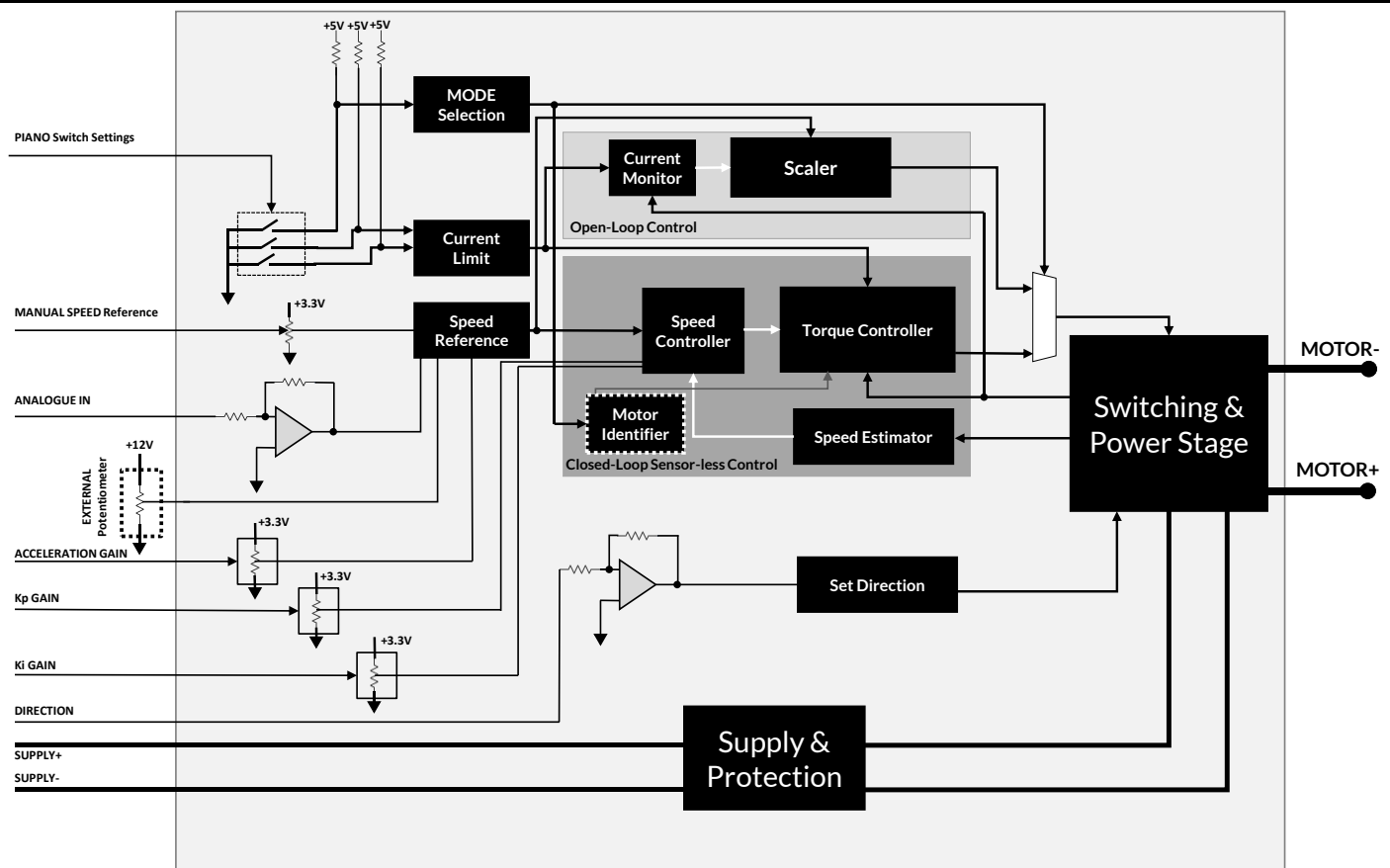
3.4.1 Block Diagram of CHERRY_XPS Driver

Figure 3-10 – Internal Block Diagram of CHERRY_XPS

3.5 System Requirements

For safely integrating CHERRY_XPS into your system, you must be sure you are satisfying the Electrical and Mechanical specifications to avoid damaging the driver as well as having the maximum efficiency and performance.

3.5.1   Motor Specification

CHERRY_XPS can support a range of motors fitting within the mentioned power ratings considering Voltage and Current limits elaborated for the driver in the datasheet, the users must select a motor which fits well inside the intervals during various conditions of the system, normally to make sure that the power rating of CHERRY_XPS is sufficient, the users should take into account the worst conditions in terms of requested power to understand if the driver can deliver their requested power or not.

3.5.2   Power Supply Specification

CHERRY_XPS driver accept an unregulated DC power supply at its supply inputs, in order to have the best performance the users should select their power supplies based on the power requested at the output of CHERRY_XPS, which depends mainly on the application and the Motor used.

In General, to foresee the possible effect of fluctuations of the power supply output on the performance of the CHERRY_XPS, the users should select a power supply rating based on the following considerations:

Power Supply Voltage: At least 10% above the requested voltage at the output to the Motor as well as the minimum voltage supply input to have the best performance and functionality.

Power Supply Continuous Current: At least 10% above the selected current Limit on the Piano Switch which is done based on the Selected Motor. In case that the Motor maximum current falls between two intervals of Current limits, the users can select the power supply output current at least 10% above the nominal current for the Motor.

4 Standards compliance and Safety

Here following is the list of the normative Directives and Standards complied with by the CHERRY_XPS Driver.

CE	Compliant with the requirements of Low Voltage Directive 2006/95/EC and of the harmonized standard EN 60204-1 on safety of electrical equipment of machines.
ROHS	Compliant with the requirements of the RoHS II Directive 2011/65/EU, restricting the use of certain substances including lead, mercury, cadmium, hexavalent chromium and halogenated flame retardants PBB and PBDE in electronic equipment

The CHERRY_XPS Driver is intended as being a component installed in complete Servo systems, meeting the requirements of the Machinery Directive 2006/42/EEC.

In order for the Servo systems to be compliant, the following guidelines must be adhered to.

1. The system must be provided with an emergency disconnect switch, as specified in section 5.3 of EN60204.1. The emergency switch will allow the user to immediately switch off the system in case of any failure or risk, and will prevent the automatic restarting of the machine after any failure condition shuts the machine down.

2. In order to comply with the accessibility requirements of section 6, the system must be enclosed in a grounded end use enclosure, and a grounding continuity shall be established for the system and for the CHERRY_XPS Driver in accordance with section 8 of EN60204.1.

3. The system mains input must be provided with suitable over current protective devices, in accordance with section 7.2 of EN60204.1.

4. The motors must be provided with overload and overcurrent protection, as specified in section 7.2 and 7.3 of EN60204.1.

The CHERRY_XPS Driver must not be put into service until the machinery into which they are incorporated has been declared in conformity with the provisions of the Machinery Directive.

4.1 General User Precautions

In order to install and work with CHERRY_XPS motor driver you must have basic understanding of electronics and mechanics as well as safety precautions and practices required when dealing with electronics, motors and strong equipment.

⚠️ **Notice**	Please read this document fully with care before attempting to install the driver, which enables you to have a complete understanding of different features and possibilities that may occur all along the installation process. You are responsible for determining the suitability of this product for the final application, the manufacturer is neither responsible nor liable for indirect or consequential damages resulting from the inappropriate use of this product
⚠️ **Warning**	The Motion mechanisms connected to the motors which is controlled by the driver may be subject to rapid and forceful motions. Unexpected motions may occur specially during the product initiations and tunings. Keep proper clearances for the operational machinery and avoid touching or contacting them directly through your body parts.
⚠️ **Warning**	Keep clear the surroundings of all exposed power terminals (power supply input, motor output, …) when the power is applied to the driver. Follow these safety instructions guidelines: • Turn on the power supplies or in case of using the batteries check their functionalities and their voltage levels. • Do not make any connection or adjustment to the driver when the power is applied. Always turn off the main power supply and let the energy stored in the driver completely discharges before making any connection or adjustment to the driver. • Do not rotate the motor shaft without power applied to the driver. The motor in this case will act as a generator and might cause damage to the driver due to uncontrolled over voltage or causing unexpected behaviors since it might make some internal driver parts operative which can lead to unforeseen results. • Do not short circuit the output of the driver intentionally and specially at moments when the motor is spinning in high speeds, this might cause permanent damage to the motor as well as driver due to the generated arcs and the excessive voltage and current spikes generated subsequently. • Do not make any internal connections to the internal circuitry of the driver, only connections to the existing connectors of the driver are allowed.
⚠️ **Caution**	Make sure the minimum inductance requirements are met! For the driver in order to stabilize the current of the motor within a defined time-frame there exist a minimum motor inductance which must be taken into account. The minimum inductance value of the PMDC motors which are capable of being controlled by the driver is mentioned in the datasheet of the driver.