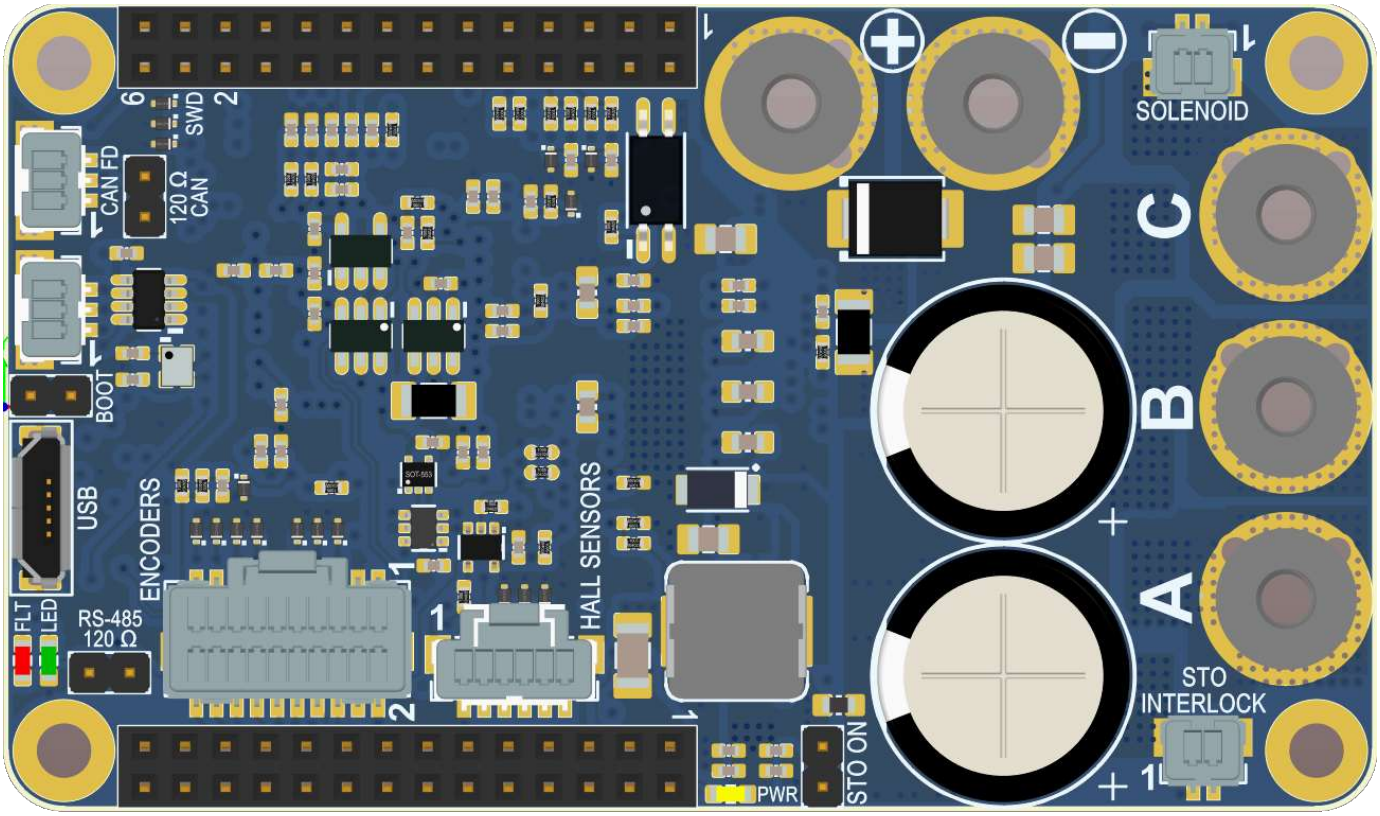
Servosila SC-120 Servo Drives

Datasheet

Revision C (April 2026)



www.servosila.com/en/motion-control

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Overview

Servosila SC-120 Servo Drive is designed for use in high-precision motion control systems, delicate industrial equipment, medical systems, gyro-stabilized systems as well as in remotely-controlled vehicles and robots. The servo drive incorporates an *advanced inverter technology* that enables ***high-bandwidth servo control*** as well as ***robust velocity control*** at ***very low*** and ***very high*** **speeds**.

The **Servosila SC-120 Servo Drive** features:

- a maximum control loop frequency of up to 42.5kHz in 1:1:1 mode for high-bandwidth servo control,
- a wide range of firmware-selectable PWM switching frequencies, 21.25kHz to 85kHz or more, that allows meeting requirements of the most demanding applications and the most delicate machine designs,
- a very high maximum speed limit, up to 4500 electrical Hz or 270 000 electrical RPM or even more,
- as well as a very low minimal controllable speed limit,
- a rich set of industry-standard encoder interfaces with resolutions of up to 32bits,
- a selection of industry-standard vehicle and industrial buses, CAN, USB, RS484, SPI, EtherCAT (via a daughterboard) for control and telemetry,
- an EtherCAT interface daughterboard for low-latency multi-axis motion control in CNC machines and robots,
- a Safe-Torque-Off (STO) / Interlock port for safety-critical systems,
- a dedicated port for controlling an electromagnetic brake using voltage pulse modulation,
- and a backward compatibility with other SC-series servo drives (SC-60, SC-25) to simplify programming.

Technical Specifications

Parameter	Description
Supported kinds of electric motors	Brushless DC Motors (PMSM, BLDC), both sensored or sensorless. Brushed Motors
Number of simultaneously connected motors: - brushless motors - brushed motors or solenoids	1x brushless motor or 1x brushed motor
Dedicate Solenoid Brake Port	1x electro-magnetic brake
Nominal Current (Motor Phase Current)	**Firmware-selectable:** *Option 1:* 80 Arms or 120 A by amplitude (default) *Option 2: 40 Arms or 60 A by amplitude (starting from Rev D only)* *Option 3:* 20 Arms or 30 A by amplitude *Option 4:* 10 Arms or 15 A by amplitude*(starting from Rev D only)*
Short-Term Peak Current (ADC range limit)	25% above the selected Nominal Current
Input DC voltage	7-60V DC
Input DC Current - Sensor Range	-100A to 100A
Switching (PWM) Frequency	**Firmware-selectable:** 21.25kHz, 25kHz, 31.25kHz, 40kHz, 42.5 kHz (default), 50kHz, 62.5kHz, 80kHz, 85kHz or any other switching frequency in between.
Control Loop Frequency	**Firmware-selectable:** 21.25kHz (default), 25kHz, 31.25kHz, 40kHz, 42.5 kHz or any other switching frequency in between. Position, Velocity and Torque/Current Control operate at the same frequency (1:1:1).
Operation modes	Electronic Torque Control (ETC) / Current Control, Electronic Speed Control (ESC) / Velocity Control, Servo Control / Position Control, Direct Drive Control, Brake, Starter-Generator / Energy Recuperation, Auto-Configuration/System Identification.
Supported algorithms of brushless motor control	Field-Oriented Control (FOC),

	Sensorless Observer Hall Sensors Observer, D-Q axis Coupling Compensation, Field Weakening, numerous Servo Control Features, Protections, Notch Filters, Low-Pass Filters, Acceleration Control many others.
Auto configuration (motor system identification) function	Yes
Hall Sensors input (discrete)	Yes (“single-ended”)
Interfaces to absolute position encoders	BISS-C (unidirectional), SSI, RS-485 (“half-duplex”), 2x Quadrature with Index Signal (“single-ended”) SPI, PWM
Max. resolution of encoder	32 bit
Built-in network router	Built-in USB-to-CAN router («USB2CAN dongle»). Both 11bit and 29bit identifiers are supported by the routing function.
Control Interfaces	CAN bus with CANopen application protocol, USB 2.0, a virtual COM port, with SLCAN application protocol. SPI, RC PWM control interface EtherCAT through daughter-board (purchased separetly)
RS485 Terminal Resistor 120 Ohm	Yes (jumper controlled)
CAN bus Terminal Resistor 120 Ohm	Yes (jumper controlled)
Supported CAN bus bit rates	1mbit/sec, 500kbit/sec, 250kbit/sec, 125kbit/sec, 100kbit/sec, 50kbit/sec
CAN bus ports	2 (parallel)
USB 2.0 ports	1
RS485 ports	1 (half-duplex)
STO / Interlock port	1 (“ON”: 3.3V to 60V; “OFF”: 0V to 1.6V)
Solenoid Brake port	1
GPIO functions	2x Limit Switch inputs

	1x Emergency Stop input 1x dedicated GPIO output (discrete or PWM signal) 1x dedicated GPIO input (discrete)
Supported operating systems	Linux (no driver is needed) including Debian, Ubuntu Windows 11 (no driver is needed) Windows 10 (no driver is needed) Windows 8 (driver is provided) Windows 7 (driver is provided)
Programming APIs	CANopen, Linux SocketCAN API, SLCAN protocol via a virtual COM-port (USB2.0) for Windows 11, 10, 8, 7 and Linux, G-code, DLL API for Python, C++, C# EtherCAT (via daughter board),
Servosila Motion Controller Software	Yes (included, free)
Software Servo Drive Simulator	Yes (included, free)
Dimensions:	68mm x 40mm x 16mm
Weight	~50 g
Power consumption when idling	120-180 mA depending on connected peripherals

Compatibility Criteria for Brushless Motors

The SC-120 servo drives are capable of controlling a very wide range of brushless motors. However, there are certain limitations applied to the brushless motors' specifications. Use the following set of rules when selecting a brushless motor for use with SC-120 servo drive.

Rule #1: Motor Phase Maximum Phase-to-Phase Current Limit

Nominal motor phase-to-phase current < **120A** by amplitude. *The optimal / most practical maximum limit is 80A by amplitude.*

If you motor has higher nominal current than the provided maximum value, the motor will likely not work well with SC-120 servo drive.

Rule #2: Electrical Time Constant Limit

Verify that **L/R > 0.00008**

where **L** is a phase-to-phase inductance, and **R** is a phase-to-phase resistance. Get these from the motor's datasheet.

If the ratio is less than the specified value, then the motor is not likely to work well with the SC-120 servo drive. Please consult with Servosila Technical Support in such a case.

Rule #3: Max Speed Limit

Verify that

(RPM/60) * (Poles/2) < 4500 (electrical Hz) for Sensorless motors or direct drive motors with Encoders,

(RPM/60) * (Poles/2) < 1600 (electrical Hz), if Hall Sensors are used for commutation,

where **RPM** is a no-load speed of the motor at the input voltage, and **Poles** is the number of rotor poles. Get these from the motor's datasheet.

If the output of the formula is more than the specified value, then the motor is not likely to work well with the SC-120 servo drive. Please consult with Servosila Technical Support in such a case.

Rule #4: Motor Voltage

The motor's Nominal Voltage must be less than or equal to 60 V DC. *The optimal / most practical maximum voltage limit is 52 V DC.*

Make sure that all the rules listed above hold, when selecting a brushless motor for use with SC-120 servo drive.

Hardware Layout

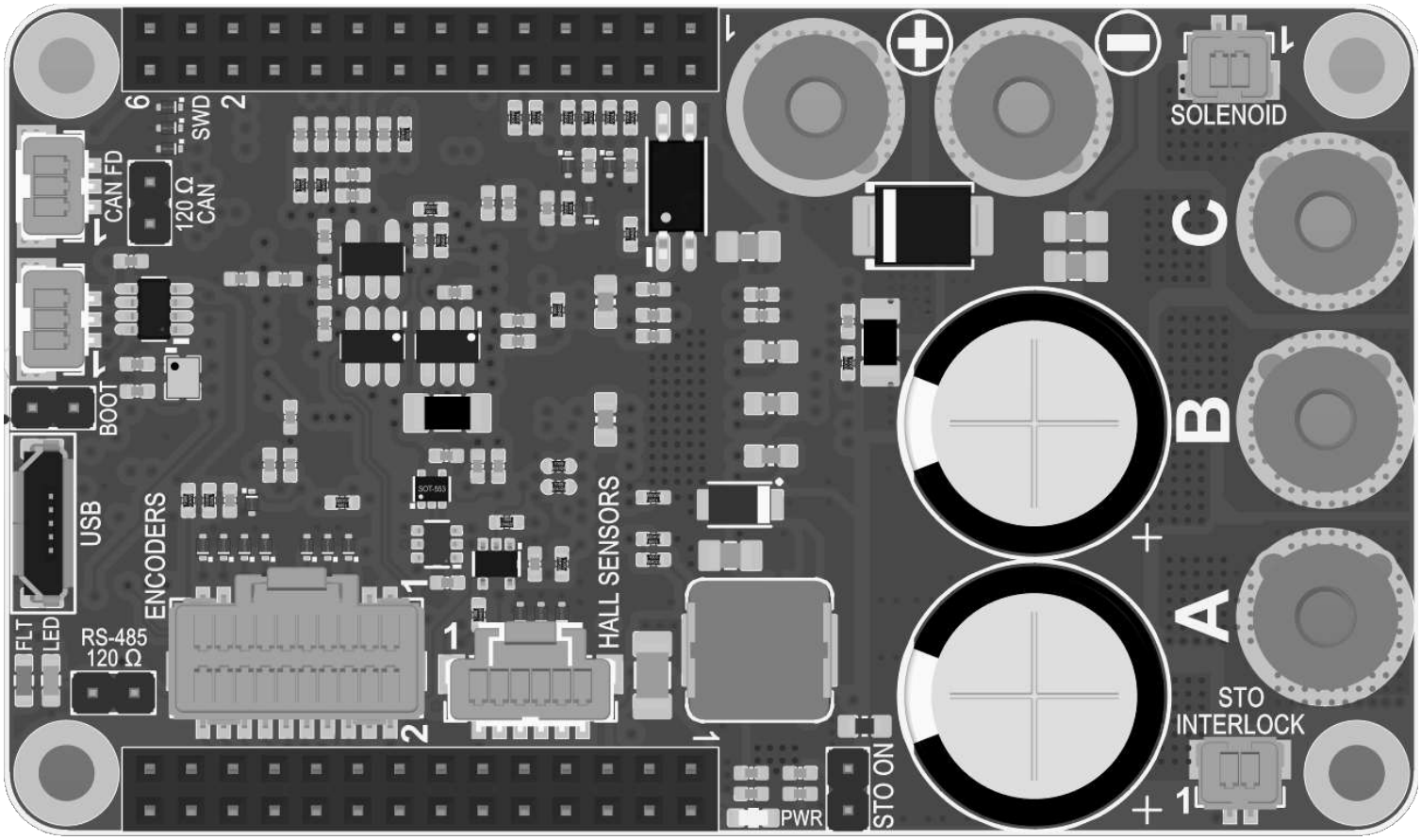


Figure 1: Servosila SC-120R Servo Drive (front side)

The servo drives come with vibration-resistant connectors for attaching motor phase cables, DC power cables, up to two encoders, and various information buses. There are two block connectors for attaching a daughterboard.

All connectors are intentionally placed on the front side of the boards only. There are no connectors on the back side of the boards. The back side is intended for installation of an (optional) heat sink, or for attaching the boards directly to an enclosure designed to act as a heat sink. All the connectors face upwards, perpendicular to the boards. None of the connectors face sideways. This arrangement simplifies cable routing within cramped spaces such as enclosures of servo actuators or mobile chassis.

The servo drives feature two identical parallel CAN bus ports, a USB port, an RS485 port, a STO/Interlock port, a solenoid brake port as well as an RC PWM input for controlling the servo drives. There an optional EtherCAT interface daughter-board for low-latency multi-axis motion control (purchased separately).

There is a way to upgrade the servo drive’s firmware via the USB port, including field firmware upgrades of servo actuators or mobile vehicles.

Electrical Connectors & Part Numbers

Connector Label	Purpose	Part #	Mates to Part #
ENCODERS	SSI, BISS-C, RS485, SPI, PWM, Quadrature	Molex 5011902027	Molex 5011892010 Pre-crimped leads: Molex 0797581019
USB	USB2.0 MICRO B port	Würth Elektronik 614105150721	USB2.0 MICRO B male
CAN A	CAN bus port A (parallel to port CAN B)	Molex 5013310407	Molex 5013300400 Pre-crimped leads: Molex 0797581019
CAN B	CAN bus port B (parallel to port CAN A)	same	same
STO / Interlock	Safe Torque Off / Interlock port	Molex 5013310207	Molex 5013300200 Pre-crimped leads: Molex 0797581019
SOLENOID	Electromagnetic Brake port	Molex 5013310207	Molex 5013300200 Pre-crimped leads: Molex 0797581019
HALL SENSORS	Hall Sensors (discrete) + Thermistor	Molex 5013310607	Molex 5013300600 Pre-crimped leads: Molex 0797581019
Block Connector 0 & Block Connector 1	Block Connector 0 and 1, combined, have a duplicate for every signal from every other connector, except the power input and motor phase connectors. The block connectors are intended for connecting daughterboards. However, if no daughterboard is present, the connectors can be used for other purposes such as accessing GPIO pins, SPI buses, interfacing encoders, and so on.	Würth Elektronik 62002821821 Würth Elektronik 62000821821	Würth Elektronik 62002821121 Würth Elektronik 62000821121

Connector Label	Purpose	Part #	Mates to Part #
-	Power Supply Negative *(polarity sensitive!)* *For better noise immunity, twist "–" and "+" power wires at intervals of 100mm. Use shorter wires, whenever possible.* *To improve EMI/EMC characteristics, consider using shielded twisted power cable and (optionally) installing ferrite ring filters on the power wires in the shield's gap. Connect the shield to a ground at the power supply/battery side.*	Würth Elektronik 746600330R	Ring Terminal M3 Use ring terminals, bolts, washers, and spring washers with improved conductivity (copper or brass). Avoid using steel bolts or steel washers. Vibration resistant connection: Bolt head → spring washer → washer → ring terminal → connector
+	Power Supply Positive *(polarity sensitive!)*	same	same
A	Brushless Motor Phase A *or Brushed Motor "+"* *Do not twist or bundle brushless motor's phase wires.* *The motor phase wires are a major source of electromagnetic emissions. Use shorter motor phase cables, whenever possible. To improve EMI/EMC characteristics, consider using shielded (not twisted) motor cables and (optionally) installing ferrite ring filters on the motor phase wires in the shield's gaps. Connect the cable shield to a ground connection at the motor end.*	same	same
B	Brushless Motor Phase B *or Brushed Motor "-"*	same	same
C	Brushless Motor Phase C	same	same

Pre-crimped leads for digital signals are Molex 0797581019, Molex 0797581018

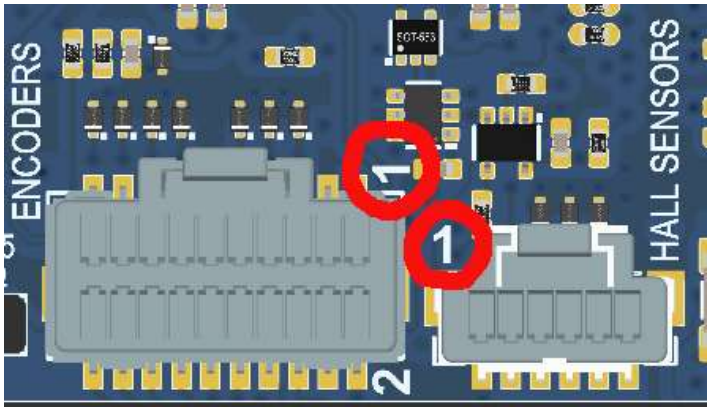
Jumpers

Label	Purpose	Part #
CAN 120 Ohm	The jumper (once installed) enables a 120 Ohm terminal resistance required by the CAN bus standard. Install the jumper on one of the servo drives in a CAN network.	Jumper shunt 2mm pitch x 3.5mm height For example: 116-CG1 Ningbo Xinlaiya Electronic Tech.Co.,Ltd
RS485 120 Ohm	The jumper (once installed) enables a 120 Ohm terminal resistance required by the RS485 network.	same
Boot	The jumper (once installed) switches the servo drive into a firmware re-flashing mode. Do not forget to remove the jumper after finishing a re-flashing procedure.	same
STO ON	The jumper (once installed) enables Safe Torque Off port. If the jumper is removed, the STO / Interlock port's input has no effect on the servo drive, irrespectively of the STO / Interlock signal. Install the jumper only if you plan to use the STO / Interlock function.	same

LEDs

Label	Purpose
POWER	This LED is directly wired to power supply lines. The LED turns on whenever a power supply is connected to "+" and "-" terminals of the servo drive.
FAULT	This LED turns on whenever firmware detects a fault or multiple simultaneous faults. A telemetry parameter "Fault Bits" tells what faults have caused the problem. Note that the firmware latches into a FAULT mode before turning the LED on. In this mode, the motor is de-energized and the firmware stops responding to any command rather than the RESET command. Send a RESET command to the servo drive in order to clear the fault latches and switch the servo drive back into an operational mode once the fault is rectified.
LED	The LED turns on whenever the servo drive receives a command from a parent control system via either CAN or USB. The LED indicates that a parent control system is successfully communicating to the servo drive.

First pin



First pin of every connector is labeled with a “1” sign. In some cases, if space permits, then pin “2” is labeled as well.

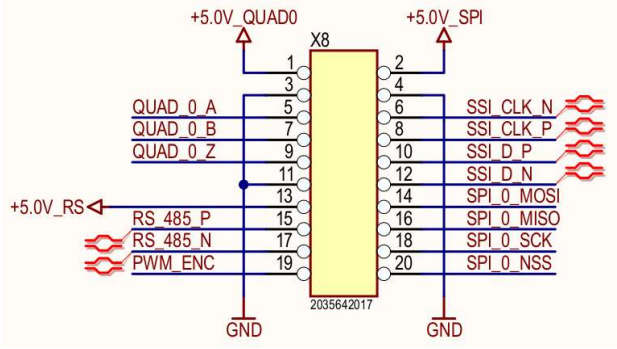
Connector: “ENCODERS”

The “ENCODERS” connector is intended for connecting angular or linear position encoders via digital interfaces. The supported interfaces are SSI, BISS-C (unidirectional), 1x Quadrature (single-ended), RS485 (half-duplex), SPI, PWM.

Note 1: Up to two encoders can be simultaneously connected to the servo drive.

Note 2: The second quadrature interface (“Quadrature 1”) can be found in “Block Connector 1”.

Schematics



Pins

Pin #	Purpose	Pin #	Purpose
1	+5.0 (power output, fuse-protected)	2	+5.0 (power output, fuse-protected)
3	GND	4	GND
5	Quadrature 0 signal “A”	6	SSI bus Clock-
7	Quadrature 0 signal “B”	8	SSI bus Clock+
9	Quadrature 0 index signal (“Z” or “I”)	10	SSI bus Data+
11	GND	12	SSI bus Data-
13	+5.0 (power output, fuse-protected)	14	SPI Master Output Slave Input (MOSI)
15	RS485 positive (half-duplex)	16	SPI Master Output Slave Input (MISO)
17	RS485 negative (half-duplex)	18	SPI Clock (CLK)
19	PWM encoder input	20	SPI Chip Select (NSS)

SSI/BISS-C Interface

Wire	Pin #	Description
+5.0V	2 (or 1)	Power output, fuse-protected
GND	4 (or 3)	Ground
Clock-	6	Clock, differential, twisted pair
Clock+	8	Clock, differential, twisted pair
Data+	10	Data, differential, twisted pair
Data-	12	Data, differential, twisted pair

The BISS-C interface is unidirectional. Maximum supported output clock frequency is 12.5 MHz.

To improve noise rejection, it is recommended to twist “Clock+” and “Clock-” wires into a twisted pair, and also twist “Data+” and “Data-” wires into a second twisted pair.

SPI Interface

Wire	Pin #	Description
+5.0V	2 (or1)	Power output, fuse-protected
GND	4 (or 3)	Ground
MOSI	14	SPI Master Output Slave Input (MOSI)
MISO	16	SPI Master Output Slave Input (MISO)
CLK	18	SPI Clock (CLK)
NSS	20	SPI Chip Select (NSS)

Maximum supported output clock frequency is 12.5 MHz.

RS485 Interface

Wire	Pin #	Description
	11 (or 3)	GND
A	15	RS485 positive (half-duplex)
B	17	RS485 negative (half-duplex)

Twist the wires A and B to improve noise rejection.

The RS485 interface is half-duplex. Maximum baud-rate is 3Mbps.

PWM Input Interface

Wire	Pin #	Description
+5.0V	13 (or 1)	Power output, fuse-protected
GND	11 (or 3)	Ground
PWM	19	PWM encoder input

Maximum input pulse frequency is 5MHz.

Quadrature Interface 0

Wire	Pin #	Description
+5.0V	1	+5.0 (power output, fuse-protected)
GND	3	GND
A	5	Quadrature 0 signal “A”
B	7	Quadrature 0 signal “B”
Z or I	9	Quadrature 0 index signal (“Z” or “I”)

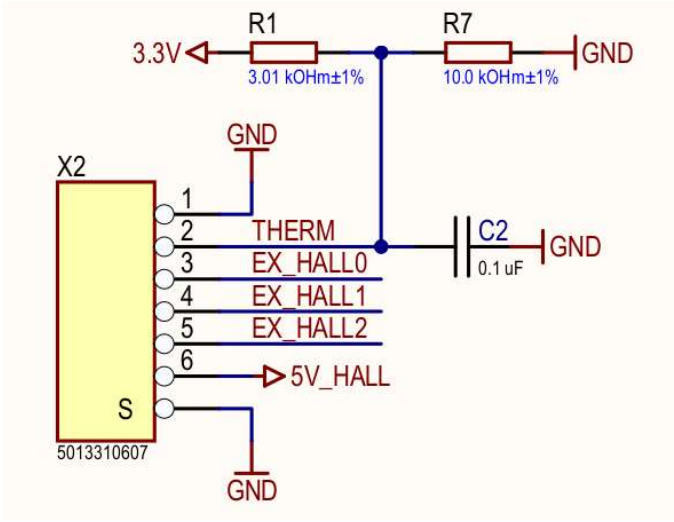
Both “push-pull” and “open collector” connections are supported. The quadrature interface is “single-ended” (not a “differential” one). In order to connect an encoder with “differential” signals, connect just one of the wires in each

pair. Try “inverted” signal first; if it does not work, try the normal signal next. Use telemetry to verify received signals.

Maximum input pulse frequency is 5MHz.

Connector “HALL SENSORS”

Schematics



Pins

Pin #	Purpose
1	Ground
2	Thermistor input, 10kOhm or 100kOhm
3	Hall signal 0 (discrete)
4	Hall signal 1 (discrete)
5	Hall signal 2 (discrete)
6	+5.0V, power supply

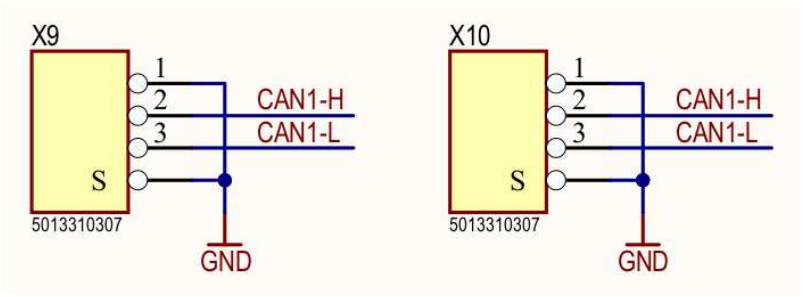
The Hall Sensors interface is “single-ended” (not a “differential” one). Both “push-pull” and “open collector” connections are supported.

Connectors “CAN A”, “CAN B”

The servo drives feature two identical parallel CAN bus ports. This simplifies cabling of multiple servo drives into a chain, for example, inside a robotic arm manipulator or a robotic chassis, and streamlines in-the-field repair or replacement process.

The servo drives come with an on-board terminal 120 Ohm resistor prescribed by the CAN bus standard. The resistor can be turned on or off via a jumper. Only one servo drive in a chain needs to have the terminal resistor enabled.

Schematics



Pins

Pin #	Purpose
1	Ground
2	CAN high (twist
3	CAN low (twist)
4	Ground

It is recommended to twist “CAN high” and “CAN low” wires into a twisted pair to improve noise rejection.

Supported bit rates are 1mbit/sec, 500kbit/sec, 250kbit/sec, 125kbit/sec, 100kbit/sec, and 50kbit/sec.

Connector “STO / Interlock” (Safe Torque Off)

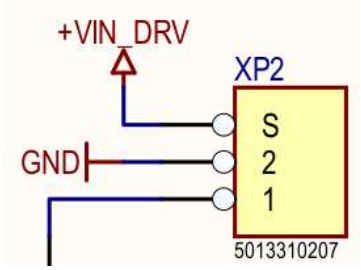
The “Safe Torque Off” function uses a hardware-only circuitry to physically disconnect electrical power from the motor. The disconnection is done irrespectively of what the firmware does and what commands the drive receives from an upper-layer control system. This is a safety function needed for a human-safe equipment maintenance (“Safe Torque Off”) or for shutting down the motor automatically, whenever an upper-layer controlling system fails and the voltage on the STO / Interlock pin drops to zero (“Interlock”).

1. While the voltage on the “STO / Interlock” pin is NEGATIVE, the motor is disconnected from the electrical power and cannot be moved by the firmware. The servo drive itself remains operational and responds to commands and sends telemetry. However, it cannot move the motor, since the motor is physically disconnected from power.

2. While the voltage on the “STO / Interlock” pin is POSITIVE, the firmware is allowed to power or unpower the motor at will. This is a normal state of affairs.

3. The “STO / Interlock” connector works in conjunction with “STO ON” jumper. If the jumper is removed, the voltage level on “STO / Interlock” pin is not important. The firmware has full control of the motor in such a case, and “STO / Interlock” function is effectively removed from the system. Install the jumper before using the “STO / Interlock” function.

Schematics

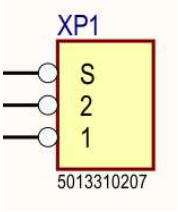


Pins

Pin #	Purpose
1	GND
2	STO / Interlock pin “ON”: 3.3V to 60V “OFF”: 0V to 1.6V

Connector “SOLENOID” (Electromagnetic Brake)

Schematics



Pins

Pin #	Purpose
1	+VIN
2	GND

The output PWM frequency is 16kHz to avoid human-audible sounds in the solenoid.

The PWM duty, and thus output voltage, is firmware-controlled in the range 0V to DC input voltage.

The maximum current is 5A.

Connectors “Block Connector 0” and “Block Connector 1”

Schematics

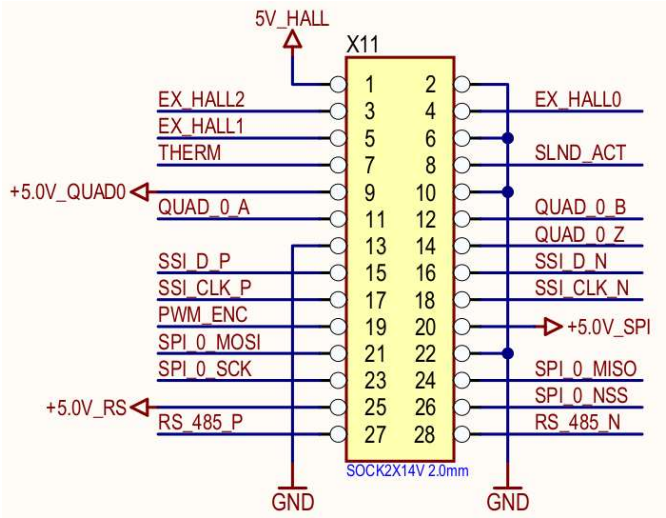


Figure 2: Block Connector 0

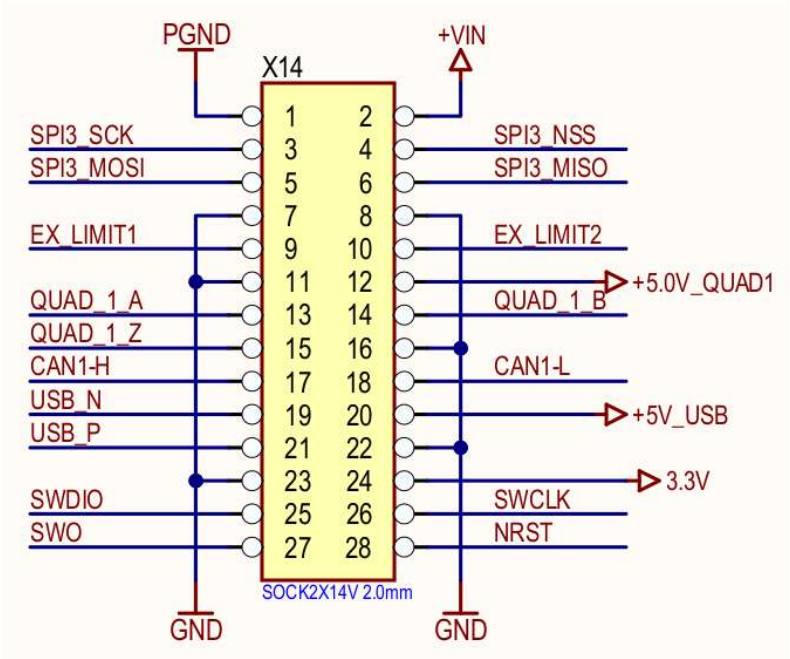


Figure 3: Block Connector 1: Option A

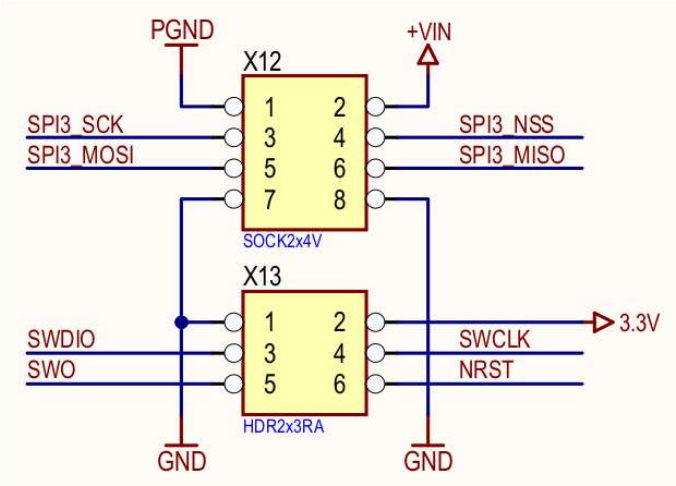


Figure 4: Block Connnector 1: Option B

The block connectors have a copy of every signal from all other connectors. A notable additions are “Quadrature 1” encoder interface, the second quadrature interface, and “Limit 1” and “Limit 2”, GPIO inputs for limit switches, which are present in a block connector only.

The block connectors are intended for connecting daughterboards. However, if no daughterboard is present, the connectors can be used for other purposes such as accessing GPIO pins, SPI buses, interfacing encoders, and so on.

Pins

Refer to descriptions of the other connectors to get information about each pin in the block connectors, or just “buzz the circuit” to match the pins in the connectors.

Receiving an RC PWM control signal

The SC-120 servo drives are capable of receiving a PWM control signal from an RC receiver such as Futaba or from a PLC with PWM output. A *duty cycle* of the PWM signal is used as a control input for speed control or servo control. The RC PWN signal is received on PWM encoder pin in “ENCODERS” connection.

- **Common ground (!!!):** Interconnected SC-120 servo drive and RC receiver/PLC **must** have a common ground.
- The input PWM signal should have 5V amplitude. It *may* work with 3.3 V signal.

Power Supply

The servo drives require 7.0 – 60.0 V DC power input. The servo drives come with built-in high-capacity filters for the power input. The power supply terminals are polarity sensitive.

Power Output

The SC-120 servo drives can provide power to external modules such as encoders using +5.0V and GND output pins.

The nominal output current is 0.150 A at 5.0V.

The output power lines are protected by fuses set at 0.300 A. The fuses are reset by power-cycling the servo drive.

Mounting

Suggested bolts are DIN912 M2.5 or DIN84 M2.5.

Thermal Management

Heatsink Installation

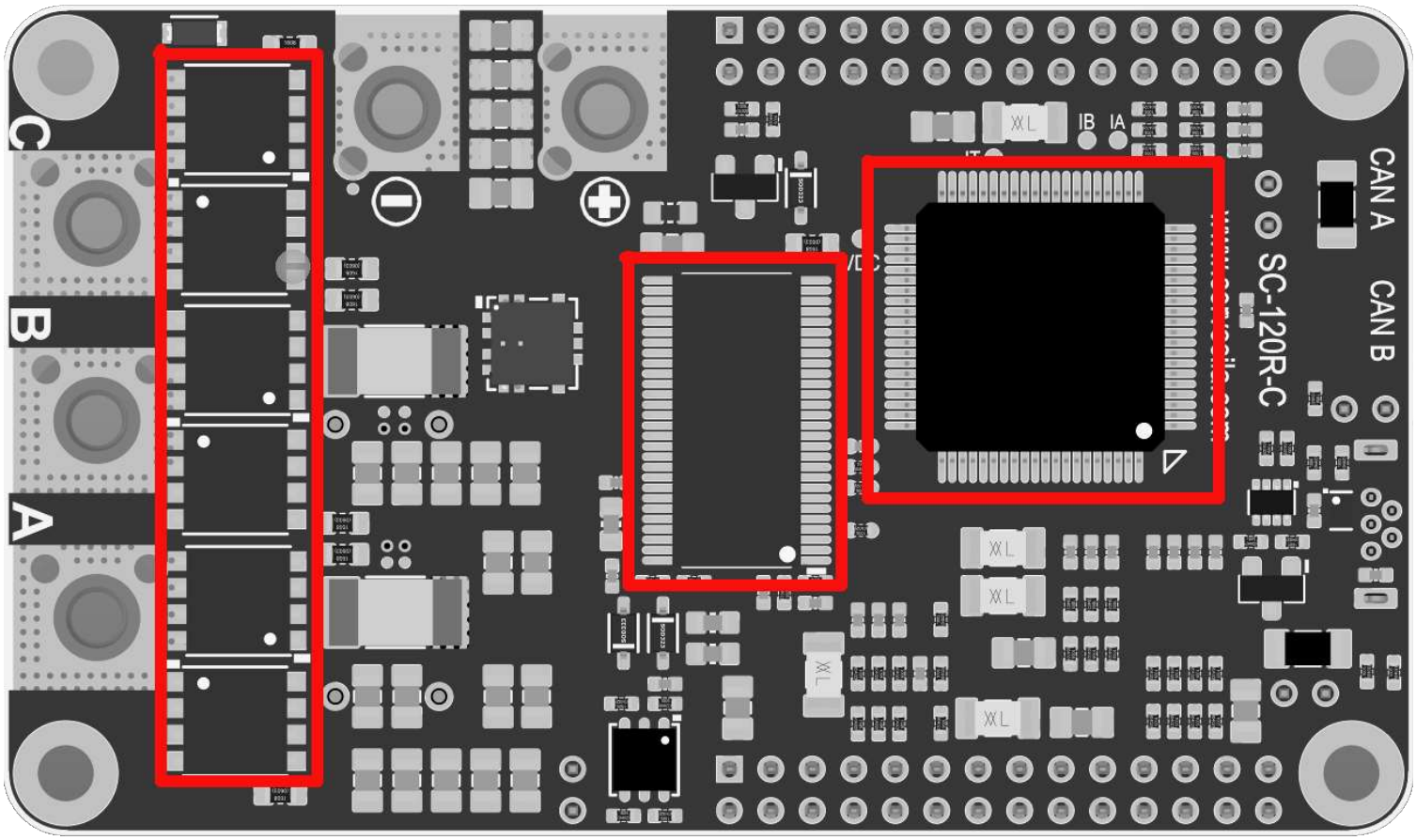


Figure 5: Servosila SC-120R Servo Drive (back side)

The red lines highlight the heat-generating ICs that need to be connected to an (optional) heatsink via a thermal interface material.

De-rating the Servo Drive

Besides installing a heatsink to dissipate heat, it is possible to reduce the amount of heat generated by the servo drive itself by “de-rating” the device.

- Decreasing PWM switching frequency helps reduce the heat generated by MOSFET switches. Switching losses in MOSFETs are proportional to the switching frequency. By lowering the switching frequency through firmware configuration, it is possible to reduce the heat generated by MOSFETs. A drawback is that now the motor might start generating more heat due to higher current ripple in phase wires, so a trade-off frequency needs to be found between heating the servo drive and heating the motor.

- Reducing input DC voltage helps reduce the heat generated by MOSFETs. If the application permits, consider using a lower DC input voltage. A drawback is that the maximum no-load speed of the motor is going to be proportionally reduced too, but not the torque at low speeds.
- Reducing control loop frequency through firmware configuration helps reduce the CPU load and thus heat generated by the CPU. A drawback is a reduced control bandwidth.

EMC/EMI Management

The servo drives generate electromagnetic emissions that interfere with nearby systems (EMI/EMC), while at the same time are susceptible to external electromagnetic noise too.

The motor phase wires are a major source of electromagnetic emissions due to the servo drive's PWM voltage modulation scheme that uses square pulses. The square pulses generate many harmonics that cause electromagnetic emissions through the motor phase wires acting as antennae.

Below are recommendations on improving EMI/EMC characteristics of the system:

- Twist differential signal wires (CAN, RS485, SSI, BISS-C) to improve electromagnetic noise immunity for digital signals.
- Twist "–" and "+" input DC power wires at intervals of 100mm. Use shorter power wires, whenever possible.
- In challenging EMI/EMC environments, consider using shielded twisted DC power cable and installing ferrite ring filters on the power wires in the shield's gap. Connect the shield of the cable to a ground at the power supply/battery side.
- When multiple servo drives are used in the same system with the same power supply or a battery, it is important to arrange a proper single ground connection ("earth") where all servo drives are connected to through their "ground" ("-") terminals.
- The shields of the shielded cables should be grounded to "earth".
- Do not twist or bundle brushless motor's phase wires.
- Use shorter motor phase cables, whenever possible. Consider using shielded (but not twisted in this case) motor phase cables and installing ferrite ring filters on the motor phase wires in the shield's gaps to attenuate the harmonics. Connect the cable shield to a ground ("earth") point at the motor end.
- The servo drive's PWM switching frequency can be increased or decreased through firmware configuration, so that the switching frequency itself and its harmonics do not fall into application frequency range of payloads or communication systems.

Servo actuators designed around Servosila SC-series Servo Drives

YouTube: http://www.youtube.com/user/servosila

www.servosila.com/en/motion-control

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