



QCI-S3-IG-01

## SilverSterling S3-IG-01

The SilverSterling™ is an OEM servo controller/driver for QuickSilver's line of NEMA 34 frame, high torque, direct drive servomotors, but is also capable of driving third party DC brush and voice coil motors. The SilverSterling S3-IG-01 also supports 3 phase brushless motors with commutation sensors. The SilverSterling controller/driver is available open framed (QCI-S3-IG-01) and enclosed (QCI-S3-IGH – separate data sheet) and designed to servo QCI's I-Grade motors through an encoder connector and a high current motor drive connector.

The SilverSterling features a 15 pin interface connector including 4 IO, CAN, RS-485, and system power input. Four IO lines are brought out to the 15 pin SIP connector. These may be selected by means of jumpers on the 60 pin header if a secondary mezzanine PCB is not utilized. If the expansion PCB is used, then these connector pins are free to be used by the customer as assigned by the expansion PCB design.

The SilverSterling also features an optional 60 pin header to allow simple and direct connection to expansion boards for both future QuickSilver product extensions and OEM custom interface printed circuit boards.

The optional 60 pin expansion header includes the ability to bring power to the board as well as access to internal +12v, +5v, and +3.3v power supplies. Access is also provided to two SPI ports (one of which may alternately be used as 4 simple IO), the internal CAN port, 4 configurable analog/digital IO (12 bit A/D), one I2C port (which may be alternately used as 2 IO), A secondary serial port (or alternately 3 I/O), motor encoder signals, one Capture Input (which can also serve as general purpose IO) and an additional 11 general purpose IO. Four connections to the 15 pin control connector are also brought out to the interface connector.

To utilize additional I/O, SPI, I2C, or secondary serial port brought out on the 60-pin header, requires custom firmware. Contact factory for firmware options.

Drive capability is two or three phase at 10A RMS / 20A peak. DC Drive capability is 20A (using both output phases connected in parallel). (Continuous rating may require external airflow)

## System Overview

### Point-to-Point Moves

- Relative or Absolute
- Velocity or Time Based
- S-Curve

### Advanced Motion Profile Moves

- Profile Move Commands
- Register Based
  - Position/Accel/Decel/Vel
  - Modify On-the-Fly

### Multi-Axis Linear Interpolation

- XYZ Coords Contained in Text File
- CANopen® used for local bus
- 1000+ Points Stored In NV Memory

### Built-In Voltage Clamp

- Regenerative Braking Resistor

### Program and Data Storage

- 32K Non-Volatile Memory:
- 2000-3000 Program Lines
- User Data Examples
  - CAM Tables
  - Motion Profiles
  - Lookup Tables

### Electronic Slip Clutch/Brake

- Variable Torque
- Wind/Unwind Applications

### Anti-Hunt™

- Optionally use Open Loop While Holding
- No Servo Dither While At Rest

### Communications

- RS-485 @ up to 230K Baud
- ASCII, Binary, Modbus®, DMX512
- Host Control While Servo in Motion
- CANopen® (Rev 03 SW and higher)

### Programming Language

- Easy, Menu Driven Interface
- Command Parameter Prompts
- No Syntax Errors
- User Namable I/O and Registers

### Advance PVIA™ Servo Loop

- 100:1 Inertial Mismatch
- Direct Drive Oversized Inertial Loads
  - Flywheels/Belt Drives
  - Typically Without Gearheads
- More Stable Than PID

### Digital 4 Quadrant Vector Drive

- DSP Driven for Reduced Noise

### Multi-Task/Multi-Thread

### Compatible with QCI Motor/Encoders

- NEMA 34 Frame

(Note: does not support 150% torque level on 34HC motor series)

## Electrical Specifications

### Input Power

#### Voltage

+12 VDC to +48 VDC, regulated. Device must be initialized for the actual operating voltage. An internal clamp isolates the input power supply from regenerated power (unless bypassed).

#### Reverse Polarity Protection

Reverse polarity protection is available on the SilverSterling. (Note, however, if power supply is not floating, connecting the V+ input to Ground will cause this potential to be present at the common connection to communications and I/O lines, which may damage these lines or that to which they are connected.

#### Input Current

20 Amps maximum for any input voltage, +12 VDC to +48 VDC. Input power should be fused at 25A max.

### Output Power

#### Output/Driver Current

20 Amp peak, 10A RMS; 20 A maximum for DC motors (using both phases in parallel).

\* With Adequate Heat Sink.

S3-IG with heatsink horizontal in still air: 12A RMS (2 phases at 8.5A RMS) typical 60C rise from 25C, ambient with no air flow. Vertical orientation typically several degrees lower. This corresponds to 100% settings for 34HK-1 motors and 75% settings for the 34HC-x motors.

Added airflow is needed for continuous 100% operation of 34HC-x motors. Intermittent operation will need to be evaluated in your application as to whether forced airflow will be needed. Higher ambient temperatures may also require force airflow. **Warning: Hot Surface, Risk of Burn.** Surface may exceed 60C for hot environments and/or with inadequate air flow.

### Encoder Interface

Designed to work with QCI's I-Grade motor/encoders. Quadrature differential signals are employed. Quadrature decoding used (i.e 2000 lines are decoded as 8000 counts.) Standard interface is 485 differential inputs. The encoder interface connector is also used to connect open collector hall sensor inputs for use with 3 phase brushless motors (internal pull-ups to 5v are provided).

## Inputs & Outputs

### Digital Inputs

0 to +3.3 VDC. LVTTTL level compatible.

On externally connected IO: Effective internal ~200K ohm pull-up impedance to +3.3 V. Inputs have a series 220 ohm / 3.3v protector to ground / Series 220 ohm ESD protection network.

Do not exceed 5v on the inputs to prevent damage to the controller.

Internal IO present at header do not have additional protection; user must provide protection needed on expansion PCB.

Drive Enable inputs are optically isolated and require 6v minimum input 3 ma. Current limited supply voltage connections are provided adjacent to the drive enable pins to provide a convenient source of power for the drive enable when external switching is not required.

### Digital Output Voltage

0 / +3.3 VDC.

### Digital Output Current

Sinking or Sourcing

2mA; (externally connected IO include a 440 series impedance).

### Analog Inputs

0 to +3.3 VDC input signal range.

12 bit ADC resolution (single).

Analog signals are read every servo cycle (120  $\mu$ sec.) and the converted analog data is processed through a 5 ms filter to reduce noise & transients.

Analog channel #1 corresponds to physical I/O #4.

### Mezzanine Connector

An optional 60 pin mezzanine connector has been provided to allow for easy interface to a user specific printed circuit board. Note that the signals on this connector are not protected, and the user must add protection to their circuit board for signals used. If the mezzanine board is not used, pins 20C-20B, 19C-19B, 18C-18B, 17C-17B must be jumpered to access IO1-IO4 at the DB-15HD SIP connector. (These signals must be connected on the mezzanine board if these functions are wanted at the four IO pins, otherwise other functions can be routed to the four external connections. Note the slight differences in pin usage between the QCI-S3-IG and the QCI-S2-IG if designing a board for both systems. Contact the factory to special order with 60 pin mezzanine. Standard products ships with a 10 pin header for manufacturing.

### Clamp Resistor

The QCI-S3-xx comes with a built in regenerative voltage clamping circuit to prevent damage to the driver from regenerated power associated with stopping a load. The QCI-S3-IG-01 has this clamping resistor attached. An external clamp resistor may be connected via the 6 pin power connector. The standard cable has the internal clamp resistor connected to the clamp circuit. The external clamp resistor should be tied between the Drive Voltage pin and the Clamp pin. The user is responsible for affixing the clamping resistor to a suitable heatsink. The internal clamp resistor is rated at 50 W, but power rating is dependent upon user supplied heatsink, and may require fan to keep driver and clamp at an allowable temperature if in

constant use. Use an external 2 ohm resistor of appropriate power rating if higher regenerative power levels are present.

## Communications

### Serial Interface

RS-485 multi-drop, Reduced unit load accommodates up to 255 nodes.  
Protected up to +/- 70v not operating, +/-30V operating.

Note: RS-485 requires a nominal 120 ohm ½ W termination resistor at each end of the network. This termination is not provided onboard and must be provided by the user. (Note: very short networks may be able to operate without termination, according to the maximum speed desired.)

### Protocols

8-bit ASCII, 9-bit binary, Modbus®, and DMX512

### Hardware Configuration Settings

Available Baud Rates: 2400, 4800, 9600, 19.2k, 28.8k, 57.6k, 115.2k or 230.4k  
(250k only for DMX512)

Data Bits: 8 (9 bits for binary)

Stop Bits: 1.5 or 2

Parity Bit: None (Modbus supports None, Even, Odd)

### CAN interface

The CAN bus connection is NOT isolated, but does include transceivers which have an extended +/- 80v fault protection range. The CANopen® communications protocol allows the unit to function as a master, slave, or peer on a CANopen network. See the SilverLode CANopen User Manual for details on the CANopen protocol. This protocol operates simultaneously and independently from the standard serial protocols.

Note that a 120 ohm ½ W termination resistor is required at each end of the CAN network (only two per system). This termination is not provided onboard the controller and must be provided by the user, even for very small networks.

CANopen® and CiA® are registered community trade marks of CAN in Automation e.V.

## STATUS LIGHTS

Three status lights are provided on each end of the box. Two sets of status lights are provided to make it easier to see them with the box mounted in different orientations. The Blue Power light indicates power is connected to the unit. The Red COMM LED indicates the unit is ready (no program running) by a dim level, it is off between communications if a program is running. It blinks brightly during each incoming communications frame. The Green Status light varies in intensity with the motor torque; if Done Bit is configured the LED lights to indicate Done (See Set Done Bit command), is also used to blink error codes if a fault is detected (and the Done bit is not configured). A Green Drive Enable LED indicates the drive enable input is active.

## Environmental Specifications

### Operational Temperature

-10 C to +70 C (Higher temperatures may require air flow across case, according to power level and duty cycle) Hot Surface – Risk of Burn on heatsink at higher temperatures and/or with insufficient air flow.

### Storage Temperature

- 40 C to +85 C

### Humidity

Continuous specification is 95% RH non-condensing.

### Shock

Limitation is approximately 50g/11ms.

Specifications subject to change without notice. See [www.QuickSilverControls.com](http://www.QuickSilverControls.com) for current information.

## Mounting the QCI-S3-IG-01

The Controller Driver is designed to be mounted between guides that support the edges of the PCB not having LEDs or connectors. The guides should not overlap more than .025 over the edge of the PCB. The driver IC is the tallest device on the back side of the board and defines the distance between the PCB and the heat sink. Four 4-40 nuts are positioned equally about and on the center line of each driver to allow access from the outside of the heatsink to pull the PCB tight to the heatsink. The connector plane of the motor and SIP connectors is the reference for alignment and the stabilizer for the connector end of the PCB.

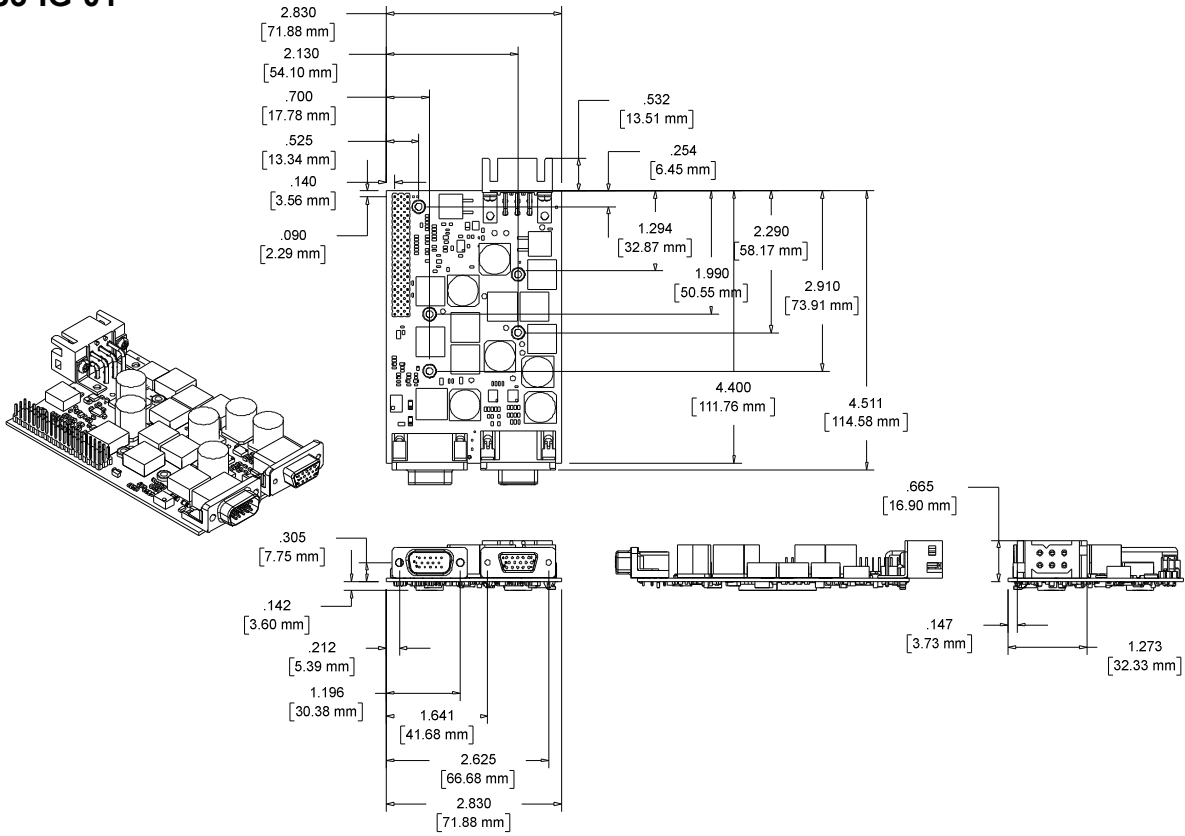
Mounting procedure: A thin layer of silicone thermal grease should first be applied to the exposed metal thermal contact of the driver IC. The driver chip should be held flat to the heatsink, and both screws tightened just finger tight (~2 in-oz). We suggest using a removable thread lock material (such as purple Loctite™) on the screws. Next, start any other mounting screws, such as the third mounting hole or the screws in the D-sub connectors. Next tighten the two screws adjacent to the driver chip alternately with an ultimate torque of 20 in-oz (0.14Nm) using a torque watch. It is important to have the thermal interface side of the driver flat to the heatsink before tightening, as tightening a screw with the IC cocked results in a significant leverage which can damage the driver chip and distort the PCB, possibly breaking components and/or solder joints. Overtightening can also damage the driver and PCB.

Proper ESD handling techniques including grounding straps should be used while handling the open frame printed circuit board to prevent damage. The 15 pin D-sub shells are grounded and should be the first contact to the PCB as an added measure. The Motor Power D-sub (5W5) shell should be grounded to the chassis and returned to the power ground.

THE THERMAL PAD ON THE DRIVER IS INTERNALLY CONNECTED TO THE DRIVER SUBSTRATE AND NEEDS TO BE ATTACHED TO A GROUNDED HEATSINK. Connecting the mounting bracket for the D-sub connectors to the heatsink will provide the needed grounding path. Do not anodize the heatsink directly opposite the driver chip nor the screw holes!

# Mechanical Dimensions

## QCI-S3-IG-01

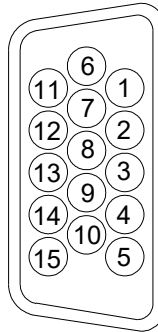




### Connector Data

#### SilverSterling Interface Port (SIP)

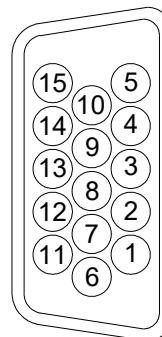
This port provides Power, RS-485 serial communications, CAN communications, and four IO. It is not backwards compatible with the SilverDust or SilverNugget. The IO is nominally 0-3.3v and should be limited to no more than 5v to avoid damage. The CAN and RS485 have extended input voltage range to improve robustness. Power ground and logic ground are internally connected. The Drive Enable is optically isolated and current limited to 3mA with an input voltage of 6v to 48v. Drive Ena Source provides a 3mA current limited power source that can be connected to Drive Enable +, with Drive Enable – connected to Power Ground to minimize wiring when the drive is to be enabled whenever driver power is present. The QCI-BO-S1 breakout board connects the drive enable to the Drive enable source via the power and ground connections. No power needs to be connected for the drive enable to function. Use the QCI-BO-S3 breakout board to connect an external hardware drive enable input. This allows the driver circuit to be disabled while the control electronics remain active.



1	DR_ENA+
2	RS-485A
3	+5V OUTPUT 100mA
4	I/O #3
5	CAN_H
6	DR_ENA -
7	DR_ENA SOURCE
8	LOGIC GROUND
9	I/O #2
10	LOGIC GND (CAN GND)
11	POWER GROUND
12	RS-485B
13	I/O #1
14	I/O #4
15	CAN_L

#### Encoder Interface

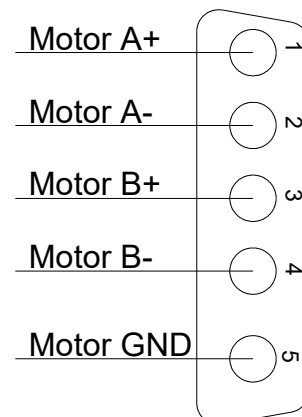
QuickSilver Controls recommends our QCI-C-D15P-D15S-nn (nn=length in feet) cable to interface between the motor encoder and the controller. The motor temperature can be monitored and limited by using a DS1822 digital thermometer, with ground connected to Encoder Ground, Power to +5v encoder power, and IO connected to Motor Memory Access. The motor temperature can be measured in 1/16 C increments in the lower half of register 241, and the over-temperature threshold can be configured via the upper half of register 241 (also in degrees C \* 16).



1	Hall Sensor 2
2	Chassis Ground
3	+ 5V Encoder Power
4	Encoder A -
5	Encoder B -
6	Hall Sensor 3
7	Hall Sensor 1
8	Encoder Z +
9	Encoder A +
10	Encoder Z -
11	Hall Sensor 4
12	Chassis Ground
13	Encoder B+
14	Encoder Ground
15	Motor Memory Access

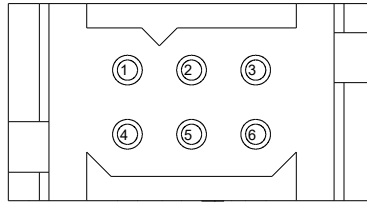
#### Motor Driver Interface

QuickSilver Controls recommends our QCI-C-D5P-D5S-nn (nn=length in feet) cable to interface between the motor and the controller.



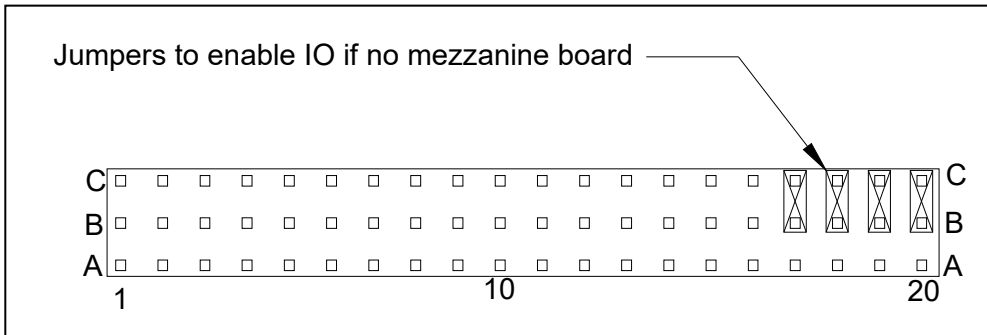
**Power Connector**

The power connector supplies driver power (12 to 48v) to V+ with Power Ground as the return. Optionally, the processor may be powered (12v-48v) via the V+ processor input, allowing the processor to



1	RES-
2	Clamp Out
3	+Vdriver (internal)
4	Power Ground
5	V+ Processor
6	V+

stay alive when the drive power is removed. The Clamp Out pin (open drain to ground) needs to be connected either to the internal clamp resistor RES-, or to an external, user supplied clamp resistor with the opposite side of the user clamp resistor tied to +Vdriver. Connecting Clamp Out directly to +Vdriver will likely result in damage to the board. Connecting +Vdriver to V+ disables the clamp operation and allows regenerated power to return to the power source, allowing regeneration to a battery. The clamp resistor should still be present to allow clamp in the case of an over-voltage.



**Mezzanine Header**

The optional Mezzanine Header provides access to additional signals when adding a customer feature

board to the S3-IG (Contact factory for custom boards added to box), or S3-IG-01. Four jumpers come standard on the S3-IG to connect the external IO (after input protection network) to the internal IO on the processor. Note that the signals on this connector are not protected and the user must add protection as needed to their customization board in order to use these signals.

Mezzanine Connector Pinout. Contact factory to use additional IO

	A	B	C
1	No Connect *** (VP on S2-IG)	No connect *** VPsen on S2-Ig	RxD_A - Primary serial port
2	+VDr = Internal driver voltage	+VDr = Internal driver voltage	TxD_A - Primary serial port
3	Power Ground (0v)	Power Ground (0v)	DE_A - Primary serial port
4	+12v @ 10mA	+5v @ 100mA	RxD_A ENA* (low to disable internal 485)
5	SPIA Slave In Master Out	TRST - RESERVED	SPIB Slave In Master Out or IO
6	SPIA Slave Out Master In	TDI - RED*	SPIB Slave Out Master In or IO
7	SPIA Clock	TDO - GREEN*	SPIB Clock or IO
8	SPIA Chip Select*	TMS - Output only	SPIB Chip Select* or IO
9	CSO A - Additional Chip select	+3.3v @ 100mA	RxD_B - Secondary serial port or IO
10	CAN TX (internal signal)	TCLK - Reserved	TxD_B - Secondary serial port or IO
11	CAN RX (Internal signal)	SDAA - I2C or IO	DE_B - Secondary serial port or IO
12	Digital Ground	SCLA - I2C or IO	ENC_A - buffered from motor encoder
13	ADCINA2 - Digital IO or Analog	Digital Ground	ENC_B - buffered from motor encoder
14	ADCINB2 - Digital IO or Analog	GPIO1	ENC_Z - buffered from motor encoder
15	ADCINA4 - Digital IO or Analog	GPIO3	ENC_S - high speed capture of encoder or IO
16	ADCINB4 - Digital IO or Analog	GPIO14	CAP_1 - High speed capture or IO
17	No Connect	Internal IO4	To SIP pin 14 via protection network, ADC1 via protection
18	No Connect	Internal IO1	To SIP pin 13 via protection network
19	+ Vprocessor *** (3.3v Ref S2-IG)	Internal IO3	To SIP pin 4 via protection network
20	DRIVE ENABLE (pull low to disable)	Internal IO2	To SIP pin 9 via protection network

\*\*\* This is different between S2-IG and S3-IG

## Recommended Components

### 1. Controller/Driver

SilverSterling QCI-S3-IG-01 is our open frame controller/driver designed to servo QCI's larger I-Grade motors through two connectors. A suitable heatsink is required for operation!

### 2. Basic Breakout (QCI-BO-S1)

QCI recommends purchasing a breakout to simplify wiring power, RS-485 communication, CAN and 4 I/O. The breakouts connect directly to the SilverSterling's 15-pin interface port (SIP).

### 3. Encoder I/F Cable

For standard system, this D-sub type cable goes between the motor and the controller. The generic part number is QCI-C-D15P-D15S-nn. Replace the last two digits "nn" with length of cable in feet (i.e. -10 for 10 feet). Standard lengths are 1, 2, 4, and 10 feet.

For IP65 system, a special IP65 cable goes in between the motor and the controller. The motors and cables are IP65, but not the controller/driver. The generic part number is QCI-C-D15P-T14S-nn. Replace the last two digits "nn" with length of cable in feet (i.e. -10 for 10 feet).

### 4. Motor Driver Cable

For standard system, this D-sub type cable goes between the motor and the controller. The generic part number is QCI-C-D5P-D5S-nn. Replace the last two digits "nn" with length of cable in feet (i.e. -10 for 10 feet). Standard lengths are 1, 2, 4, and 10 feet.

For IP65 system, a special IP65 cable goes in between the motor and the controller. The motors and cables are IP65, but not the controller/driver. The generic part number is QCI-C-D5P-T6Snn. Replace the last two digits "nn" with length of cable in feet (i.e. -10 for 10 feet).

### 5. Input power cable

The Power cable connects to the 6 pin power connector on the QCI-S3-IG. It carries driver power and connects the internal clamp resistor. The part number is QCI-C-S3S-04 for a 4 foot cable. Other configurations including connections for external clamp resistor and for separate processor power can be ordered from the factory. The part number for the connector with 6-pins and no wires is QCI-CK-S3S.

### 6. Motor

The SilverSterling S3 is capable of driving high power NEMA 34 I-Grade motor/encoder. See the following datasheet for more information:

QCI-DS009\_QCI-A34 - 34 Frame Motors.

### 7. Power Supply

Power supply selection is motor dependent, but the following will work with all high power (two connector) 34 Frame motors.  
 SE-1000-48 (48V, 20.7A, 1000 Watt)

**Part Numbers**

silverSterling™ IG Controller/Drivers		
Driver	Controller	Options
<p><b>QCI-S3-IG-xx:</b></p> <ul style="list-style-type: none"> <li>• Best paired with I-Grade Motor/Encoders</li> <li>• 10A RMS continuous</li> <li>• 20A peak per phase</li> <li>• 20A @ 12v-48v</li> <li>• Included Clamp circuit and resistor.</li> <li>• Isolated Drive Enable input</li> </ul>	<p><b>IG</b> – SilverSterling S3 IG</p> <ul style="list-style-type: none"> <li>• 4 TTL Inputs or Outputs</li> <li>• 1 Analog input (IO#4)</li> <li>• 1 PWM output (IO#2)                             <ul style="list-style-type: none"> <li>○ Use QCI-BO-S1A</li> </ul> </li> <li>• ASCII, 9 bit Binary, Modbus®, DMX-512®</li> <li>• CANopen® (with Rev 03 sw)</li> <li>• DB15HD (pin): SIP Connector</li> <li>• DB15HD (socket): Motor I/F</li> <li>• DB5W5 (socket): Motor Power</li> <li>• 6 pin Input power Connector</li> </ul>	<p><b>01</b> – Board Only</p> <ul style="list-style-type: none"> <li>• Requires user to properly heat sink.</li> </ul>
Example: For IG board only		
<b>QCI-S3</b>	<b>IG</b>	<b>01</b>
Selection creates part number: <b>QCI-S3-IG-01</b>		

Example Part Numbers:  
 QCI-S3-IG-01

**Contact Information**

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