SilverNugget N3 I-Grade

The SilverNugget is a servo controller/driver for NEMA 34 frame microstep motors.
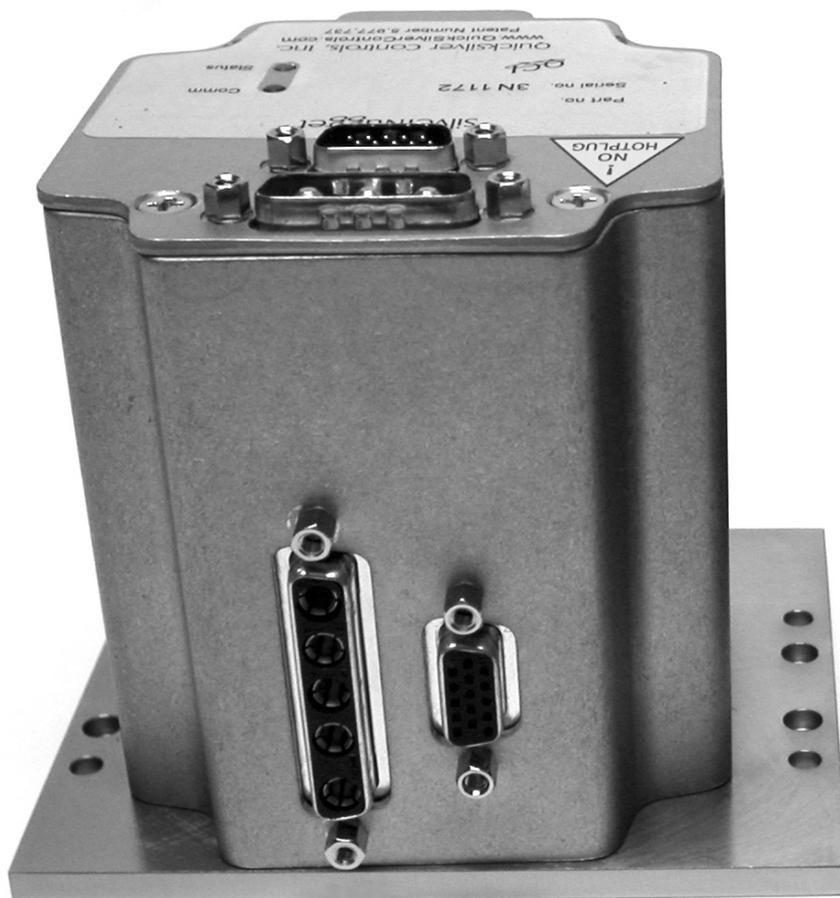
System Overview

Special Functions
- Electronic Gearing/Caming
- 100:1 Inertial Mismatch
- Anti-Hunt™: Eliminates servo dither.
- Multi-Tasking (Run Programs During Motions)
- Position & Velocity Using Analog Input
- Variable Torque Brake (Eliminates Slip Clutches)

Memory Size
- Program Buffer: 200 words
- Non-Volatile: 32K bytes Thousands of program lines and data storage.

Analog Inputs
- 4 Inputs (0 To +5 Volts)
- Continuous And Single Readings
- Can Be Used For Motion Control

Digital I/O
- 7 I/O Lines (All TTL Level)
- I/O Can Be Programmed For Input Or Output

Servo Cycle Rate
- 120 microseconds = 8.33 kHz

Maximum Rotational Speed
- 4000 RPM

General Commands
- Conditional Jumps
- Wait On Inputs
- Delay Timer
- Program Call And Return
- Math Functions: Add, Sub, Mult, Div
- Logic Functions: AND, OR, XOR
- Storing And Loading User Data
- Load And Run Other Programs

Motion Commands
- Move Relative And Absolute
- Linear & S-Curve Acceleration & Deceleration
- Velocity Mode
- Torque Mode
- Step And Direction Input
- Complex Profiles (Change Position, Velocity, Acceleration Or Deceleration On The Fly)

Initialization Commands
- RS-232 Or RS-485
- Serial Baud Rate
- Address Number For Network Operation
- All Digital I/O As Inputs or Outputs
- Servo Control Constants
- Torque Limits
- Motor Shutdown Conditions & Recovery
- Input Voltage
- Over Voltage & Under Voltage Detection
- Over Temperature
- Error Limits
- End of Travel Limits
- Multi-Tasking Enable/Disable
- Driver Enable/Disable

Read Status & Info Commands
- Errors Conditions
- Internal Conditions
- I/O States
- Data Registers
- Position, Velocity, Target Etc.

Electrical Specifications

Input Power

Voltage
+12 VDC to +48 VDC, regulated. Device must be initialized for the actual operating voltage.

Over-Voltage Protection
None available. Voltages exceeding +55 VDC will permanently damage the controller/driver electronics. **All N3 servo systems require active voltage clamping regardless of the deceleration profile**. See the High Current Voltage Clamp technical document, QCI-TD017, for information on the voltage clamp. For aggressive braking/deceleration motions or applications with high inertial loads, substantial power dissipation by the voltage clamp is required.

Reverse Polarity Protection
Controller Input Power is reverse protected by a diode. None available for the Driver Input Power. Connecting supply voltage in reverse can damage the driver electronics. However, limiting the supply current externally, to 20 Amps or less, will greatly minimize the chance of hardware failure.

Input Current
20 Amps maximum for any input voltage, +12 VDC to +48 VDC.

Output Power

Output/Driver Current
18 Amps continuous per phase *; 24 Amps peak per phase *.

- With Adequate Heat Sink.

Maximum Output Power
800-Watts continuous power with adequate heat dissipation.

Encoder Interface

Primary Encoder Resolutions
4000 Lines = 16000   counts/revolution
Designed to work exclusively with QCI's I-Grade motor/encoders.

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Other trade names cited are property of their explicit owner.

Inputs & Outputs

Digital Inputs
0 or +5 VDC. TTL level only. Active low (sinking).
Inputs 1, 2 and, 3 have internal 4.7K ohm pull-up resistors to the +5 V.
Inputs 4, 5, 6, and 7 have an effective internal 200K ohm impedance to +5 V.

Digital Output Voltage
0 or +5 VDC. TTL level only.

Digital Output Current
Sinking or Sourcing
All 7 I/Os ± 5 milliamps

I/O Over-voltage Protection
Each I/O line is double protected with parallel MOV clamping devices followed by series over-voltage limiting.

External (Secondary) Encoder Maximum Bandwidth
1 million counts per second.

Analog Inputs
0 to +5 VDC input signal range.
10 bit ADC resolution (single).
11 bit ADC resolution (differential).
Analog inputs 1 to 4 are mapped to share digital I/O lines 4 to 7.
Each input has an effective internal 200K ohm impedance to +5 VDC.
Analog signals are read every servo cycle (120 usec.) and the converted analog data is processed through a 5 ms filter to reduce noise & transients.

Communications

Hardware Interfaces
RS-232, RS-232 multi-drop, or RS-485 multi-drop (software selectable).

Protocols: 8-bit ASCII, 9-bit binary, or Modbus®

Communication Line Protection
 Each line is protected with MOV clamping devices.

Hardware Configuration Settings
Available Baud Rates: 2400, 4800, 9600, 19.2k, 28.8k, 57.6k, 115.2k or 230.4k
Data Bits: 8
Stop Bits: 1.5 or 2
Parity Bit: None

Connector Data

SilverLode Multi-Function Interface (SMI) Port (On Board)

The SMI port is a DB15HD (pin) connector containing input power, I/O and communications. Any QCI breakout with an SMI port can be connected to this port via an SMI cable (QCI-EC-SMI-nn).

Technical Data (DB-15HD)
15-pin High Density D-subminiature, Plug (w/pins) type gender.
Crimp type contacts, Rated at 5 Amps per contact.
Shell size is a std. DB-9.

SMI Pin Layout
Front View on
SilverNugget
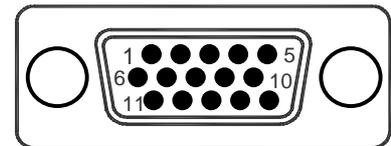
SMI Port

Signal Comments:

* Drive Enable operates from a DC voltage range of +10 to +48 to enable the servo drive. It is commonly connected to the +V driver power supply when not used independently.

Controller +V Power (pin 7) and both Controller Power Grounds (pins 6 & 11) must connect respectively to the +V and ground terminals of a +8 to +48 VDC supply.

I/O lines 1, 2, and 3 each has a 4.7k Ohm pull-up resistor connected to the internal +5 VDC 100mA power supply.

I/O lines 4 thru 7 each have a 200k Ohm effective pull-up impedance to the internal +5 VDC power supply.

**** N3 Controller Power Ground is isolated from the SilverNugget Case.**

Pin #	Signal Description	
6	Controller Power Ground	
1	*Drive Enable	
11	Controller Power Ground	
7	Controller +V Power (+8 to +48 V)	
2	RS-485 A / RS-232 Tx	
12	RS-485 B / RS-232 Rx	
8	Logic Ground	Input
3	+5 VDC Supply (100mA max.)	
13	I/O #1	
9	I/O #2	LOAD / Output
4	I/O #3	
14	I/O #4	
10	I/O #5	
5	I/O #6	
15	I/O #7	
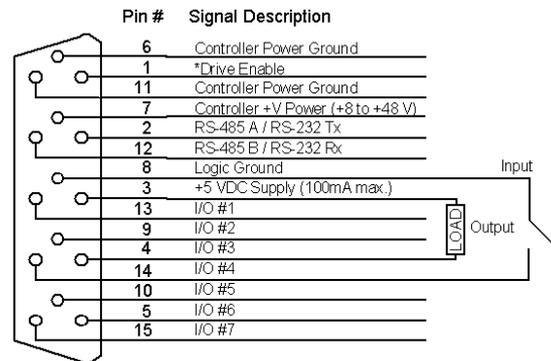
DB-3 Connector

This high current connector is found on each SilverNugget N3. It connects an external power source to the servo drive only. DB-3 power cables are offered by QCI, allowing easy connection to power sources.

Technical Details (DB-3W3)
3 contact D-subminiature, Socket (w/plugs) type gender.
Size 20 solder cup contacts, Rated at 20 Amps per contact.
Shell size is standard DB-15.

DB-3 Plug Layout
Front View on SilverNugget
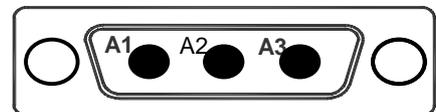
DB-3 Plug to Signal Assignments

| Pin	Signal Description
A1	Chassis Ground †
A2	+V Power Input (+12 to 48 +VDC)
A3	Power Ground (Input) †

†N3 DB-3 Comments:

Power Ground (A3) & Chassis Ground (A1) are **not** internally shorted together.

+V Input Power and Power Ground are not reverse bias protected.

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DB-5 Connector
This high current connector provides drive current to the motor windings.

Motor A+ — 1
Motor A- — 2
Motor B+ — 3
Motor B- — 4
Motor GND — 5
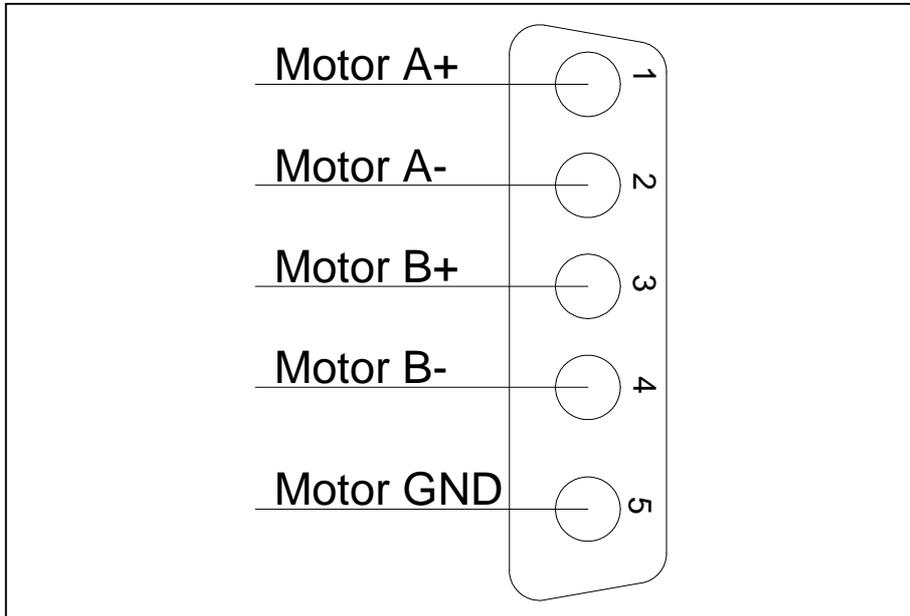
The "Motor GND" signal is connected to the controller chassis. This pin should be connected to the shields and shield drain wires associated with the two driver twisted pairs. It should be connected at both the controller and motor ends of the cable, also connecting to the connector housings at both ends.

DB-15 Socket type Connector (Side DB-15)
This connector provides the encoder position feedback signals needed for commutation.

No Connect	6
No Connect	11
No Connect	1
No Connect	7
Motor Body Ground	12
	2
Encoder Z	8
Encoder B	13
Encoder +5v	3
Encoder A	9
Encoder GND	14
Encoder A-	4
Encoder Z/	10
Reserved	15
Encoder B-	5
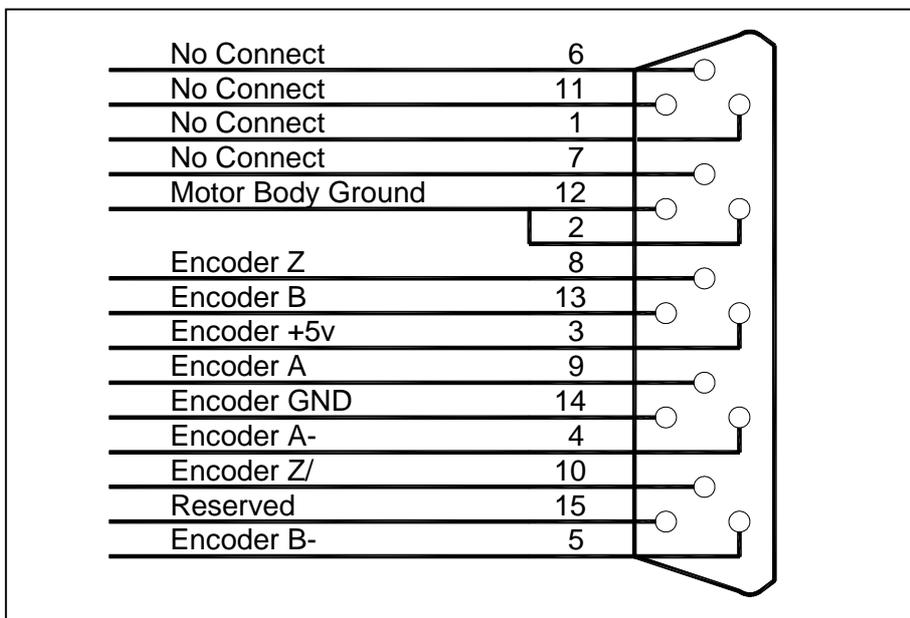
The "Motor Body Ground" in the 15 pin connector is internally connected to the chassis (same as Motor Ground). These grounds should be connected to the encoder shields and connector housing only at the controller end of the cable. These should NOT be connected to the anything at the motor end of the cable. This minimizes chopper noise coupling to the encoder signals.

Mechanical Specifications
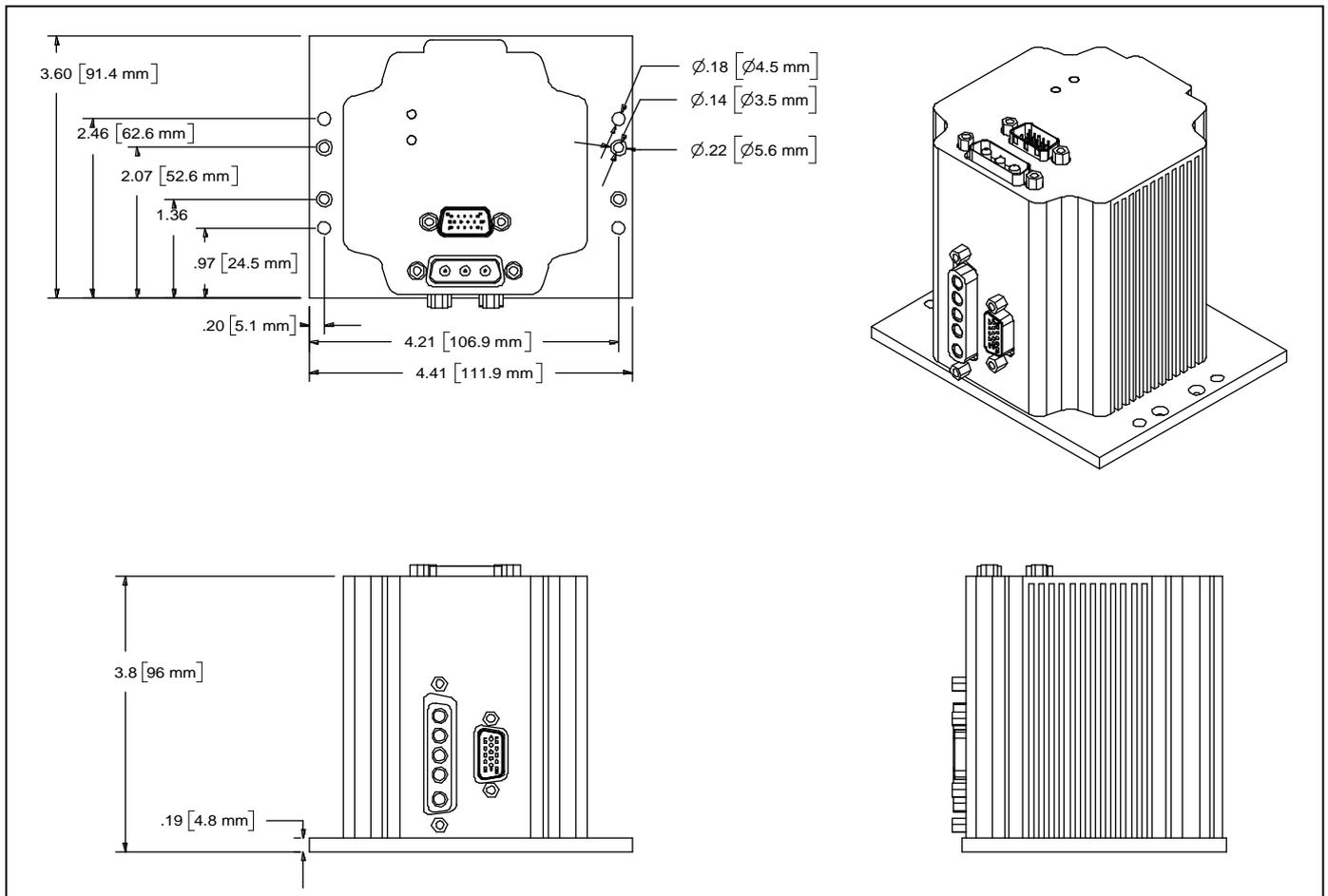
Note: See our website for 2D drawings and 3D models.

Environmental Specifications

Operational Temperature
 -10 C to +80 C

Storage Temperature
- 40 C to +85 C

Humidity
Continuous specification is 95% RH non-condensing.

Shock
Limitation is approximately 50g/11ms.

IP Rating
IP50

System Recommendation

Start-Up Kit
For first time users, QCI recommends purchasing the QCI-SKB-N3-EE Start-Up Kit which includes:
- SilverNugget N3 (QCI-N3-E3-04-EE) & Datasheet (QCI-DS006)
- QuickControl Software CD, User Manual & Command Reference (QCI-SLM)
- Basic Breakout 3 (QCI-BO-B3) & Tech Doc (QCI-TD038)
- Communication Cable (QCI-C-D9M9F-6)
- Clamp Module w/ Internal Resister (QCI-CLCF-04-R2) & Tech Doc (QCI-TD017)
- Line Power cable (QCI-34EC-LP-10)
- 4' DB15HD Motor I/F Cable (QCI-C-D15P-D15S-4)
- 4' D5P Motor I/F Cable (QCI-C-D5P-D5S-4)
- Start-Up Kit Setup Instructions (QCI-TD023)

With this Start-Up kit, a power supply, and a motor/encoder, you will have everything you need to get started. See technical document QCI-TD023 on our website for details.

The system detailed below uses the QCI-SKB-N3-EE.

Standard System
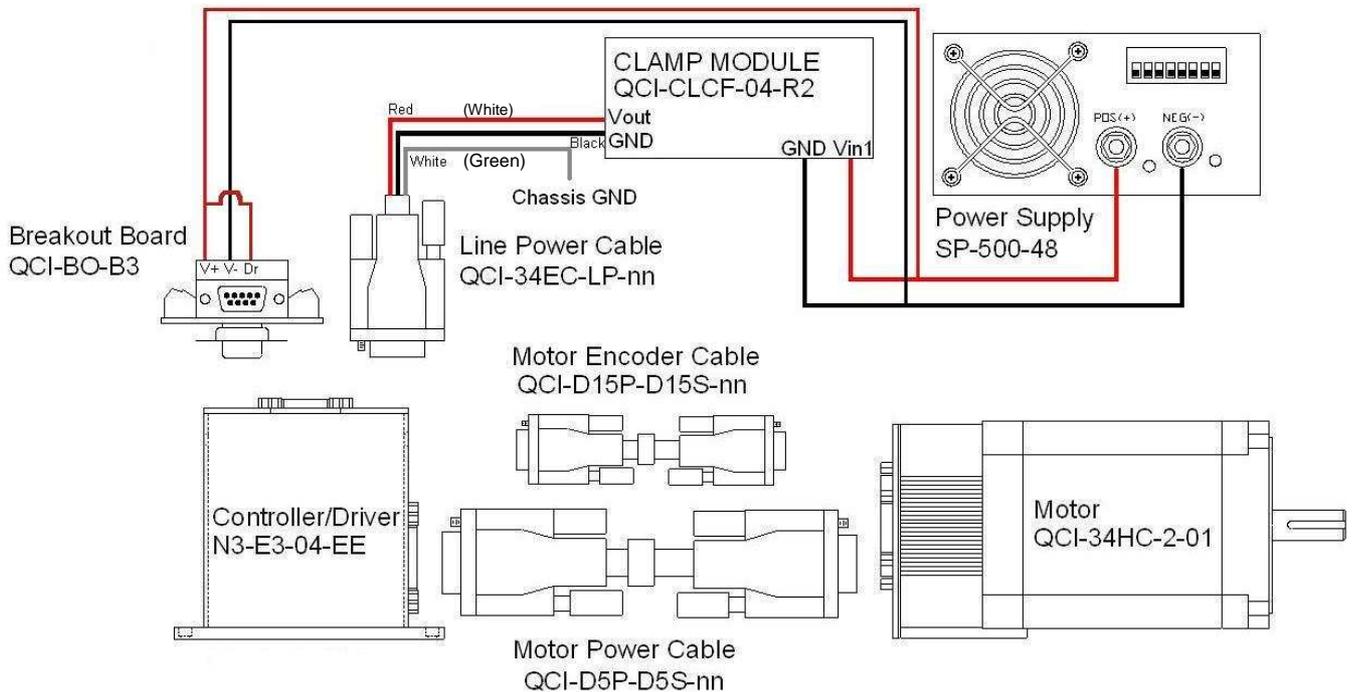
Note: the QCI-34EC-LP-nn cable may come in Red/Black/White or White/Black/Breen (V+/V-/Chassis)

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Basic Breakout Module (i.e. QCI-BO-B3)
QCI recommends purchasing a breakout to simplify wiring power, communications and I/O. The recommended breakout module for any N3 system is QCI-BO-B3.

Encoder Cable (i.e. QCI-C-D15P-D15S-nn)
This encoder cable goes between the motor and the SilverNugget. 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 stock lengths are 1, 4, and 10 feet.

Motor Cable (i.e. QCI-C-D5P-D5S-nn)
All N3 systems require a separate high power cable due to high power delivery in the system. The generic part number is QCI-C-D5P-D5S-nn (nn = length). Replace the last two digits "nn" with length of cable in feet (i.e. –10 for 10 feet). Standard stock lengths are 1, 4, and 10 feet.

Motor (i.e. QCI-A34HC-n)
The SilverNugget N3 is capable of driving any 34-frame I-Grade motor/encoder. See the following datasheets for more information:

> QCI-DS009: NEMA 34 frame I-Grade Motor/Encoder

N3 Line Power Cable (i.e. QCI-34EC-LP-nn)
This DB3 power cable provides the main power input to the system from the clamp module.

Clamp Module (i.e. QCI-CLCF-04-R2)
A clamp module is required for all N3 system to protect the main power bus from regenerative braking during high acceleration and deceleration operations. See QCI-TD017 for more details on the high current clamp module.

Power Supply (i.e. SCN-800-48, SP-500-48, SE-1000-48)
Power supply selection is motor dependent. See motor datasheet for power supply recommendations.

> SP-500-48 (500 watts power supply)
> SCN-800-48 (800 watts power supply)
> SE-1000-48 (1000 watts power supply)

24V Optical I/O Module (QCI-OPTMC-24)
DIN mountable breakout used in place of the QCI-BO-B3 to breakout the 7 TTLLV I/O to isolated, 24V I/O. Note, an SMI cable (QCI-EC-SMI-2) is required to connect the controller to the OPTMC.

Other Recommendations

SilverLode User Manual & Command Reference (QCI-SLM)
For beginning and brand new users, please see chapter 1 User Manual for getting started instructions. The SilverLode user manual is in a textbook format. It begins with the fundamentals of use and progresses into advanced topics that are application oriented. Any new user can follow the material in a natural progression of product usage. In addition, there are exercises throughout the text that provide users a hands-on approach toward understanding the topics better. The manual is thorough, but not exhaustive. Users that explore this material fully and complete the exercises should gain the ability to operate, program, and prototype any SilverLode servo system into working applications.

Both the user manual and command reference are available for download on our website. QuickSilver also sell hard copies of the SilverLode User Manual & Command Reference set under part number QCI-SLM.

Software QuickControl
QuickControl® allows developers to quickly program and operate all SilverLode family of products using a standard PC running Windows (2K, XP, or Vista). Communication to the SilverLode controller/driver products is accomplished from the PC's serial port (i.e. COM1 or COM2). QuickControl also provides tools for uploading and downloading programs and user data. Data can be typed in manually or import from text files. Documentation features include remarks, line labels, namable registers and I/Os.

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Part Number

SilverNugget™ N3 I-Grade Controller/Drivers			
DRIVER	**CONTROLLER**	**OPTION**	**MOTOR INTERFACE**
QCI-N3 - 10 Amps • For 34 Frame • 10 Amps per Phase Continuous* • 20 Amps Peak * Depending on heat sink (25C ambient).	**E3** – Standard • 8 bit ASCII or 9 bit binary protocols **M3** – Modbus® • Same as E3 except 9 bit binary protocol replaced with Modbus® protocol **F4** – Same as E3 except incoming encoder is divided by 4 to emulate a 4000CPR encoder	**04** – I-Grade • SilverLode Multi-Function Interface (SMI) Port • DB15 (socket) I-Grade Interface for encoder signals. • DB3 (pin) Connector for input power • DB5 (socket) I-Grade Interface for motor windings.	**EE -** Standard I-Grade Interface for connection to I-Grade motor / encoders.
To create a part number, choose one from each column above.			
QCI-N3	**E3**	**04**	**EE**
This selection creates the part number: **QCI-N3-E3-04-EE**			