



## SilverNugget™ N2-IX

The SilverNugget N2-IX is a servo controller/driver for QCI's line of NEMA 11, 17, 23, and 24 frame, high torque, direct drive, servo motors. The N2-IX Servo Controller/Driver is designed to operate QCI's I-Grade motors through a single motor interface cable, which carries motor power and encoder feedback. This single cable solution allows for easy installations and simple cable routing.

Power, communications, and I/O are accessed through a single DB15 high density interface connector. The interface includes 7 I/O, all of which support both LVTTTL and analog signals, and one of which also supports 0 to 10v analog. A hardware drive enable is available as a factory option. All 7 I/O also have soft configurable pull-up/pull-down resistors, which may also be disabled, for more flexibility.

## 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
  - Velocity
  - Modify On-the-Fly
  - Non-zero velocity start & stop

### Input/Output

- 7 LVTTL Digital I/O
  - Bi-Directional
  - Set While In Motion
- 7 Analog Inputs (Joystick)
- 1 Analog 0-10v Input
- 1 Output supports PWM out
- 1 Input supports PWM in
- Programmable Logic Switch out
- Secondary Encoder In
- Encoder Out (single ended and differential)

### Program and Data Storage

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

### Electronic Gearing/Camming

- Follow External Signals
  - Encoder (A/B Quadrature)
  - Step and Direction
- Gearing plus Trapezoid motion
- Electronic Cam
  - Import Cam Table from File
- Gearing with extended precision:
  - A/B gearing
  - xxx.xxxxxxx multiplier (8 places behind decimal point)

### Electronic Slip Clutch/Brake

- Variable Torque
- Wind/Unwind Applications

- Communications
- RS-485 (ASCII, Modbus®, DMX, 9-bit)
- Up To 230K Baud
- Host Control While Servo in Motion

### Programming Language

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

### Advance PVIA™ Servo Loop

- Improvement Stability
- Simulated Viscous Inertial Damper
- 100:1 Inertial Mismatch
- Direct Drive Oversized Inertial Loads
  - Flywheels
  - Belt Drives
  - Typically eliminates need for Gearheads

### Anti-Hunt™

- Optionally transition to open loop while in position – automatically changes back to full servo if position is disturbed.
- No Servo Dither While at Rest

### Multi-Task/Multi-Thread

- Two programs plus a motion simultaneously
- Multiple background protection settings

### Compatible with QCI's Hybrid Servo Motors

- NEMA 11 Frame
  - 4000 Counts/Rev Encoder
  - Up to 9 oz-in (continuous)
- NEMA 17 Frame
  - 8000 Counts/Rev Encoder
  - Up to 43 oz-in (continuous)
  - IP50 or IP65
- NEMA 23 Frame
  - 8000 Counts/Rev Encoder
  - Up to 190 oz-in (continuous)
  - IP50 or IP65
- NEMA 24 Frame
  - 8000 Counts/Rev Encoder
  - Up to 330 oz-in (continuous)
  - IP50 or IP65

## Electrical Specifications

### Input Power

#### Voltage

+12.5 VDC to +48 VDC, regulated. Device must be initialized for the actual operating voltage. An external clamp may be required if rapid decelerations of large loads are present. Both V+ pins and both PGND pins shall be used. The power circuit shall be fused at no more than 8A if the power supply is capable of more than 8 Amps. PGND is also connected to the frame of the controller/motor.

#### Input Current

5.5 Amps maximum for any input voltage, +12.5 VDC to +48 VDC per controller.

### Output Power

#### Output/Driver Current

5 Amps continuous per phase.

#### Maximum Output Power

200 Watts continuous power at nominal 25C ambient. May be derated at higher temperatures according to air flow.

### Inputs & Outputs

#### Digital Inputs

0 to +3.3 VDC. LVTTTL level compatible. All inputs have a light pull-up (~100k ohm to 3.3v). All I/O have an optional programmable pull-up/pull-down of 2.2 k ohm; the source to these resistors may also be floated if no pull-up or pull-down is needed. The seven IO are protected to +/- 40v.

#### Digital Output Voltage

0 / +3.3 VDC.

#### Digital Output Current

Sinking or Sourcing: 2mA

#### External Encoder Inputs

Maximum Bandwidth: 5 million counts per second from a secondary encoder, quadrature decoding. (External encoder input filtering at minimum setting.)

#### Analog Inputs

All 7 I/O may be used as Analog Inputs: 0 to +3.3 VDC input signal range.

IO7 has a secondary circuit to handle 0 to +10v input signal range; the input protection will isolate the normal 3.3 v input channel allowing the 0 to 10v operation.

Resolution: 12 bits (before filtering), interpolated to 15 bits via filtering.

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

## Communications

### Serial Interface

RS-485 multi-drop, Reduced unit load accommodates up to 254 nodes.  
Protected up to +/- 60v.

Note: RS-485 requires a nominal 120 ohm ½ W termination resistor at each end of the network for longer runs. This termination is not provided onboard and must be provided by the user. Simple termination is sufficient, biased termination is not needed with this device.

### 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)

## Servo Control Specifications

### 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. Encoder receiver includes ability to detect invalid signal amplitudes and open or shorted traces.

### Maximum Rotational Speed

4000 Revolutions per Minute; limited in controller software.

### Servo Cycle Rate

120 microseconds → 8.33 kHz

### Software Torque Control

Signed 16-bit control: 1 part in 32767

### Internal Memory

**Serial Communications Buffer Size:** 10 words

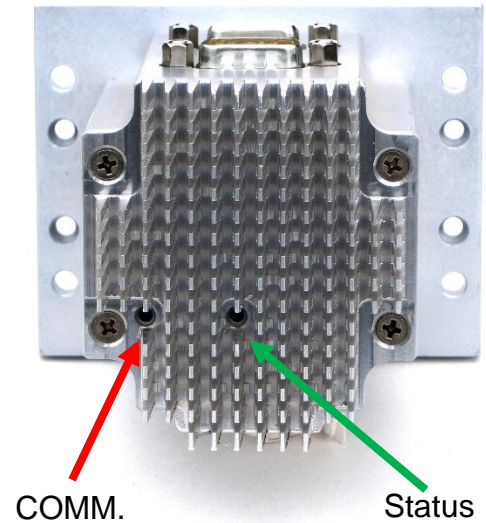
**Program Buffer Size:** 1023 words

### Non-Volatile Memory Size:

32K bytes (16K words)

## Status Lights

Two status lights are provided on the back of the SilverNugget. The COMM. LED (normally Red) 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 Status light (normally Green) varies in intensity with the motor torque (negative torque dimmer, positive torque brighter); 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).



## Environmental Specifications

### Operational Temperature

-10 C to +70 C. Continuous torque curves of mated I-Grade motors taken at 20C; derating may be needed at higher temperatures.

### Storage Temperature

- 40 C to +85 C

### Humidity

Continuous specification is 95% RH non-condensing.

### Shock

Limitation is approximately 50g/11ms.

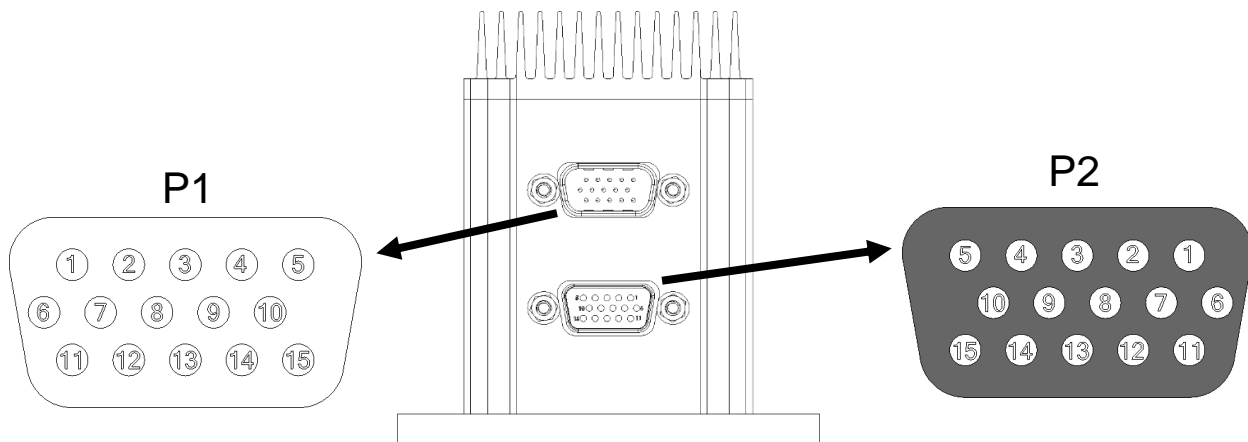
## Connector Data

### SilverLode Multi-Function Interface (SMI) Port (P1)

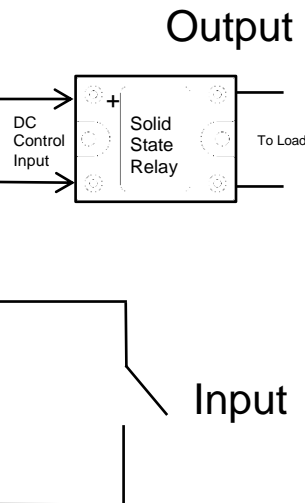
The SMI port is a DB15HD (pin) connector containing input power, I/O and communications. The Basic Breakout (QCI-BO-B4) attaches directly to the SMI port (no cable) and provides access to all signals. Alternately, an SMI cable (QCI-C-EC-SMI-nn, nn=length) can be used to interface with the optical I/O module, QCI-OPTMC-24.

### Motor Interface Connector (P2)

The Motor Interface Connector is a DB15HD (socket) connector that carries the motor driver signals and the encoder feedback signals. P2 connects to a QuickSilver NEMA 17, 23, or 24 frame I-Grade Motor/Encoder via a Motor Interface Cable (QCI-C-D15P-D15S-nn , nn=length).



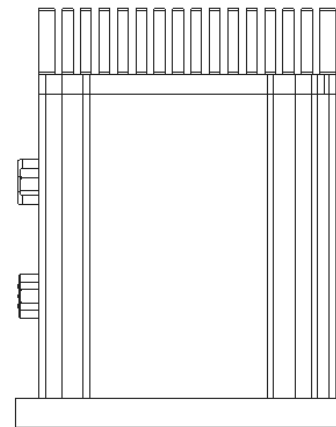
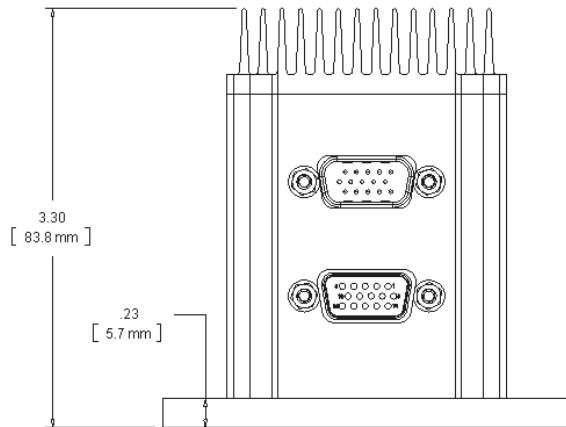
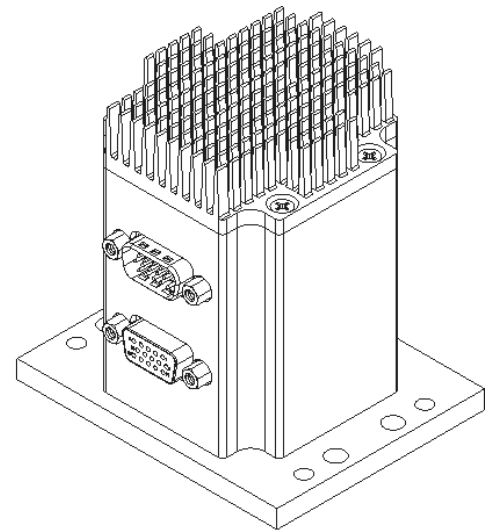
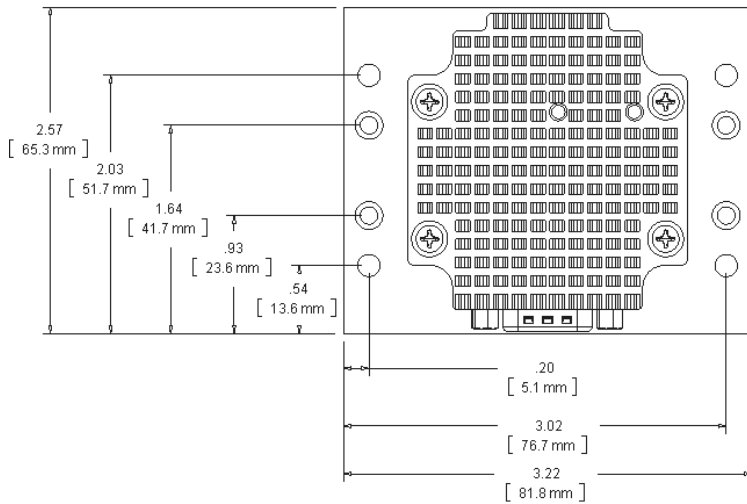
P1	
Pin	Signal
1	V+
2	RS-485 A
3	+5v Out
4	I/O #3
5	I/O #6
6	Power Ground
7	V+
8	Logic Ground
9	I/O #2
10	I/O #5
11	Power Ground
12	RS-485 B
13	I/O #1
14	I/O #4
15	I/O #7



P2	
Pin	Signal
1	Motor Phase B+
2	Motor Body Ground
3	Encoder +5v
4	Encoder A-
5	Encoder B-
6	Motor Phase A+
7	Motor Phase B-
8	Encoder Z
9	Encoder A
10	Encoder Z/
11	Motor Phase A-
12	Motor Body Ground
13	Encoder B
14	Encoder Ground
15	Motor Memory**

\*\* Motor Memory supports QCI I-Grade motors

## Mechanical Dimensions



Note: See our website for 2D drawings and 3D models. Specifications subject to change without notice. See [www.QuickSilverControls.com](http://www.QuickSilverControls.com) for current information.

## Recommended Components

### SilverNugget N2-IX Start-Up Materials

For first time users, QCI recommends purchasing the following items to aid with use of the N2-IX controller:

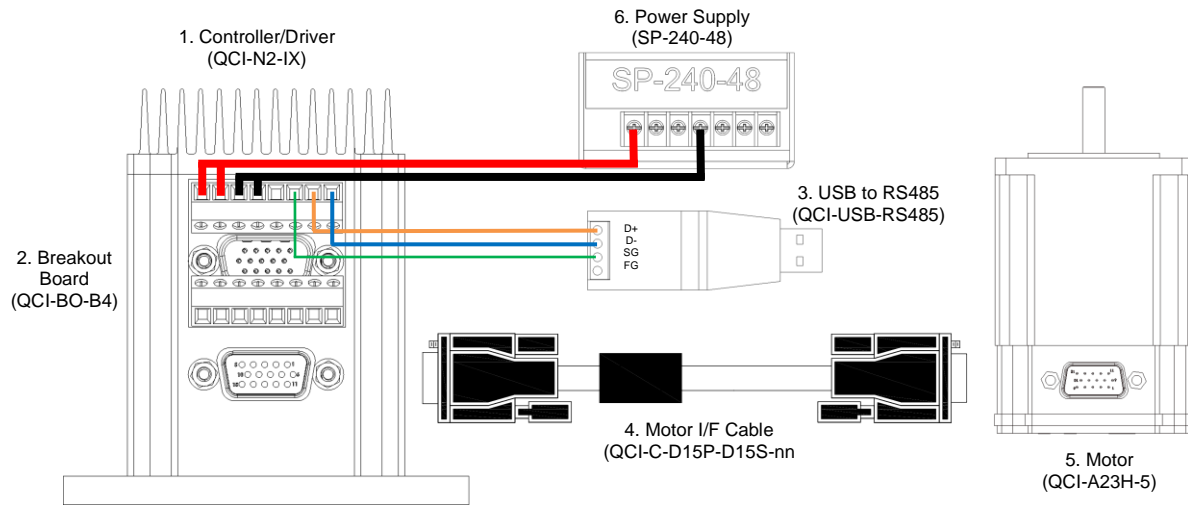
- 4' DB15HD Motor Interface Cable (QCI-C-D15P-D15S-04)
- Basic Breakout Module (QCI-BO-B4)
- USB to RS485 converter (QCI-USB-RS485)
- Desired QCI I-Grade Motor

Optionally:

- 240W, +48V Power Supply (SP-240-48)
- Power Supply Cord w/ Flying Leads (QCI-C-ACP-FLY-6)

Configuration Software: QuickControl™ is free and available from our website.

**Typical System Setup**



**1. Controller/Driver**

The standard controller/driver is QCI-N2-IX.

**2. Basic Breakout Module**

QCI recommends purchasing a breakout to simplify wiring power, RS-485 communication, and 7 I/O. The QCI-BO-B4 breaks out all the signals into screw terminals blocks for wiring convenience. See QCI-TD086 for more information.

**3. USB to RS485 Converter**

USB-RS-485 converter provides a USB powered serial port with RS-485 signaling. See QCI-TD073 USB-RS485 Converter Setup Guide for information on network termination and shielding recommendations.

**4. Motor Interface Cable**

For standard system, 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 stock lengths are 1, 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).

**5. Motor**

The SilverNugget is capable of driving QCI’s NEMA 11, 17, 23 and 24 I-Grade motor/encoder. For IP65 system, add “-6T” to the end of the standard motor part to designate an IP65 motor (i.e., QCI-A23H-5-6T).

See the following datasheets for more information:

- QCI-DS007: NEMA 17 I-Grade Motor/Encoder
- QCI-DS008: NEMA 23 I-Grade Motor/Encoder
- QCI-DS017: NEMA 11 M-Grade Motor/Encoder
- QCI-DS028: NEMA 24 I-Grade Motor/Encoder



**6. Power Supply**

Power supply selection is motor dependent, but the following will work with 11, 17, 23, and 24 frame motors.

SP-240-48 (48V, 5A, 240 Watt)

**7. External Regenerative Clamp (not shown)**

Rapid deceleration of larger loads may require a Clamp circuit if the capacitors in the power supply output are not sufficient to hold the recovered energy. Continuous braking of a load also may require the Clamp to handle the generated power. See QCI-TD017 for more information.

QCI-CLCF-04-R2

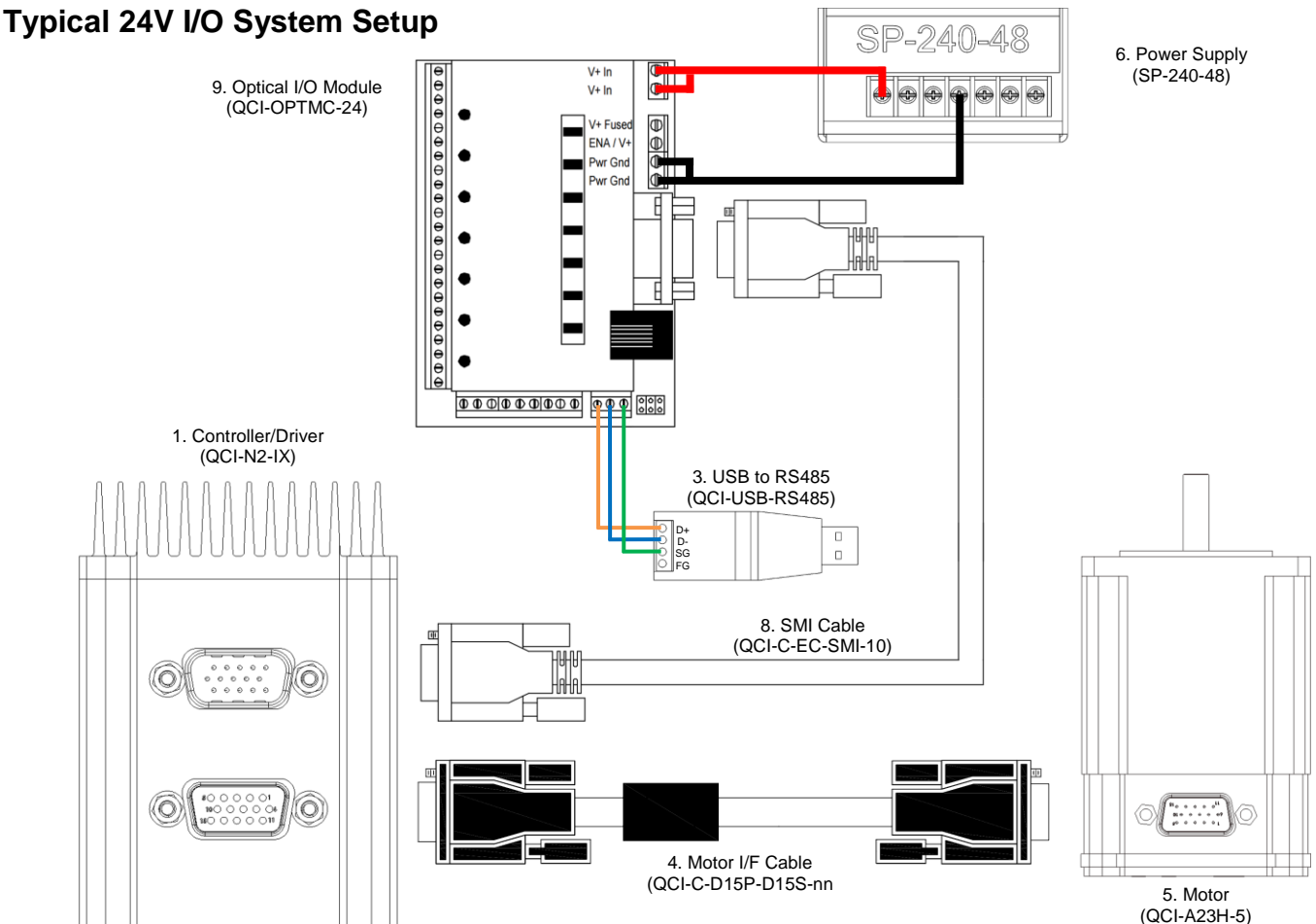
**8. SilverNugget Multi-Function Interface Cable (shown below)**

The QCI-EC-SMI-nn is used to connect the SilverNugget IX to QCI-OPTMC-24 Optical I/O Module. Replace the last two digits “nn” with length of cable in feet (i.e. –10 for 10 feet). Standard lengths are 2 and 10 feet.

**9. Optical I/O Module (shown below)**

The QCI-OPTMC-24 converts SilverNugget IX’s SMI Port LVTTTL I/O to optically isolated 24V I/O. See QCI-TD013 for more information.

**Typical 24V I/O System Setup**



## **New Notable Commands and Features vs. N2-xx-04-EE**

### **Analog Continuous Read Extended (ACX)**

The ACX command adds additional analog channels that can be read and filtered into a dedicated register. See Command Reference Manual for more information.

### **Configure I/O (CIO)**

For the SilverNugget N2-IX series, the CIO commands adds programmable pull-up/pull-down resistors.

### **Configure I/O, Immediate Mode (CII)**

The CII command adds the ability to configure an I/O for input or output via serial interface at any time, even during program execution.

### **Calculation Extended (CLX), Calculation with Data (CLD)**

Versatile calculation commands with output plus two inputs.

### **Motor Memory**

SilverNugget N2-IX has the ability to read motor memory stored in QCI's I-Grade motors (via Motor Memory signal). Motor memory contains motor type and encoder alignment calibration information. Therefore, running the Index Phase Alignment (IPA) is no longer necessary when initializing the SilverNugget N2-IX nor re-running the IPA when swapping motors, as the SilverNugget N2-IX will automatically read motor memory on power-up. If no motor memory is found or a different motor type was read from what was initialized, the controller will fault and flash the status LED accordingly. See User Manual for status LED information.

### **Increased Program Buffer Size**

The SilverNugget N2-IX's program buffer is 1023 word. For comparison, the SilverNugget N2-xx-04-EE's program buffer is 200 words.

### **Multi-Threaded Capability**

The SilverNugget N2-IX has the capability of running two threads in addition to a motion. If two threads are running, each thread alternates execution, causing each thread to execute at 240 microsecond ticks rather than 120 microsecond ticks when only one thread is running. See Multi-Thread Operation in User Manual for more details.

## Differences Between SilverNugget N2-IX and N2-xx-04-EE

The SilverNugget N2-IX uses a more advanced Digital Signal Processor (DSP) for its computing engine, which allows QuickSilver to add more features. Every effort was made to make the SilverNugget N2-IX series backwards compatible with the SilverNugget N2-xx-04-EE series. The following is a list of differences between the SilverNugget N2-IX and N2-xx-04-EE series controllers. For more details on the individual products, please see their datasheets and respective SilverLode Command Reference Manuals.

### Communication

#### Serial Interace (SIF)

SilverNugget N2-IX only supports RS-485. The RS-485 A&B lines are the same on both series (same pinout). RS-232 is no longer supported.

#### Protocol (PRO)

SilverNugget N2-IX, supports all three of QCI's protocols (8 Bit ASCII, 9 Bit Binary, Modbus®) with same firmware. Separate part numbers (i.e. M3, M7) are no longer needed to call out Modbus protocol.

#### ACK Delay (ADL)

For SilverNugget N2-IX, a negative Delay Count is interpreted as the number of 40uSec ticks to delay. Positive Delay Count is still interpreted as the number of 120uSec ticks to delay. This feature is used by ModBUS protocol to set inter frame timing.

### Digital Inputs/Outputs

Background: Today's DSP technologies are moving toward smaller sizes and faster performance. As a result, lower operating voltages are necessary to reduce the power consumption of the system and generate less heat to compensate for the smaller size DSPs.

The SilverNugget N2-IX's DSP is based on a 3.3V design as opposed to the SilverNugget N2-xx-04-EE's DSP which is based on a 5.0V design. As stated earlier, every effort was made to make the N2-IX backward compatible, so that the N2-IX can accept a 0-5 Volt inputs, however due to limitation of the DSP, the output is only 0 – 3.3 Volts. Drive levels are 2mA, sinking and sourcing. All seven I/O now support analog inputs. Programmable pull-up pull-down resistors are now 2.2k, and can be programmed to be open as well.

NOTE: The use of 5V pullups on outputs is not recommended as they will most likely override the output capability of the SilverNugget N2-IX.

### Data Input Range

	SilverNugget N2-xx-04-EE	SilverNugget N2-IX
Input Range	0 to 5.0V	0 to 3.3V
Valid HIGH	2V – 5V	2V – 5V
Valid LOW	0 – 0.8V	0 – 0.8V

**I/O Output Range**

	SilverNugget N2-xx-04-EE	SilverNugget N2-IX
Output Range	0 to 5.0V	0 to 3.3V

**Pull-Up Resistance**

Input	SilverNugget N2-xx-04-EE	SilverNugget N2-IX
1	4.7K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
2	4.7K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
3	4.7K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
4	~200K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
5	~200K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
6	~200K	~100K when pullup off, 2.2k to 0v or 3.3v programmable
7	~200K	~1MΩ pull down when pullup off, 2.2k to 0v or 3.3v programmable

**Sinking or Sourcing Limits**

Output	SilverNugget N2-xx-04-EE	SilverNugget N2-IX
1	5mA	2mA
2	5mA	2mA
3	5mA	2mA
4	5mA	2mA
5	5mA	2mA
6	5mA	2mA
7	5mA	2mA

**Analog Inputs**

	SilverNugget N2-xx-04-EE	SilverNugget N2-IX
Total Available Analog Inputs	4	7
Range	0 to 5.0V	0 to 3.3V
Number of Bits	10	12
Resolution	4.88mV	0.805mV
Data range when read into a register	0-32767	0-32760
0 to +10V input	N/A	Available on I/O #7, separate analog channel scaled to 0-10v

## Primary Encoder Support

### Encoder Index

SilverNugget N2-IX supports standard, single index pulse encoders as well as QCI's special 49 index encoder. This is soft configured at initialization time. The SilverNugget N2-xx-04-EE required separate firmware for the 49 index encoders.

### Encoder Resolution Reduction

SilverNugget N2-IX supports a user configurable encoder resolution reduction via our QuickControl software through the Initialization Wizard. Separate part numbers (i.e. F2, F4) are no longer needed to call out an encoder resolution reduction.

## Secondary Encoder Support

### Select External Encoder (SEE)

#### Index Source

- 0 = I/O #6
- 1 = I/O #3 (not supported in N2-IX)
- 2 = Enable Internal Encoder onto I/O# 4, 5, and 6.

#### Encoder Style

- 0 = A/B Quad on I/O# 4 & 5
- 1 = Step Up/Down on I/O# 4 & 5 (not supported in N2-IX)
- 2 = Step & Direction on I/O# 4 & 5
- 3 = Step & Direction on I/O# 2 & 3 (not supported in N2-IX)
- 7 = Configure I/O# 4, 5, and 6 back into I/O.

### Enable Encoder Monitor (EEM)

EEM command outputs a buffered copy of the raw encoder signals onto I/O# 1, 2, and 3. For SilverNugget N2-IX, if the EEM command is enabled **and** the SEE command is enabled to output the internal encoder on I/O# 4, 5 and 6, then the encoder signals to I/O # 1, 2, and 3 are **inverted** so as to provide differential encoder output signals.

### Select Encoder Filter (SEF)

For SilverNugget N2-IX, Select Encoder Filter:

- 0 = 100ns filter
- 1 = 300ns filter (was 600nS for N2-xx-04-EE)

## Motor Driver

The SilverNugget N2-IX has a continuous per phase rating of 5 Amps. The SilverNugget N2-xx-04-EE's continuous per phase rating is 3.5 Amps. (Driver is rated to 6A, the connector is only rated to 5A). Minimum input voltage for full current is now 12.5v rather than 12v.

## Commands No Longer Supported

The following are commands not supported by SilverNugget N2-IX as the modulo encoder output function is not available in the N2-IX. The new ability to use ratios or high accuracy decimal scaling for the encoder following modes has made the hardware divisors no longer useful.

- Modulo Clear (MDC)**
- Modulo Set (MDS)**
- Modulo Trigger (MDT)**

## Part Numbers

silverNugget N2-IX Controller/Driver	
<b>Controller/Driver</b>	
QCI-N2-IX	<p><b>Standard:</b></p> <ul style="list-style-type: none"> <li>• 8-bit ASCII, Modbus® RTU, DMX512, 9-bit</li> <li>• 12.5v to 48v</li> <li>• RS-485 – multiple protocols</li> <li>• 7 LVTTTL I/O                             <ul style="list-style-type: none"> <li>○ All configurable as 0-3.3v analog inputs</li> </ul> </li> <li>• 1 Output supports PWM Out                             <ul style="list-style-type: none"> <li>○ Use QCI-BO-B1A to amplify to 0-5v</li> </ul> </li> <li>• 1 Input supports PWM In</li> <li>• SilverLode Multi-Function Interface (SMI) Port                             <ul style="list-style-type: none"> <li>○ DB15 High Density (Pin)</li> </ul> </li> <li>• Motor Interface Port                             <ul style="list-style-type: none"> <li>○ DB15 High Density (Socket)</li> </ul> </li> </ul>

## Contact Information

QuickSilver Controls, Inc.  
 990 N Amelia Ave  
 San Dimas, CA 91773  
 +1 (909) 599-6291 or (888) 660-3801  
 +1 (909) 599-6289 FAX  
[www.QuickSilverControls.com](http://www.QuickSilverControls.com)