SilverNugget N2 M-Grade

The SilverNugget is a servo controller/driver for NEMA 17 & 23 frame microstep motors.

SilverNugget N2 Datasheet: Stand Alone Servo Controller/Driver For NEMA 17 & 23 Frame Micro Step Motors

Model Numbers: N2
Series: E1, E5, M1 and M5

All specifications listed in this datasheet are believed to be free of errors. They are subject to change without notice.

The SilverNugget is a highly compact motion controller and amplifier for driving high pole count micro step NEMA 17 and 23 frame motors. With the addition of a high-resolution encoder and a bipolar micro step motor, the SilverNugget provides a high performance rotary positioning system. The SilverNugget has two integrated cables for interfacing with the primary encoder as well as the micro step motor. Once connected, the QuickControl software will guide a user through the SilverNugget encoder alignment and configuration process.

SilverNugget is specifically designed to drive 100 poles, 1.8° degree step motors. To best utilize the capabilities of the SilverNugget, select a motor that has been optimized for micro stepping.

SilverNugget Series Descriptions

E1 - Series includes the following:
*   7 I/O lines, input/output programmable
    Lines 4-7 can be setup as 0-5 VDC analog inputs
*   Selectable RS-232/RS-485 communications
*   8 bit ASCII or 9 bit binary protocols
*   32K byte internal nonvolatile memory
*   400 byte program execution buffer
*   Differential Encoder configuration

E5 – Series adds the following:
*   Driver enable line (replaces I/O line 3)

M1, M5 – Modbus® (no additional cost)
Same as E1 or E5 except 9 bit binary protocol is replaced with Modbus® protocol.

Wiring and Cable Specifications

Encoder Feedback Connection: 8-Wire Encoder Cable

Designation	Wire Color		Wire Gauge
Encoder +5V	Red		26 AWG
Encoder Gnd	Black		26 AWG
Encoder A+	White		26 AWG
Encoder A-	Yellow		26 AWG
Encoder B+	Green		26 AWG
Encoder B-	Blue		26 AWG
Z+ (index +)	Orange		26 AWG
Z- (index -)	Brown		26 AWG

- For a back mounted encoder, the encoder's A Channel should lead B Channel when the front motor shaft rotates clockwise.

Encoder Cable Specifications

Nominal Cable Diameter =	0.25 inches
Minimum Bend Radius =	1.8 inches
Each Wire Pair Has A Shield	
Shields Connected To SilverNugget Case	

Driver Winding Signals: 4-Wire Motor Cable

Designation	Wire Color		Wire Gauge
Winding A+	Red		20 AWG
Winding A-	Blue		20 AWG
Winding B+	Yellow		20 AWG
Winding B-	White		20 AWG
Drain †	Bare Wire		2x22 AWG ‡

Motor Cable Specifications

Nominal Cable Diameter =	0.24 inches
Minimum Bend Radius =	1.7 inches
Each Wire Pair Wrapped with Shield and 22 AWG Drain Wire	

† The Drain Wires and Shields, collectively called the Drain, are connected to the SilverNugget case. QCI recommends connecting the Drain to the micro step motor chassis.

‡ The Drain current rating is that of two 22 AWG wires in parallel.

Stepper Motor Wiring Configuration

Four Wire Bipolar Configuration

Ideally, the SilverNugget will be interfaced with a four wire bipolar motor. Then the SilverNugget four wire motor cable will match up with the leads from the micro-step motor. Although, the SilverNugget will work with motors that have more than 4 wires.
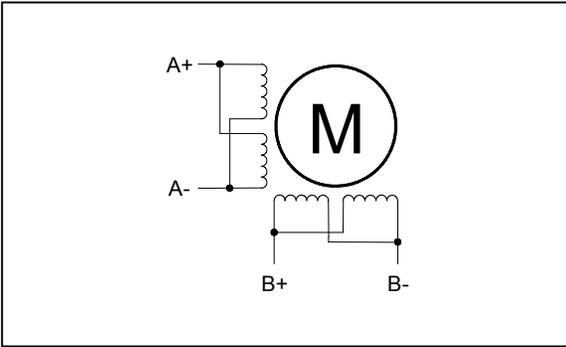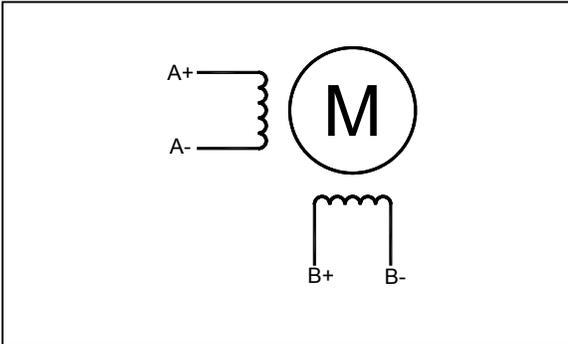
8 Wire Parallel Wiring Bipolar

Some bipolar micro step motors are manufactured with 8 wires. Typically, an eight wire motor is wired in a parallel configuration for use with the SilverNugget. However, a series wiring configuration is acceptable. Either configuration is perfectly legitimate to obtain the best motor characteristics and achieve optimum performance.
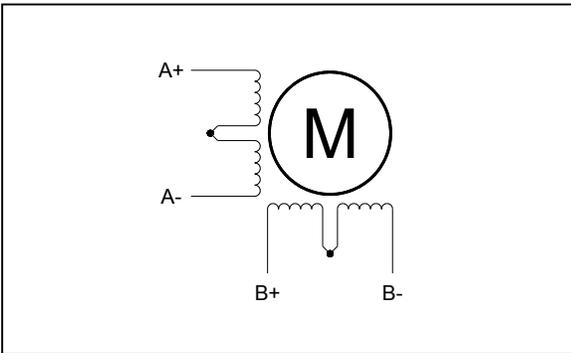
8 Wire Series Wiring Bipolar Configuration

Unipolar motors are not compatible with the SilverNugget.
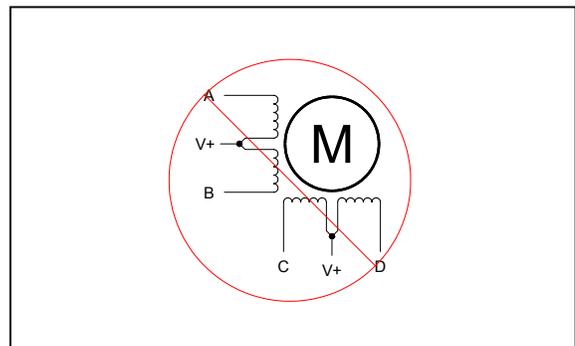
Unipolar Configuration

SilverNugget Cable Connector Options

SilverNugget Part Number Cabling Interface Designation:

BB04

- Cable lengths (ft)
- Encoder Connector
- Motor Connector
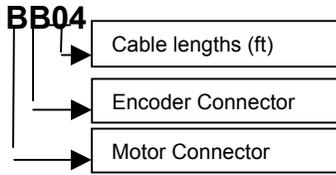
The first letter specifies the type of connector placed on the end of the motor cable. The second letter specifies the type of connector placed on the end of the encoder cable. Options for the motor and encoder cable are interchangeable. For example, ordering a SilverNugget, with the ABxx option, would mean the motor cable has flying leads and the encoder cable has a Molex connector.

Cable lengths are available from 1 foot to 25 feet in one foot increments. For longer lengths, contact QCI Support.

A – Cable has flying leads.
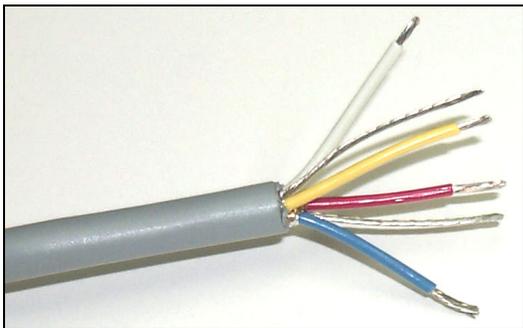
The AA option comes with flying leads on both the Motor and Encoder cables.

B – Molex Connector, with crimped pins, attached to end of cable.
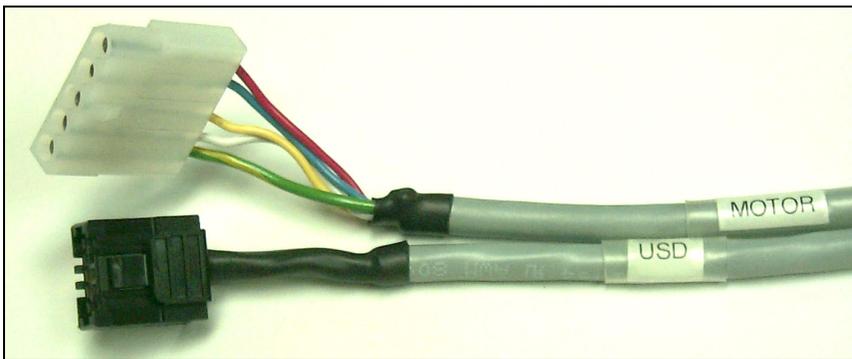
The BB option (standard SilverNugget option) comes with a Molex connector on each cable.

B Option on Encoder Cable
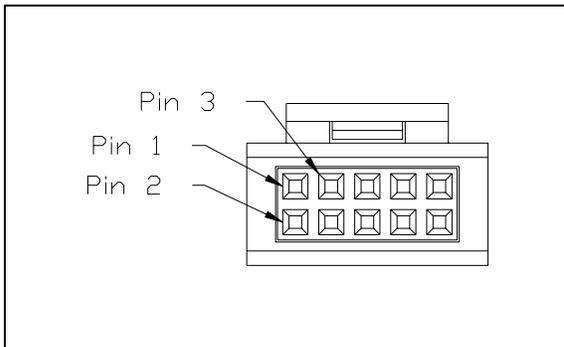
Encoder Cable Connector Face View.

Encoder Cable Connector Pinout

Pin Number	Signal	Wire Color
1	Not Used	
2	Encoder Gnd	Black
3	Z- (Index -)	Brown
4	Z+ (Index +)	Orange
5	Encoder A-	Yellow
6	Encoder A+	White
7	Encoder +5V	Red
8	Not Used	
9	Encoder B-	Blue
10	Encoder B+	Green

- The B option for the encoder cable interfaces with a US Digital 10 pin, dual row differential encoder connector.

Encoder Cable Connector Part Numbers

Description	Molex Part #	Series	Total Used
Housing	15-04-5104	70013	1
Insert	22-55-2103	70450	1
Female Pins	16-02-0104	70058	8

Mating Connector Part Numbers

Description	Molex Part #	Series	Total Used
Housing	50-65-0010	70022	1
Insert	22-55-2103	70450	1
Male Pins	16-02-0117	70021	8

- The 70058 and 70021 series pins, with 26 AWG wire, are rated for 1.8 Amps each.

Recommended Crimping Tool

Description	Molex Part #
Crimper	11-01-0208

B Option on Motor Cable
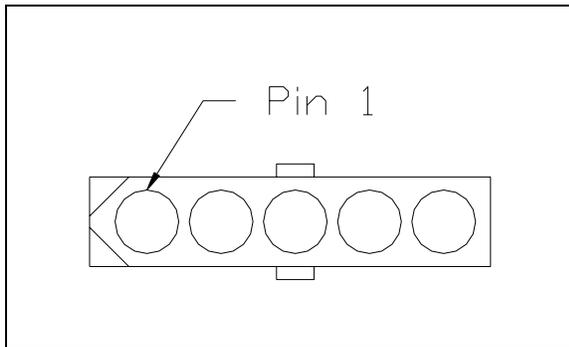
Motor Cable Connector Face View.

Motor Cable Connector Pinout

Pin Number	Signal	Wire Color
1	Winding A+	Red
2	Winding A-	Blue
3	Winding B+	Yellow
4	Winding B-	White
5	Chassis Gnd	Grn/Ylw

- A short length (approx. 1 inch) of 20 AWG wire is soldered between the Drain and the Chassis Ground Pin on the SilverNugget BB option motor connector.

Motor Cable Connector Part Numbers

Description	Molex Part #	Series	Total Used
Housing	03-09-1054	2629r	1
Female Pins	02-09-1119	1381	5

Mating Connector Part Numbers

Description	Molex Part #	Series	Total Used
Housing	03-09-2057	2629p	1
Male Pins	02-09-2118	1380	5

- The 1381 and 1380 series pins, in a five circuit housing with 20 AWG wire, are rated for 6 Amps each.

Recommended Crimping Tool

Description	Molex Part #	Series
Crimper	638-11-3200	63811

Typical Wiring Diagram:
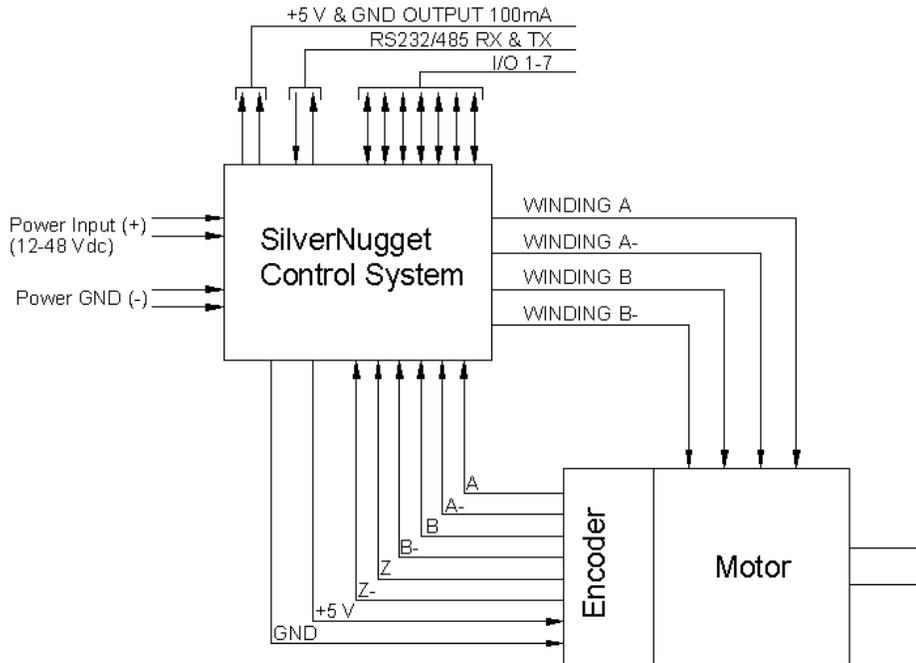
Typical System Setup:
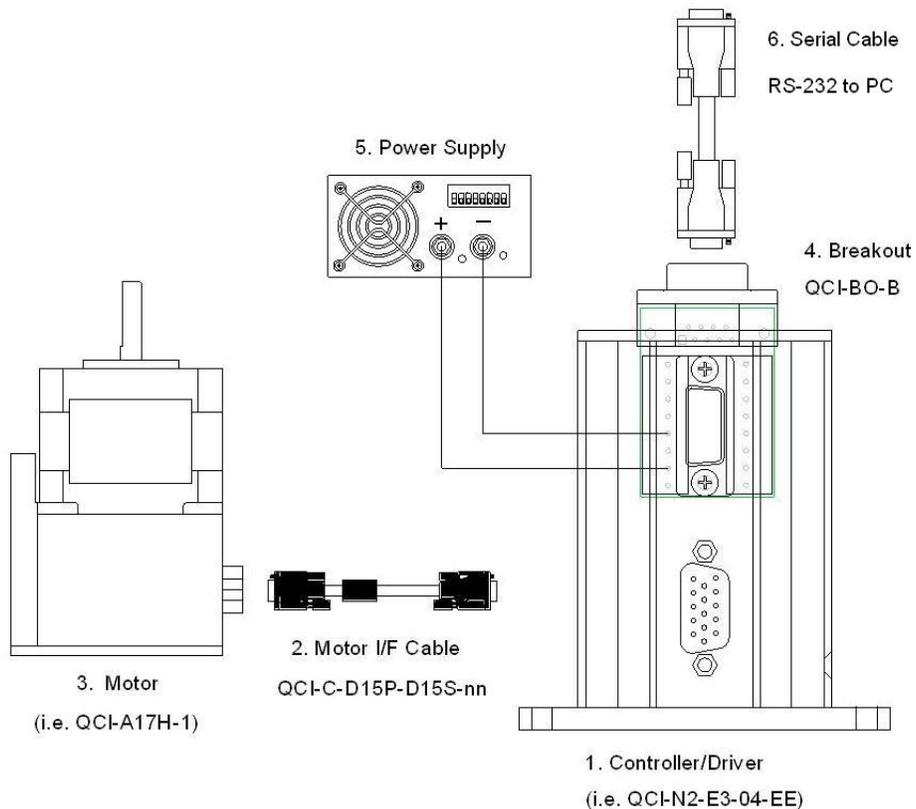
N2 SilverNugget Primary Connector Data

Standard N2 SilverNugget servo controller/drivers are designed with one main connector, a DB-15 for controller signals and input power. These are non-IP65 rated.

DB-15 Connector Description

This connector is found on all SilverNugget E series servo systems. On the N2 SilverNugget, the connector permits access to I/O lines, serial communications, controller power and the servo. It connects to all QCI DB-15 (SMI) cables for easy connection to QCI Accessory Products.

Technical Data (DB-15HD)

15-pin High Density D-subminiature, Plug (w/pins) type gender.
Crimp type contacts, Rated at 5 Amps per contact.
Max. wire gauge is 20 AWG, Shell size is a std. DB-9.

DB-15 Pin Layout
Front View on
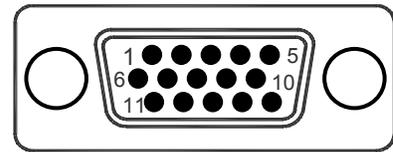
Pin #	Signal
6	Power Ground
1	+V (Input Power)
11	
7	
2	RS-485 A / RS-232 Tx
12	RS-485 B / RS-232 Rx
8	Logic Ground
3	+5 Volts @ 100mA
13	I/O #1
9	I/O #2
4	I/O #3
14	I/O #4
10	I/O #5
5	I/O #6
15	I/O #7

Input
LOAD Output

Signal Comments:

+V Input Power and Power Ground lines 1, 7, 6, and 11 are not reverse bias protected.

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.

** A Drive Enable option is available on 17 and 23 series servos. I/O line 3 becomes the drive enable signal line. In this configuration it has a 4.7k-Ohm pull-down resistor connected to the internal logic ground.

*** All Grounds are tied common and are connected to the SilverNugget case.

Electrical Specifications

<u>**Supply Power (Input)**</u>
Voltage: +12 VDC to +48 VDC, regulated.
Every SilverNugget must be initialized for the actual operating voltage.

Over-Voltage Protection: None available.
Voltages exceeding +55 VDC will permanently damage the controller/driver electronics.
Supply inputs may require active voltage clamping for aggressive braking/deceleration motions or applications with high inertial loads. See the Voltage Clamp Module technical document, QCI006TD, for more information on the voltage clamp. Contact QuickSilver Controls for application specific recommendations.

Reverse Polarity Protection: None available.
Connecting supply voltage in reverse can damage controller and the driver circuitry. However, limiting the supply current externally, to 5 Amps or less, will greatly minimize the chance of hardware failure.

Input Current: 4 Amps maximum for any input voltage, +12 VDC to +48 VDC.

<u>**Digital Inputs & Outputs**</u>
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.

Outputs: 0 or +5 VDC. TTL level only. ± 5 milliamps (sinking or sourcing).

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

<u>**External Encoder Inputs**</u>
Maximum Bandwidth: 1 million counts per second from a secondary encoder.

<u>**Analog Inputs**</u>
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 µsec.) and the converted analog data is processed through a 5 ms filter to reduce noise & transients.

Communications

Serial 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

Servo Control Specifications

Permissible Primary Encoder Resolutions

500   Lines = 2000   counts/revolution (minimum recommended resolution)
1000 Lines = 4000   counts/revolution
2000 Lines = 8000   counts/revolution
4000 Lines = 16000 counts/revolution
(Encoder resolutions up to 128,000 counts/revolution are possible, but untested.)

Primary Encoder Index or Z Channel

QCI highly recommends obtaining an encoder with an Index or Z channel for use with the SilverNugget. The index allows the SilverNugget to perform minor alignment corrections while in motion. While the SilverNugget will work without an index signal, complications can arise. For example, some encoder manufacturers use the same optical reader for encoders with and without an index. Therefore, the Z channel can potentially output a signal even though there isn't a true index. Contact QCI Support for further information on using an encoder without an index.

Maximum Rotational Speed

4000 Revolutions per Minute; limited in controller software.

Output/Driver Current

3.5 Amps continuous per phase *; 4.5 Amps peak per phase *.

    * With Adequate Heat Sink.

Maximum Output Power

150 Watts continuous power with adequate heat dissipation.

Typical Bipolar Micro Step Motor Parameters

NEMA Size	Minimum Winding Insulation Rating	Typical Phase Current Rating		Phase Winding Resistance		Phase Winding Inductance		Motor Constant K_m (V/rad/sec)		Rotor Inertia (oz-in^2)	
17 Frame	48 Volts	2 Amps	to 5.1 Amps	0.5Ω to	2.1Ω	0.7mH to	3mH	0.06 to	0.19	0.19 to	0.37
23 Frame	48 Volts	3.5 Amps to	5 Amps	0.25Ω to	1.2Ω	0.54mH to	5.7mH	0.1 to	0.52	0.74 to	2.35

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 (20 bytes)

Program Buffer Size: 200 words (400 bytes)

Non-Volatile Memory Size:
32K bytes (16K words): Standard on all N2 servos.

Environmental Specifications

Electronics Temperature Specifications

Operational: -10 C to +70 C

Storage: - 40 C to +85 C

Humidity

Continuous specification is 95% RH non-condensing.

Shock

Limitation is approximately 50g/11ms.

Mechanical Specifications:

Mechanical Dimensions

TOP VIEW — 3.22, 2.57

SIDE VIEW — 2.34

FRONT VIEW — 2.20, 1.99, 2.14, 0.15, HD DB-15 Connector
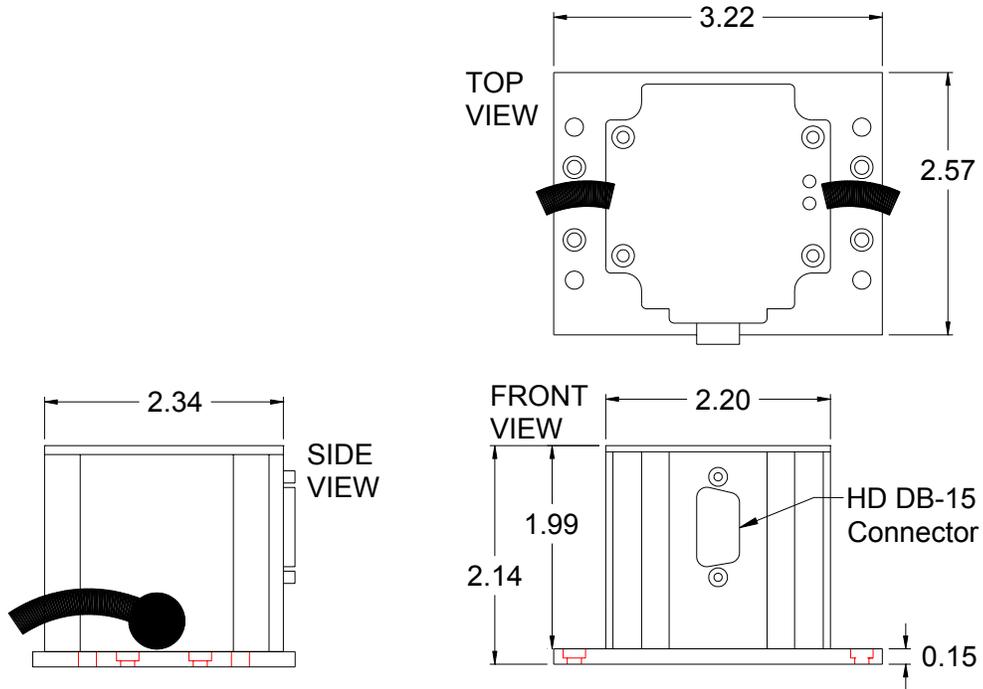
Weight including Cables
12 ounces (approx.)