GRADEPOINT™ RTK

GRADING DEMO KIT

SQ-CST-0408
2x NorthPoint™ Navigators, Coupled RTK-GNSS and INS with Kinematic Aiding, AHRS, Rugged, J1939

SQ-NPG-0038 and SQ-NPG-0040

DESCRIPTION

The GradePoint™ RTK Grading Demo Kit contains two NorthPoint™ Navigators mounted to a rigid bar to facilitate installation and setup. When connected to a SitePoint™ local base, grading accuracy of < 2 cm vertical height can be achieved with update rates of 100 Hz, enabling a reliable, one-step grading system, greatly simplifying small machine, small site grading applications.

The NorthPoint™ computes a fast, low latency RTK-GNSS and INS integrated navigation solution (Position, Velocity and Attitude), ideal for real-time machine control where fast response time is critical for safety and performance. It maintains accuracy even in the presence of high shock, magnetic interference, acceleration, and vibration.

The system employs dual frequency, multi constellation RTK GNSS coupled with a high-stability, temperature compensated ceramic packaged MEMS IMU for excellent long-term performance and reliability.

The RTK GNSS-INS and active antenna are fully integrated in an extremely rugged waterproof housing, greatly simplifying system architecture, and increasing overall reliability. Multiple sensors can be daisy chained together on the CAN bus to create large measurement systems.

KEY FEATURES

- **High Vertical Accuracy Grading**
- **Static and Dynamic Heading**
- **Fast 3D Position, Pitch, Roll, Yaw**
- **Fully integrated GNSS, INS and Antenna**
- **Configurable as Rover or Base**
- **RTCM Corrections via CAN Bus or Bluetooth (BLE)**
- **Daisy Chain Sensors**

SPECIFICATIONS OVERVIEW

Parameter	Specification
Measurement axes	6 degrees of freedom (6DOF)
Relative position accuracy (local base)	0.7 cm (1-σ, horizontal) 1.4 cm (1-σ, vertical)
Dynamic orientation angle accuracy (pitch, roll, yaw)	0.1° (1-σ, 1-meter baseline)
Shock, acceleration and vibration use conditions	▪ 1 *g*RMS random vibration 5 Hz to 500 Hz ▪ 1 *g* acceleration 1 second ▪ 20 *g* ½ sin 10 mSec ▪ 100 *g* ½ sin 0.1 mSec
Output rate	100 Hz (coupled GNSS + INS), 8 Hz (GNSS alone)
Temperature range	-40 º to 85 º C
Voltage	5 – 36 V
Current	110 mA typ. @ 13.6 VDC
Protection	IP68/69K

MEASUREMENTS

- **IMU (3-axis acceleration and 3 axis angular rate)**
- **X, Y, Z Position**
- **X, Y, Z Velocity**
- **Pitch, Roll, Heading**

DESIGNED FOR HEAVY VEHICLES

- Primary tier 1 supplier to more than half of the world's leading heavy vehicle OEMs

- Specifically designed, tested, and qualified to meet the unique environmental operating requirements of commercial, construction, military, agricultural and mining vehicles.

SQ-CST-0408 kit (SQ-NPG-0038 and SQ-NPG-0040 mounted on an aluminum bar).

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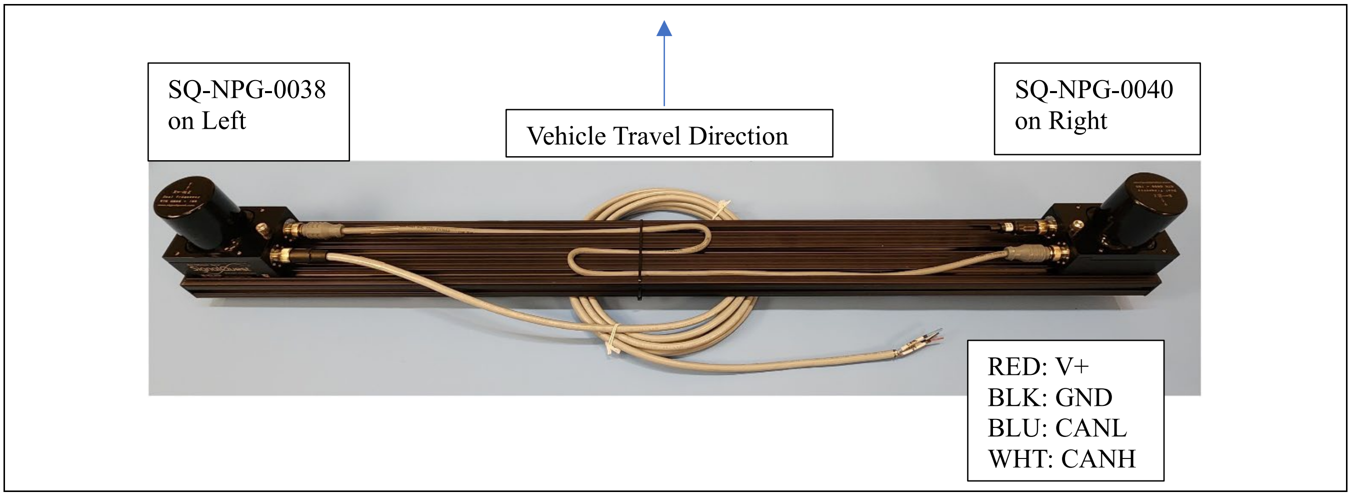
SYSTEM OVERVIEW



Two SQ-NPG sensors mounted on aluminum bar with magnet mounting under bar.

SYSTEM CONTENTS

- **SQ-NPG-0038**
  - Relays RTK aiding from NTRIP phone App., or SignalQuest SQ-SPT-0022 Local base (Bluetooth) to CAN bus network.
  - Provides measurements required for heading calculation on the other sensor.
- **SQ-NPG-0040**
  - Provides positioning and attitude of the system on the CAN bus network.
- Magnet mount base mounting bar
  - Positive stops for sensor positioning at end of bar.
  - 1/4-20 bolts to mount each sensor.
  - Adjustable magnet mount base
- M12 (flying lead) x M12 (F) 5M cable
  - Connects between SQ-NPG-0038 sensor and customer’s CAN controller.
- M12 (F) x M12 (M) 1M cable
  - Connects between SQ-NPG-0038 and SQ-NPG-0040 sensors.
- M12 (F) CAN Terminator
  - Provides 120 ohm CAN terminator at end of daisy chain.

SYSTEM CONFIGURATION

Configuration		**SQ-NPG-0038 (Bluetooth + CAN)**	**SQ-NPG-0040 (CAN Only)**
Device Address		C5	C4
Base Address		C3	C5
Orientation		05	07
Baud Rate		1000k	1000k
Soft Terminator		Disabled	Disabled
GNSS Mode		Rover	Rover
INS Lever Arm		N/A	X = -835 mm Y = 0 mm Z = 0 mm

DATA GROUP MESSAGES (NN = C4 FOR INS SENSOR)

This sensor transmits its measurements in a group of messages, back-to-back. The messages in the group are queued for transmission so higher priority traffic on the CAN bus may be transmitted seamlessly, and messages from other devices may be interleaved due to priority. Each group is sent in order and consists of the following messages:

J1939 PGN	CAN Message ID	Name	Data Field
65280	0x18FF00nn	Header Message	Byte 1: Group Counter (Increments from 0 to 255 and rolls over) Byte 2: Valid/Stale Bit Mask (bit clear indicates stale or invalid data) Bit 0: High Precision Latitude (PGN 65281) Bit 1: High Precision Longitude (PGN 65282) Bit 2: High Precision Height (PGN 65283) Bit 3: Relative North (PGN 65284) Bit 4: Relative East (PGN 65285) Bit 5: Relative Down (PGN 65286) Bit 6: Relative Base Line Length (PGN 65287) Bit 7: Reserved Byte 3~8: UTC time, derived from GPS System Time unsigned 48-bit integer in Seconds x10^3
65281	0x18FF01nn	High Precision Latitude	Byte 1~8: signed 64-bit integer, in degrees x10^9, negative is South
65282	0x18FF02nn	High Precision Longitude	Byte 1~8: signed 64-bit integer, in degrees x10^9, negative is West
65283	0x18FF03nn	High Precision Height	Byte 1~8: signed 64-bit integer, in meters x10^4
65284	0x18FF04nn	Relative North	Byte 1~4: Relative North pos, signed 32-bit integer in meters x10^4, negative is South Byte 5~8: Confidence 1 σ, unsigned 32-bit integer in meters x10^4
65285	0x18FF05nn	Relative East	Byte 1~4: Relative East pos, signed 32-bit integer in meters x10^4, negative is West Byte 5~8: Confidence 1 σ, unsigned 32-bit integer in meters x10^4
65286	0x18FF06nn	Relative Down	Byte 1~4: Relative Down pos, signed 32-bit integer in meters x10^4, negative is Up Byte 5~8: Confidence 1 σ, unsigned 32-bit integer in meters x10^4
65287	0x18FF07nn	Relative RTK Base-Line Length	Byte 1~4: Relative Length, signed 32-bit integer in meters x10^4 Byte 5~8: Confidence 1 σ, unsigned 32-bit integer in meters x10^4 NOTE: The value in never less than 0.010 meters
65289	0x18FF09nn	Acceleration (Accelerometers)	Byte 1~2: X-accel, signed 16-bit integer, in *g*'s x10^3. Byte 3~4: Y-accel, signed 16-bit integer, in *g*'s x10^3. Byte 5~6: Z-accel, signed 16-bit integer, in *g*'s x10^3. Byte 7~8: reserved
65290	0x18FF0Ann	Angular Rates (Gyros)	Byte 1~2: X-gyro, signed 16-bit integer, in deg/sec x10^1. Byte 3~4: Y-gyro, signed 16-bit integer, in deg/sec x10^1. Byte 5~6: Z-gyro, signed 16-bit integer, in deg/sec x10^1. Byte 7~8: reserved
65300	0x18FF14nn	INS Position Confidence	Byte 1~2: North 1 σ, unsigned 16-bit integer, in meters x10^3 Byte 3~4: East 1 σ, unsigned 16-bit integer, in meters x10^3 Byte 5~6: Down 1 σ, unsigned 16-bit integer, in meters x10^3 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)

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J1939 PGN	CAN Message ID	Name	Data Field
65302	0x18FF16nn	INS Attitude Confidence	Byte 1~2: Roll 1 σ, unsigned 16-bit integer, in degrees x10^2 Byte 3~4: Pitch 1 σ, unsigned 16-bit integer, in degrees x10^2 Byte 5~6: Yaw/Heading 1 σ, unsigned 16-bit integer, in degrees x10^2 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)
65292	0x18FF0Cnn	Trailer/Status	Byte 1: Group Counter (Increments from 0 to 255 and rolls over) Byte 2: Current Number of Satellites in use Byte 3~4: DOP (Dilution of Precision) x10^2 Byte 5: Bluetooth RTCM corrections received in last 10 seconds, unsigned 8-bit integer (ranging from 0 to 10) Byte 6: Status flags: Bit 0: Differential Mode 1 = GNSS is being aided with Differential Corrections Bit 1: Valid Fix 1 = Valid Bit 2~3: RTK Ambiguity 0 = No RTK 1 = Float RTK operation 2 = Fixed RTK operation Bit 4~7: GNSS Fix Type 0~1 = No Fix 2 = 2D Fix 3 = 3D Fix 4 = GNSS 5 = Fixed Base Mode (aka 'Time Only') Fix Byte 7: Status flags: Bit 0~1: Reserved Bit 2: Survey In Failed 1 = Survey In Operation Failed Bit 3: Survey In Position Valid 1 = Survey In Operation Completed Bit 4: Survey In Busy 1 = Survey In Busy Bit 5: Reserved Bit 6: Position Valid 1 = Relative North, East and Down Position is valid Bit 7: Valid Time 1 = UTC Time is Valid (Derived from GNSS Time) Byte 8: Reserved

Note that all multi byte values are Least Significant Byte first.

INS Position, Velocity and Attitude (PVA) Data Group Messages (nn = C4 for INS Sensor)

These messages are transmitted with minimum latency after the INS PVA solution becomes available. The timestamp reflects the Time of Validity (TOV) of the PVA solution (derived from the 1 PPS GNSS signal).

Typically, 100 Hz, programmable Rate Decimation is available.

J1939 PGN	CAN Message ID	Name	Data Field
65360	0x18FF50nn	UTC Timestamp	Byte 1~6: UTC time, derived from GPS System Time unsigned 48-bit integer in Seconds x10^3 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)
65361	0x18FF51nn	INS North (RTK if INS unavailable)	Byte 1~4: Relative Position, signed 32-bit integer in meters x10^4 Byte 5~8: Velocity, signed 32-bit integer in meters x10^3
65362	0x18FF52nn	INS East (RTK if INS unavailable)	Byte 1~4: Relative Position, signed 32-bit integer in meters x10^4 Byte 5~8: Velocity, signed 32-bit integer in meters x10^3
65363	0x18FF53nn	INS Down (RTK if INS unavailable)	Byte 1~4: Relative Position, signed 32-bit integer in meters x10^4 Byte 5~8: Velocity, signed 32-bit integer in meters x10^3
65364	0x18FF54nn	INS Attitude	Byte 1~2: Roll, signed 16-bit integer, in degrees x10^2 Byte 3~4: Pitch, signed 16-bit integer, in degrees x10^2 Byte 5~6: Yaw/Heading, unsigned 16-bit integer, in degrees x10^2 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)
65365	0x18FF55nn	Delta Theta	Byte 1~2: X Angle, signed 16-bit integer, in degrees x10^4 Byte 3~4: Y Angle, signed 16-bit integer, in degrees x10^4 Byte 5~6: Z Angle, signed 16-bit integer, in degrees x10^4 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)
65366	0x18FF56nn	Delta V	Byte 1~2: X, signed 16-bit integer, in m/s x10^4 Byte 3~4: Y, signed 16-bit integer, in m/s x10^4 Byte 5~6: Z, signed 16-bit integer, in m/s x10^4 Byte 7: Factory Use Byte 8: Group Counter (Increments from 0 to 255 and rolls over)

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CAN Configuration

PGN 61184 (0x00EF00) PDU1 Sensor Configuration Commands:

Setting	PGN [Message ID*]	Function Code**+++	Index	R/W bit	Size	Data Range	Units	Comments
Device Address	0x18EFddss [dd = Destination, ss = Source]	0x010014E0 0x810014E0	0x0014E0	Read (0) Write (1)	1	0x80 ~ 0xFB Factory Default: 0xC3 or 0xC4 or 0xC5	N/A	Sensor will store the new address to non-volatile memory, reboot and attempt to claim the new address, following the claim procedure described above. No other reply is generated when this value is written, instead the J1939 address claim message is transmitted. **NOTE:** It is not necessary to issue a 'SAVE' Settings command after writing this value. Values above 0xF7 (247) are discouraged as these are special purpose J1939 addresses. [**NOTE:** This command will accept a legacy size value of 2.]
Base Address	0x18Efddss	0x010014E1 0x810014E1	0x0014E1	Read (0) Write (1)	1	0x80 ~ 0xFB Factory Default: 0xC3	N/A	BASE address is the Address that a Rover monitors to RTCM aiding broadcasts. If the BASE address equals the DEVICE address, the sensor becomes a BASE and will transmit RTCM aiding messages. Sensor will store the new address to non-volatile memory. **NOTE:** It is not necessary to issue a 'SAVE' Settings command after writing this value. (Values above 0xF7 (247) are discouraged as these are special purpose J1939 addresses.) Note that all Sensors can have their BASE address assigned simultaneously by writing to the J1939 Global Address (0xFF). [**NOTE:** This command will accept a legacy size value of 2.]

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Setting	PGN [Message ID*]	Function Code**+++	Index	R/W bit	Size	Data Range	Units	Comments
Orientation	0x18Efddss	0x010014DC 0x810014DC	0x0014DC	Read (0) Write (1)	1	4 ~ 7 Factory Default: 0	N/A	Set or Read the Sensor Orientation. See the section titled "ORIENTATION CONFIGURATION CHART". There are 4 different valid settings. The setting must be 'SAVE'ed, and the sensor power-cycled or reset ('COLD' command) before the new orientation takes effect.
Baud Rate	0x18Efddss	0x010014E4 0x810014E4	0x0014E4	Read (0) Write (1)	1	0 ~ 3 Factory Default: 3	N/A	3=250K 0=1000K Currently only 250K and 1000K supported. Requires SAVE command. Note that the CAN Baud Rate will not change until Power to the sensor is cycled, or the unit is software rebooted using the 'COLD' boot command. **NOTE:** It is not necessary to issue a 'SAVE' Settings command after writing this value. All units on the bus can have their Baud Rates changed, and the entire system can then be restarted.
Terminator	0x18Efddss	0x010014E5 0x810014E5	0x0014E5	Read Write	1	0x00 or 0x01 Factory Default: 0x01	N/A	0x00 to ENABLE the built-in CAN terminator 0x01 to DISABLE the built-in CAN terminator **NOTE:** This setting must be 'SAVE'ed, and the sensor power-cycled or reset before the terminator is enabled or disabled.
Cold Boot	0x18Efddss	0x80FFFFF0	0xFFFFF0	Write Only	0	"COLD" (0x43 0x4F 0x4C 0x44)	N/A	Reboots the sensor as if it were power cycled. No reply is generated when this command is sent. Note this message uses a unique layout and message size of '0'.

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Setting	PGN [Message ID*]	Function Code**+++	Index	R/W bit	Size	Data Range	Units	Comments
Save to Non-Volatile Memory	0x18Efddss	0x80FFFFF0		Write Only	0	"SAVE" (0x53 0x41 0x56 0x45)	N/A	Saves all settings listed in this table, except Device Address, to non-volatile memory. No reply is generated when this command is sent. Note this message uses a unique layout and message size of '0'.

* The required CAN Message ID is: [(Priority<<26) + (PGN<<8) + (Destination<<8) + Source]
** The Function code is the composite of the Index R/W bit and Size. [Function Code = (R/W<<31) + (Size<<24) + Index]
+++ Note that the use of 0xAn/0x2n instead of 0x8n/0x0n in the Function code is permitted for consistency with legacy commands in other products. 0x8n/0x0n is the correct value, since bit 6 (0x20) is ignored because it is one of the 'Spare' bits.

GNSS CONFIGURATION

GNSS Constellations and Update Rates

Constellations	ROVER Update Rate
GPS, GLONASS, GALILEO, BeiDou	8 Hz (RTK) 100 Hz (INS)

LIMITATIONS AND WARNINGS

TESTING

The performance of each system is verified through build-time testing. Each system is tested before and after factory calibration to ensure reliable performance.

SYSTEM INTEGRATION TESTING

Thorough testing should be carried out prior to product release to ensure system integration has not introduced unforeseen problems. The system integrator assumes the ultimate responsibility for the safety of the target application.

NOTICE

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REVISION TABLE SQ-CST-0408

Rev. #	Rev. Date	Revised By	Description	Lot Numbers
A	2023-09-08	SER	Created from CST-0397 Rev C Datasheet	
B	2023-09-14	CAS	Page 1 consistency revisions	

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