ENGINEERING CHANGE NOTIFICATION FORM

ECN: 80200568	REV: 1	ISSUE DATE: 6/12/2018

TYPE OF CHANGE: Firmware Modification

DETAILED DESCRIPTION OF CHANGE:
Firmware release 0.74 for CSAC boards includes multi-GNSS support and configuration, dynamic servo loop settings and auto mode for monitoring and switch, and bug addressing related to 1PPS offset jump, NMEA time parsing, and UTC time update issues.

REASON FOR CHANGE:
Functionality improvements, added features and bug fixes.

PRODUCTS AFFECTED:

Firmware Version	Model
Firmware 0.73 and previous versions for CSAC	CSAC [1] HD CSAC, HD CSAC LP [1] LN CSAC [2] DROR-IIA [2]

Notes:
[1] Requires CSAC GPSDO firmware variant
[2] Requires LN CSAC firmware variant

AVAILABILITY:

MILESTONE	DATE
ECN release for firmware release files	6/12/2018

Release 0.74 for CSAC based boards provide the following added features:

1. Concurrent-GNSS Capabilities

Beginning in Q3 2018 Jackson Labs Technologies, Inc. will ship CSAC units with the new NEO-M8 and LEA-M8 GPS receivers. This upgrade allows concurrent GNSS capability. Firmware version 0.74 will auto-detect the GNSS receiver type, and older boards with LEA/NEO-6 GPS receivers are fully compatible to firmware 0.74, but do not support concurrent GNSS capability.

Firmware 0.74 or later with uBlox-8 receivers is capable of simultaneously receiving up to three concurrent GNSS systems at one time. Concurrent GNSS operation aids performance by allowing reception of up to 72 GNSS satellites in challenged reception areas such as in urban canyons, under foliage, indoors, or close to the earth's poles, etc. Using multiple GNSS systems also increases robustness by not relying on a single GNSS system. Several of the systems operate at different carrier frequencies, so using multiple GNSS systems can increase immunity against jamming which often occurs at only one carrier frequency.

The multiple GNSS systems each have their own reference time and representation of UTC. For example, GPS uses the GPS time standard and provides a method to convert GPS time to UTC as defined by the US Naval Observatory (USNO). GLONASS, Galileo and BeiDou have similar reference times and UTC definitions. The unit with multi-GNSS support automatically adjusts for offsets between the different GNSS time reference standards and synchronizes the 1PPS output to UTC (USNO) when GPS is being received. If GPS is not being received, the 1PPS output is synchronized to the best representation of UTC (USNO) available.

The selection of GNSS systems is made with the GPS:SYST:SEL command as detailed below. Because these systems operate at different carrier frequencies with different bandwidths, it is necessary to use a GNSS antenna that is designed to receive all the required GNSS systems. Please note that the new and emerging Galileo system is now functional, and uses the same carrier frequency as GPS L1, albeit with a wider bandwidth. In our experience Galileo sats can be received with good C/No carrier to noise figures (>40dB) with standard legacy GPS antennae and distribution amplifiers/splitters. JLT thus recommends enabling at a minimum GPS, Galileo, and SBAS concurrently with the command: GPS:SYST:SEL GPS GAL SBAS, see also below. Using other GNSS systems such as Glonass will require an antenna system designed to support Glonass signals.

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The internal GNSS receiver can track up to three different GNSS systems concurrently, such as GPS, Galileo, Glonass, and SBAS at the same time, however only two different carrier frequencies may be received at any given time, so BeiDou and Glonass cannot be enabled concurrently when either GPS, Galileo, or QZSS are simultaneously enabled as that would require tracking three different carrier frequencies. Attempting to configure an invalid combination of GNSS systems with the GPS:SYST:SEL command will result in a Command Error response with no change to the configuration.

2. GPS:SYSTem:SELect [GPS | SBAS | QZSS | GAL | BD ^ GLO]

This command selects the GNSS systems that are enabled in the GNSS receiver and are used to generated the timing and positioning information for the NMEA data, and to generate the 1PPS reference for the GNSDO. The command is followed by a list of the shortened names of the GNSS systems to enable. The shortened names of supported GNSS system include GPS, SBAS, QZSS, BD (BeiDou), GAL (Galileo) and GLO (GLONASS). Please see above for restrictions on the concurrent GNSS systems that can be enabled. Invalid combinations of GNSS systems will result in a Command Error response and no change to the configuration.

The following example command will enable GPS, SBAS, Galileo and GLONASS all concurrently:

```
GPS:SYST:SEL GPS SBAS GAL GLO
```

The following command will query the currently enabled GNSS systems:

```
GPS:SYST:SEL?
```

The unit with multi-GNSS support will respond to the query with the list of enabled GNSS systems such as:

```
GPS SBAS GAL GLO
```

3. Dynamic loop parameter adjustment

All loop parameters can be controlled via the serial ports. Firmware 0.74 offers two different phase loop time constants for the filter oscillator loop to accommodate different mission scenarios (stationary versus mobile, steady state operation versus power cycling, etc.). These time constants determine the behavior of the unit during steady state operation, and when a frequency error is induced into the filter oscillator by adverse environmental effects such as tilt/shock of the unit, or due to thermal shocks.

The loop adjustments typically include a NORMAL/FAST time constant options set with the SERVo:MODE command described below. The following table shows typical parameter settings for CSAC based boards:

Table 1: Recommended Loop Settings

Usage	Normal Time Constant	Fast Time Constant
Loop Behavior	benign	aggressive
SERV:EFCS	0.6	2.0
SERV:PHASECO	1.2	10.0
SERV:EFCD	10	5

4. SERVo:MODE <AUTO| NORMal | FAST | OFF>

This command allows auto-setting of all of the servo loop parameters to factory-default values as described above with one single command entry. This command is useful in setting the filter loop time constants for different mission profiles to accommodate different usage scenarios of the product. The loop time constant of the CSAC can be chosen with these settings. The AUTO mode lets the firmware determine by itself which loop time constant is used, thus optimizing the units' performance dynamically depending on the environmental effects on the CSAC. The AUTO setting will quickly react to phase perturbations and will try to set NORMAL settings (long time constant) whenever the unit is in stable conditions to minimize residual noise, and to improve the ADEV performance of the filtered output as much as possible for a particular environment. NORMAL settings are useful in stationary applications, whereas FAST settings are preferred for mobile applications such as in vehicles, man-packs, or aircraft.

The SERVo:MODE? query command responds with the current setting. If SERVo:MODE OFF is sent or in factory-default settings, the SERVo:MODE? query will result in a Command Error response. By default, the servo mode is disabled and NORMAL settings are used.

5. SERVo:STATe?

This query responds with the current loop parameter settings, NORMAL or FAST. When the SERVo:MODE command is configured to AUTO, the SERVo:STATe? Query responds with the automatically selected loop parameter setting, NORMAL or FAST. If the servo mode currently in OFF setting, the SERVo:STATe? query will result in a Command Error response.

6. SERVo:EFCScale:FAST

Controls the Proportional part of the PID loop for FAST servo loop settings only. Changing this variable while response of SERVo:STATe? command is NORMAL will not change current operation of servo loop. Typical values are 0.7 to 6.0. Larger values increase the loop control at the expense of increased noise while locked. Setting this value too high can cause loop instabilities.

This command has the following format:
SERVo:EFCScale:FAST <float> [0.0 , 500.0]

7. SERVo:EFCDamping:FAST

Sets the Low Pass filter effectiveness of the DAC for FAST servo loop settings only. Changing this variable while response of SERVo:STATe? command is NORMAL will not change current operation of servo loop. Values from 2 to 50 are typically used. Larger values result in less noise at the expense of phase delay.

This command has the following format:
SERVo:EFCDamping:FAST <int> [2, 4000]

8. SERVo:PHASECOrrection:FAST

This parameter sets the Integral part of the PID loop for FAST servo loop settings only. Changing this variable while response of SERVo:STATe? command is NORMAL will not change current operation of servo loop. Loop instability will result if the parameter is set too high. Typical values are 10.0 to 30.0.

This command has the following format:
SERVo:PHASECOrrection:FAST <float> [-500.0, 500.0]

Release 0.74 for CSAC based boards provide the following improvements:

Issue 1:

The 1PPS offset jump may occur with abnormal EFC change.

Resolution:

Firmware 0.74 fixes the issue by normalizing the filter offset due to change of EFC values.

Issue 2:

The UTC time may be parsed incorrectly in NMEA sentences when valid UTC is not yet available from the uBlox receiver.

Resolution:

Firmware 0.74 fixes this issue.

Issue 3:

The UTC time will not update from start-up until a GPS fix and UTC time is available.

Resolution:

Firmware 0.74 fixes the issue by starting the RTC counter from zero upon start-up.

Issue 4:

The UTC time will not update during holdover with GPS fix.

Resolution:

Firmware 0.74 fixes this issue.

REFERENCE DOCUMENTS/ATTACHMENTS:

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