NavIC on OEM7

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Background

NavIC is the Regional Navigation Satellite System (RNSS) constellation operated by the India Space Research Organization (ISRO). NavIC is also known as Indian Regional Navigation Satellite System (IRNSS). For more information on NavIC, visit the NavIC home page.

As of May 2021, 8 NavIC satellites are transmitting, and 6 satellites are healthy. NavIC broadcasts on L5 (1176.45 MHz) and S (2492.028 MHz), and NovAtel OEM7 receivers track the L5 signal. ISRO has announced that NavIC will be expanded by 4 satellites in the future. Additionally, ISRO has announced a new signal will be broadcast on the L1 frequency (1575.42 MHz).

NavIC satellites are geostationary satellites (GEO) and inclined geosynchronous satellites (IGSO). NavIC is designed to provide service to India and the area covered by the 1500 km contour from the Indian geopolitical boundary. NavIC satellites are not in view in many parts of the world.

NovAtel OEM7 receivers track NavIC satellites and can be configured to use NavIC in positioning.

All information in this application note applies to the 7.08.00 firmware release.

Channel Configuration

To track NavIC satellites, the receiver must be configured to a channel configuration that includes NavIC. Here are the steps to check if the channel configuration has NAVIC, and to change it if necessary. An example is below. User input is highlighted in blue, and key fields are in yellow. Note that not all firmware models include NavIC channels. In 7.08.00, models starting with these three characters have NavIC channel configurations: FSN, FSD, FFN, MFN, MFD, JSN, JSD, JDN, JDD, JFN.

1. Check the CHANCONFIGLIST
   ```
   LOG CHANCONFIGLIST
   ```
2. Check which channel configuration is in use. This is the first number after the log header (the highlighted 3 below). The log format is here.
3. Check this channel configuration and see if it includes NAVICL5. If it does include NAVICL5, no change is required, and no more steps are necessary. In the below example, the 3rd channel configuration does not include NAVICL5.
4. Find a channel configuration that does include NAVICL5. That is highlighted in the 4th, 5th, 6th, 7th, 8th, and 9th channel configuration in the example below.
5. Change the channel configuration using the SELECTCHANCONFIG command. For the example, to use the 5th:
   ```
   SELECTCHANCONFIG 5
   ```
6. Note that a SELECTCHANCONFIG command will reset the receiver. To save the other configuration parameters before the reset, enter a SAVECONFIG command.

```
[COM1]LOG CHANCONFIGLIST

<OK
[COM1]<CHANCONFIGLIST COM1 0 74.0 FINESTEERING 2155 250873.379 03100008 d1c0
16304
<       3 9
<              7
<              16 GPSL1L2PL5
```

```
<              4 QZSSL1CAL2CL5
<              4 SBASL1
<              14 GLOL1L2
<              16 GALE1E5B
<              22 BEIDOUB1B2
<              5 LBAND
<              7
<              16 GPSL1L2
<              4 QZSSL1CAL2C
<              4 SBASL1
<              14 GLOL1L2
<              16 GALE1E5B
<              22 BEIDOUB1B2
<              5 LBAND
<              7
<              16 GPSL1L2PL2CL5
<              4 QZSSL1CAL2CL5
<              4 SBASL1
<              14 GLOL1L2PL2C
<              16 GALE1E5AE5BALTBOC
<              22 BEIDOUB1B2
<              5 LBAND
<              8
<              16 GPSL1L2PL2CL5
<              4 QZSSL1CAL2CL5
<              4 SBASL1L5
<              14 GLOL1L2PL2C
<              16 GALE1E5AE5BALTBOC
<              20 BEIDOUB1B1CB2B3
<              8 NAVICL5
<              5 LBAND
<              8
<              16 GPSL1L2PL2CL5L1C
<              4 QZSSL1CAL2CL5L1CL6
<              4 SBASL1L5
<              14 GLOL1L2PL2CL3
<              11 GALE1E5AE5BALTBOCE6
<              16 BEIDOUB1B1CB2B3
<              8 NAVICL5
<              5 LBAND
<              8
<              16 GPSL1L2PL2CL5
<              6 QZSSL1CAL2CL5
<              4 SBASL1L5
<              14 GLOL1L2PL2CL3
<              9 GALE1E5AE5BALTBOCE6
<              24 BEIDOUB1B1CB2B3
<              8 NAVICL5
<              5 LBAND
<              8
<              16 GPSL1L2PL2CL5
<              4 QZSSL1CAL2CL5
<              4 SBASL1L5
```

```
<         14 GLOL1L2PL2CL3
<         16 GALE1E5AE5BALTBOCE6
<         16 BEIDOUB1B1CB2B3
<         8 NAVICL5
<         5 LBAND
<         8
<         16 GPSL1L2PL2CL5
<         4 QZSSL1CAL2CL5L1CL6
<         4 SBASL1L5
<         14 GLOL1L2PL2CL3
<         11 GALE1E5AE5BALTBOCE6
<         20 BEIDOUB1B1CB2B3
<         8 NAVICL5
<         5 LBAND
<         8
<         16 GPSL1L2PL2CL5L1C
<         4 QZSSL1CAL2CL5L1C
<         4 SBASL1L5
<         14 GLOL1L2PL2CL3
<         16 GALE1E5AE5BALTBOC
<         20 BEIDOUB1B1CB2
<         8 NAVICL5
<         5 LBAND
[COM1]SELECTCHANCONFIG 5

<OK
```

Logs

For more information on the logs, including examples, visit the NovAtel OEM7 receiver documentation portal.

If a NavIC satellite is tracked, measurements including pseudorange, ADR, Doppler, C/No, and lock time can be viewed in the same logs as other GNSS/RNSS constellations:

- RANGE
- RANGECMP
- RANGECMP2
- RANGECMP4
- TRACKSTAT

NavIC navigation data is in these logs:

- NAVICALMANAC
- NAVICEPHEMERIS
- NAVICIONO
- NAVICRAWSUBFRAME
- NAVICSYSCLOCK

To see what NavIC satellites are used in positioning, use either of these logs:

- BESTSATS
- PSRSATS

To see what NavIC satellites are visible, use this log:

- SATVIS2

Note that in 7.08.00, there is not information about NavIC satellites in the BESTPOS log.

Different users will have different requirements. For most NavIC users, it is recommended to log at least:

```
LOG RANGEB ONTIME 1
LOG BESTPOSB ONTIME 1
LOG BESTSATSB ONTIME 10
LOG NAVICEPHEMERISB ONCHANGED
LOG NAVICALMANACB ONCHANGED
```

NMEA Logs

NavIC information is also available in some of the NMEA logs, including:

- GPGRS (GNGRS when multi-constellation)
- GPGSA (GNGSA when multi-constellation)
- GPGSV (NavIC is GIGSV)

To record NavIC information in NMEA logs, the NMEATALKER command must be used to allow multi-constellation output:

```
NMEATALKER AUTO
```

To include the system and signal type in GPGRS and GPGSA, configure to NMEA version 4.11 with the NMEAVERSION command:

```
NMEAVERSION V41
```

For most NMEA users, these commands and logs are recommended:

```
NMEAVERSION V41
NMEATALKER AUTO
LOG GPGSA ONTIME 1
LOG GPGSV ONTIME 1
```

Note that in 7.08.00, the NavIC system ID is reported as 5 and QZSS is 6. This is different than the user manual and the NMEA 0183 standard, so the firmware will be fixed in a future release. In the manual and the standard, QZSS is 5 and NavIC is 6.

RINEX Logs

NavIC information is included in RINEX files starting with version 3.03. To convert OEM7 logs to RINEX, use NovAtel Convert. Information on the logs to collect for a full RINEX dataset are in this RINEX application note. At a minimum, these logs are needed for NavIC in RINEX:

```
LOG VERSIONB ONCE
LOG BESTPOSB ONCE (Alternatives: PSRPOS or MARKPOS)
LOG RANGEB ONTIME 1 (Alternatives: RANGECMP, RANGECMP2 or RANGECMP4)
LOG NAVICEPHEMERISB ONCHANGED
LOG NAVICSYSCLOCKB ONCHANGED
LOG NAVICIONOB ONCHANGED
```

Commands

For more information on the commands, including examples, visit the NovAtel OEM7 receiver documentation portal.

Configuration commands specific to NavIC are:
- NAVICECUTOFF

Several commands that apply to other constellations also apply to NAVIC, including:
- ASSIGNALL
- DATADECODESIGNAL
- DLLTIMECONST
- DOPPLERWINDOW
- ELEVATIONCUTOFF
- ITSPECTRALANALYSIS
- LOCKOUTSYSTEM
- SETTIMEBASE
- TRACKSV
- UNLOCKOUTSYSTEM

The FRESET command has two NavIC specific options:
- FRESET NAVICEPHEMERIS
- FRESET NAVICALMANAC

For many users, no configuration commands are recommended. However, if using NavIC in the position solution is desired, more information the next section.

NavIC in Positioning

In all channel configurations except with a first character of J, NAVIC is locked out of positioning by default. To change this, the system must be unlocked with an UNLOCKOUTSYSTEM command:

```
UNLOCKOUTSYSTEM NAVIC
```

By default, for dual or multi-frequency models, the receiver determines the ionospheric corrections based on tracking multiple frequencies from the same satellite. This is the most accurate way to determine the ionospheric correction. For this reason, if the receiver is tracking multi-frequency signals, then by default it does not include satellites in positioning if only one signal is tracked. This is because it has not computed a multi-frequency ionospheric correction. For instance, if a receiver is tracking GPS L1, GPS L2, and NavIC L5, only the GPS L1/L2 measurements are used by default, since only one NavIC signal was tracked.

However, if the receiver has a single-frequency model or is not tracking any satellites on multiple frequencies, then by default it uses a different method to compute the ionospheric correction. In this case, it uses all healthy satellites in positioning. NavIC L5 would be used in this case, as long as UNLOCKOUTSYSTEM NAVIC was sent.

A user can change the ionospheric correction setting with the SETIONOTYPE command. One setting configures the receiver to use all healthy satellites in positioning even if it is only tracking one frequency (such as NavIC L5). To use this setting, enter this command:

```
SETIONOTYPE KLOBUCHAR
```

In summary, to use NavIC in positioning, enter these commands:

```
UNLOCKOUTSYSTEM NAVIC
SETIONOTYPE KLOBUCHAR
```

NavIC in Positioning Example

The section has an example of NavIC in positioning. The BESTSATS logs are shown so it is clear which satellites are being used. This example data was collected from a receiver in India with multi-frequency and all constellations. User input is highlighted in blue, and NavIC satellites in yellow. Here are the steps:

1. First, it has the default UNLOCKOUTSYSTEM and SETIONOTYPE settings for non-J models. NavIC satellites are marked LOCKEDOUT and not used.

2. Next, after `UNLOCKOUTSYSTEM NAVIC` but still with the default SETIONOTYPE setting. Most NavIC satellites are now marked NOIONOCORR and are not used.

3. Finally, with both `UNLOCKOUTSYSTEM NAVIC` and `SETIONOTYPE KLOBUCHAR`. Most NavIC satellites are marked GOOD and are used. At this time, two are broadcasting anomalous navigation data and are marked as NOEPHEMERIS.

```
[COM1]LOG VERSION

<OK
[COM1]<VERSION COM1 0 35.0 FINESTEERING 2155 336885.991 02000020 3681 16407
<     2
<         GPSCARD "FFNRNNCBE" "DMGW17140703X" "OEM719-1.02"
"OM7MR0800RN0000" "OM7BR0001RBG000" "2020/Oct/15" "14:04:36"
<         OEM7FPGA "" "" "" "OMV070001RN0000" "" "" ""
[COM1]LOG BESTSATS

<OK
[COM1]<BESTSATS COM1 0 35.0 FINESTEERING 2155 336557.000 02000020 be05 16407
<     51
<         GPS 16 GOOD 00000003
<         GPS 1 GOOD 00000003
<         GPS 27 GOOD 00000003
<         GPS 21 GOOD 00000003
<         GPS 22 GOOD 00000003
<         GPS 31 GOOD 00000003
<         GPS 25 GOOD 00000003
<         GPS 10 GOOD 00000003
<         GPS 26 GOOD 00000003
<         GPS 4 GOOD 00000003
<         GPS 3 GOOD 00000003
<         GPS 32 GOOD 00000003
<         QZSS 194 GOOD 00000003
<         QZSS 199 GOOD 00000003
<         QZSS 193 GOOD 00000003
<         GLONASS 14-7 GOOD 00000003
<         GLONASS 2-4 GOOD 00000003
<         GLONASS 18-3 GOOD 00000003
```

```
<          GLONASS 13-2 GOOD 00000003
<          GLONASS 12-1 GOOD 00000003
<          GLONASS 1+1 GOOD 00000003
<          GLONASS 24+2 GOOD 00000003
<          GLONASS 17+4 GOOD 00000003
<          GLONASS 3+5 GOOD 00000003
<          GALILEO 1 GOOD 00000009
<          GALILEO 31 GOOD 00000009
<          GALILEO 24 GOOD 00000009
<          GALILEO 4 GOOD 00000009
<          GALILEO 5 GOOD 00000009
<          GALILEO 36 GOOD 00000009
<          GALILEO 25 GOOD 00000009
<          GALILEO 9 GOOD 00000009
<          GALILEO 11 GOOD 00000009
<          BEIDOU 26 GOOD 00000011
<          BEIDOU 24 GOOD 00000011
<          BEIDOU 42 GOOD 00000011
<          BEIDOU 40 GOOD 00000011
<          BEIDOU 38 GOOD 00000011
<          BEIDOU 45 GOOD 00000011
<          BEIDOU 22 GOOD 00000011
<          BEIDOU 21 GOOD 00000011
<          BEIDOU 39 GOOD 00000011
<          BEIDOU 34 GOOD 00000011
<          NAVIC 1 LOCKEDOUT 00000000
<          NAVIC 2 LOCKEDOUT 00000000
<          NAVIC 3 LOCKEDOUT 00000000
<          NAVIC 4 LOCKEDOUT 00000000
<          NAVIC 5 LOCKEDOUT 00000000
<          NAVIC 6 LOCKEDOUT 00000000
<          NAVIC 7 LOCKEDOUT 00000000
<          NAVIC 9 LOCKEDOUT 00000000
[COM1]UNLOCKOUTSYSTEM NAVIC

<OK
[COM1]LOG BESTSATS

<OK
[COM1]<BESTSATS COM1 0 35.5 FINESTEERING 2155 336568.000 02000020 be05 16407
<      51
<          GPS 16 GOOD 00000003
<          GPS 1 GOOD 00000003
<          GPS 27 GOOD 00000003
<          GPS 21 GOOD 00000003
<          GPS 22 GOOD 00000003
<          GPS 31 GOOD 00000003
<          GPS 25 GOOD 00000003
<          GPS 10 GOOD 00000003
<          GPS 26 GOOD 00000003
<          GPS 4 GOOD 00000003
<          GPS 3 GOOD 00000003
<          GPS 32 GOOD 00000003
```

```
<          QZSS 194 GOOD 00000003
<          QZSS 199 GOOD 00000003
<          QZSS 193 GOOD 00000003
<          GLONASS 14-7 GOOD 00000003
<          GLONASS 2-4 GOOD 00000003
<          GLONASS 18-3 GOOD 00000003
<          GLONASS 13-2 GOOD 00000003
<          GLONASS 12-1 GOOD 00000003
<          GLONASS 1+1 GOOD 00000003
<          GLONASS 24+2 GOOD 00000003
<          GLONASS 17+4 GOOD 00000003
<          GLONASS 3+5 GOOD 00000003
<          GALILEO 1 GOOD 00000009
<          GALILEO 31 GOOD 00000009
<          GALILEO 24 GOOD 00000009
<          GALILEO 4 GOOD 00000009
<          GALILEO 5 GOOD 00000009
<          GALILEO 36 GOOD 00000009
<          GALILEO 25 GOOD 00000009
<          GALILEO 9 GOOD 00000009
<          GALILEO 11 GOOD 00000009
<          BEIDOU 26 GOOD 00000011
<          BEIDOU 24 GOOD 00000011
<          BEIDOU 42 GOOD 00000011
<          BEIDOU 40 GOOD 00000011
<          BEIDOU 38 GOOD 00000011
<          BEIDOU 45 GOOD 00000011
<          BEIDOU 22 GOOD 00000011
<          BEIDOU 21 GOOD 00000011
<          BEIDOU 39 GOOD 00000011
<          BEIDOU 34 GOOD 00000011
<          NAVIC 1 NOEPHEMERIS 00000000
<          NAVIC 2 NOIONOCORR 00000000
<          NAVIC 3 NOIONOCORR 00000000
<          NAVIC 4 NOIONOCORR 00000000
<          NAVIC 5 NOIONOCORR 00000000
<          NAVIC 6 NOIONOCORR 00000000
<          NAVIC 7 NOEPHEMERIS 00000000
<          NAVIC 9 NOIONOCORR 00000000
[COM1]SETIONOTYPE KLOBUCHAR

<OK
[COM1]LOG BESTSATS

<OK
[COM1]<BESTSATS COM1 0 41.0 FINESTEERING 2155 336594.000 02000020 be05 16407
<     51
<          GPS 16 GOOD 00000001
<          GPS 1 GOOD 00000001
<          GPS 27 GOOD 00000001
<          GPS 21 GOOD 00000001
<          GPS 22 GOOD 00000001
<          GPS 31 GOOD 00000001
```

```
<          GPS 25 GOOD 00000001
<          GPS 10 GOOD 00000001
<          GPS 26 GOOD 00000001
<          GPS 4 GOOD 00000001
<          GPS 3 GOOD 00000001
<          GPS 32 GOOD 00000001
<          QZSS 194 GOOD 00000001
<          QZSS 199 GOOD 00000001
<          QZSS 193 GOOD 00000001
<          GLONASS 14-7 GOOD 00000001
<          GLONASS 2-4 GOOD 00000001
<          GLONASS 18-3 GOOD 00000001
<          GLONASS 13-2 GOOD 00000001
<          GLONASS 12-1 GOOD 00000001
<          GLONASS 1+1 GOOD 00000001
<          GLONASS 24+2 GOOD 00000001
<          GLONASS 17+4 GOOD 00000001
<          GLONASS 3+5 GOOD 00000001
<          GALILEO 1 GOOD 00000001
<          GALILEO 31 GOOD 00000001
<          GALILEO 24 GOOD 00000001
<          GALILEO 4 GOOD 00000001
<          GALILEO 5 GOOD 00000001
<          GALILEO 36 GOOD 00000001
<          GALILEO 25 GOOD 00000001
<          GALILEO 9 GOOD 00000001
<          GALILEO 11 GOOD 00000001
<          BEIDOU 26 GOOD 00000001
<          BEIDOU 24 GOOD 00000001
<          BEIDOU 42 GOOD 00000001
<          BEIDOU 40 GOOD 00000001
<          BEIDOU 38 GOOD 00000001
<          BEIDOU 45 GOOD 00000001
<          BEIDOU 22 GOOD 00000001
<          BEIDOU 21 GOOD 00000001
<          BEIDOU 39 GOOD 00000001
<          BEIDOU 34 GOOD 00000001
<          NAVIC 1 NOEPHEMERIS 00000000
<          NAVIC 2 GOOD 00000004
<          NAVIC 3 GOOD 00000004
<          NAVIC 4 GOOD 00000004
<          NAVIC 5 GOOD 00000004
<          NAVIC 6 GOOD 00000004
<          NAVIC 7 NOEPHEMERIS 00000000
<          NAVIC 9 GOOD 00000004
```

Troubleshooting NavIC in Positioning

If NavIC isn't being used in positioning, the problem is very likely to be either the receiver configuration or tracking NavIC.

First, use the procedure in the Channel Configuration section above to ensure the receiver has NavIC channels.

Next, check the configuration in the RXCONFIG log to confirm these commands are present:

```
UNLOCKOUTSYSTEM NAVIC
SETIONOTYPE KLOBUCHAR
```

For example:

```
[COM1]LOG RXCONFIG

<OK
[COM1]<RXCONFIG COM1 3 43.5 FINESTEERING 2155 336563.608 02000020 f702 16407
<      UNLOCKOUTSYSTEM COM1 3 43.5 FINESTEERING 2155 336563.608 02000020 f702
16407
<      NAVIC
<RXCONFIG COM1 2 43.5 FINESTEERING 2155 336586.733 02000020 f702 16407
<      SETIONOTYPE COM1 2 43.5 FINESTEERING 2155 336586.733 02000020 f702
16407
<      KLOBUCHAR
```

If the receiver has NavIC and is configured for NavIC positioning, check the RANGE logs to ensure the NavIC satellites are tracked. If they are not tracked, the problem could be any of:

- NavIC satellites are not in view - ISRO defines an extended service area as an area enclosed by the rectangle from latitude 30 degrees south to 50 degrees north, longitude 30 degrees east to 130 degrees east.
- The sky is obstructed - confirm the antenna is outside, and there are no buildings blocking the sky.
- The antenna does not support L5 - 1176.45 MHz.
- The antenna cabling has a problem - confirm it is tracking other GNSS signals or test another cable.
- There is RF interference - check the ITDETECTSTATUS log to see if there is L5 interference.

NovAtel Support

To help answer questions and/or diagnose any technical issues that may occur, the NovAtel Support website is a first resource. Remaining questions or issues, including requests for temporary authorization codes, can be directed to NovAtel Support. To enable the online form and submit a ticket, first select a "Product Line" and then an associated "Product" from the list.

Documentation

Complete details on receiver installation, operation, and the logs and commands described in this application note can be found in the OEM7 Receiver Documentation Portal.

Contact Hexagon | NovAtel

support.novatel@hexagon.com 1-800-NOVATEL (U.S. and Canada) or 1-403-295-4900

For more contact information, please visit novatel.com/contact-us