MicroStrain by HBK Technical Note

3DM-GQ7
Current Firmware Upgrade

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Summary
This technical note details the most current firmware available for the MicroStrain by HBK **3DM-GQ7** inertial sensor. The technical note additionally describes firmware changes since the initial product release and the use of SensorConnect software to perform the firmware upgrade.

Detail
As we see in the table below, the current firmware for the model 6284-4220 **3DM-GQ7** is version **1.1.04**. This firmware is contained in the file object entitled **GQ7_Firmware_1104_b12.zhex**.

3DM-GQ7 Firmware

Firmware Version	ChangeLog
1.0.01	Initial Firmware Release
1.0.02	1. Added odometer scale factor state to EKF to improve speed measurement and added ODOMETER_SCALE_FACTOR_ERROR (0x8247) and ODOMETER_SCALE_FACTOR_ERROR_UNCERTAINTY (0x8248) data fields. 2. Modified GNSS preprocessing to improve tight coupling / RTK performance. 3. Removed oscillations in attitude under static conditions in Vertical Gyro/AHRS mode. 4. Initial gyro bias convergence improved. 5. Now accepts GPS Time Update command (0x0172) when the PPS source is anything but one of the internal receivers. 6. USB driver modified to stop sending data when no host is detected via SET_LINE_CONTROL_STATE packet. This fixes a communications failure issue in Linux and Windows when the host reboots and the device was in streaming mode. 7. LED behavior modified to be consistent given above USB driver change.
1.0.03	1. Fixed bug with DA float solution uncertainty not updating if the number of L2 measurements are below threshold. 2. Fixed an inaccuracy in the calculation of DA float update using inertial data. 3. Improved recovery time of poor dual antenna fix. 4. Modified Kalman filter reset code to: a) prevent filter divergence for large clock jumps (occasionally seen on power up after initial PPS lock), b) ensure complete reset, both major and minor cycle. 5. Modified filter data timestamp assignment so that timestamps are monotonic, even after reset (they were resetting to zero for one major cycle after reset). 6. Lowered residual warning threshold for dual antenna measurement.
1.0.04	Fixed estimation filter orientation matrix and quaternion to match DCP (were the inverse transformation.)

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1.0.05	1. Fixed field index and field count values for raw GNSS data fields (0x20 and 0x22) to reflect only transmitted data (disabled constellations aren't counted now). 2. Balanced DA float solution to rely less on L2, and to reduce reliance on initial measurements and reduce chance of outliers giving a bad initial fix. 3. Modified RTK processing to improve long baseline performance. 4. Added (0x82,0x49) filter data with clearer information regarding DA fix. 5. Updated warning flag conditions for error states (high bias/scale factors/mounting errors) will trigger warning flags. 6. Made antenna offset error tracking enabled by default. 7. Fixed certain raw GNSS data quantities not being transmitted properly. 8. Fixed GNSS solution data not decimating properly when raw GNSS data was also selected for transmission.
1.0.06	Fixed a bug in the reference position configuration command (0x0D, 0x55) that caused an invalid parameter error for altitudes of 0 or less. These should be allowed.
1.0.07	1. Added complementary filter support. 2. Fixed a bug causing the compensated acceleration vector (0x82, 0x1C) to be reported incorrectly from the Kalman filter. 3. Added support for quaternion sensor-to-vehicle transform. 4. Increased serial buffer size to address issues with dropped packets when streaming large amounts of raw GNSS data over the serial port.
1.0.08	1. Added post-EKF smoothing to position, velocity, and attitude estimates to reduce sawtoothing. 2. Improved handling of GNSS data inconsistencies between receivers to reduce impact of multipath effects, etc. 3. Adjusted EKF measurement model for pressure sensor aiding to improve consistency. 4. Fixed bug which caused sensor to incorrectly report a dual antenna configuration error when antenna separation was less than 50 cm (actual lower limit is 25 cm).
1.0.09	This is an urgent firmware release to address an algorithm error in the GNSS signal tropospheric delay model that causes filter instability in southern latitudes (< 0 degrees). An interpolation table used to compute coefficients was incomplete over the range of possible input values.
1.0.10	Firmware version changed to assist with internal production needs. Device executable remains the same.
1.1.02	**General** 1. NMEA message support via (0x0C,0x0C) and (0x0C, 0x04). 2. New low pass filter configuration command (0x0C,0x54) which enables filtering for selected EKF data – deprecates (0x0C,0x50). 3. Added GNSS LLH Position and NED velocity to factory support channels. 4. Device initial startup time improved via concurrent GNSS module initialization. 5. Continuous BIT command (0x01, 0x08) will now latch results between calls, similar to streaming BIT (0xA0, 0x01). 6. Additional added data descriptors: (0xA0,0x02), (0x91,0x12), (0x91,0x13), (0x91,0x14), (0x91,0x12), (0x91,0x13), (0x91,0x14), (0xFF,0xD7), (0xFF,0xD8). 7. Diagnostic packet now reports timing information.

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1.1.02 (continued)	**Navigation Filter** 1. Auto-adaptive filtering now mitigates the effects of external vibrations. 2. Filter position output improved when GNSS receivers disagree. 3. Filter warning flags thresholds tuned to reduce spurious indications. 4. Position, velocity, and heading warning flags will now be triggered by high residuals in certain measurements. 5. An optional IMU lever arm offset can be applied to filter position and velocity outputs (0x0D,0x56). 6. Fixed not entering AHRS mode when the magnetometer is set as the initialization source and declination is set manually. 7. The filter can now be configured to use GNSS1 or GNSS2 only, if desired. 8. Fixed an error in GNSS antenna offset command handling for external receivers; enforced 10 meter limit on any individual GNSS antenna offset at the command level. **Dual Antenna** 1. Dual antenna performance increased at high angles of roll/pitch. **GNSS** 1. GNSS module firmware update to support SBAS and spoofing/jamming indication. 2. Added SBAS support, configuration, and data output. 3. Added spoofing/jamming indications via the RF Error Detection Field (0x9x, 0x14). 4. Added receiver firmware version to GNSS receiver info command. 5. GPS Leap seconds valid flag now properly set. 6. RTK dongle fault bit in continuous bit now functions properly. 7. GPS ephemeris messages indicate when they are using modernized GPS ephemeris via a valid flag. **IMU** 1. Over-range detection supported for accelerometer, gyroscope, magnetometer, and pressure sensor outputs: see over-range status message (0x80,0x18) and continuous built-in-test message (0xA0,0x01.) 2. The complementary filter was updated with improvements from CV7 development. 3. Fixed bug that caused complementary filter angles to occasionally report NaN in rare circumstances. 4. Fixed bug that resulted in an occasional inaccurate acceleration measurement.
1.1.03	**General** 1. Added NMEA GST message to provide uncertainty estimations when using NMEA. 2. Corrected RMC magnetic variation out of range error. 3. Custom NMEA messages now use $PMSRA, $PMSRR due to rebranding. 4. NMEA VTG and RMC course over ground now bounded by [0, 360] instead of [-180, 180]. 5. USB now works on Mac computers. **Navigation Filter** 1. Fixed filter not processing GNSS measurements when only 1 constellation was enabled. 2. Fixed bug that showed secondary GNSS receiver aiding measurement summary as used when both receiver fixes are invalid. 3. ZUPT and angular ZUPT default values are now non-zero by default. 4. Default auto antenna calibration max value set to 0.15 meters. 5. Fixed bug that caused the filter to enter "Full Nav" and reject GNSS measurements if the chosen PPS was selected to be an unconnected receiver and the connected receiver was providing a valid solution.

1.1.03 (continued)	**GNSS** 1. Receivers occasionally report incorrect superframe number for the GLONASS ephemeris raw frames, resulting in splicing of 2 different GLONASS ephemerides, causing filter error in some circumstances. This has now been compensated. 2. Fixed a bug in the GLONASS ephemeris caused by TOW day rollover that would cause filter error in some circumstances. 3. Improved timing when a large number of satellites are in view and RTK corrections are being received. The filter now receives all of the data within the required time, eliminating occasional missed measurements and filter mode toggling. 4. Receivers occasionally send a bit-inverted value for the TOE entry in the GPS ephemeris raw frame. This would cause filter error in some circumstances. A check has been added to prevent this. **IMU** 1. North compensation for Complementary Filter now enabled by default. 2. Support for new magnetometer added as the current magnetometer is EOL.
1.1.04	**GNSS** Fixed raw GNSS data corruption when all constellations are enabled and the physical constellation configuration results in an unusually high number of visible satellites. This issue also affects the dual antenna algorithm's ability to form a solution, preventing filter initialization if this is the only heading initialization source. This issue appeared in less than 1% of cases when the above conditions were met. **IMU** Fixed complementary filter quaternion inversion (0x80, 0x0A).

Upgrading Firmware With SensorConnect

The firmware on the *3DM-GQ7* inertial sensor may be upgraded with MicroStrain by HBK's SensorConnect software. The Windows software is available for download and installation on the MicroStrain website at: https://www.microstrain.com/software/sensorconnect. The user is required to download the ZHEX file from the *3DM-GQ7* web page. SensorConnect performs the upgrade under user control.

Support

MicroStrain by HBK support engineers are always available by phone, email, chat, and Teams to support you in any way we can.