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High quality measurements for helicopter applications using sensor telemetry

Dr.-Ing. Ernst Manner[1], Dr.-Ing. Stephanie Manner[2], Dr. Julia Manner[3]
[1,2,3,] MANNER Sensortelemetrie GmbH, Eschenwasen 20, 78549 Spaichingen, GERMANY
manner@sensortelemetrie.de

Abstract:

More and more players on the market try to get in the game of sophisticated helicopter manufacturers. There are several interesting industries that helicopters are needed for. The famous ones like military and air transport for air lifting are now extended by new mobility concepts like the electrical urban air mobility.

But all have the same challenges with innovations on drives and transmission leading to many newly designed critical rotating components where temperature, strain, force or acceleration measurements for durability and operational strength need to be exercised.

In this paper, MANNER shortly sums up the challenges that come with the engineering and development of a high-quality, high accuracy telemetry measurement system. A system withstanding all environmental constraints and mechanical challenges but being flexible for the customer as well as for the different measurement tasks in every mean.

Sample timestamping and data structure need to be taken into account for accurate measurements in such big measurement tasks.

The request for IENA and Precision time protocol (PTP V2) has been realized as one way to go with the new generation of telemetry systems.

The aim of this paper is to provide the reader a good insight on the challenges of telemetry systems on helicopters and the solutions that have been found to realize a highly reliable, highly accurate yet very flexible measurement system that now is an answer to all measuring tasks on a helicopter.

Key words: - sensor telemetry, helicopter applications, time synchronized data acquisition of rotor signals, Precision time protocol (PTP V2) with IENA, Complex measurement tasks, Strength and Durability measurement.

Harsh environments and measurement tasks

There are several locations where a telemetry for measurement task is needed. Weather it is due to small installation space, or high and low temperatures, function a high altitude, high vibration level or steel surroundings. The measurement has to be performed for either health and usage monitoring, maintenance or for qualification reasons.

Installation space:

Not always is a space for installation resyulting during the development of the helicopter and its components. Often there has to be done a retrofit, meaning a measurement system placed in a location where there has never been the thought of implementing a system for measurement purposes. This often resulting in installation challenges that can hardly be overcome.

Environmental conditions that are prominent not only in aircrafts but are even more prominent and demanding in helicopters are summed up in the DO160 or CS29 specification.

The most known ones are vibration, temperature, altitude.

The vibration level and the resonant frequencies of the mechanical and physical components are diverse.

The long-term mechanical integrity as well as electrical function under vibration has to be guaranteed.

One term is micro phonic disturbances but there are more. All this has to be taken into account when developing a system for aircraft applications.

The temperature rages can be extreme. Ranging from -50°C to 160°C or even higher, depending mainly on the measurement task and installation location.

Light weight and minimized dimensions are of extraordinary importance. Due to the challenge of retrofit or post engineering and post design fit, there is often few to no space available. Nevertheless, the measurement is crucial for qualification or further optimization of the part.

The telemetry system, especially the rotating components have to be minimal in size and weight and show a large range of flexibility like the choice of sensors and filter settings.

The flexibility of a telemetry measurement system makes it customizable in short time. This is often a game changer in fast development cycles. To be able to define the sensor and measurement signals necessary on the fly helps to realize this short development cycles.

All these mentioned challenges as

- EMI/EMC proofness
- Vibration robustness
- Temperature range
- Pressure altitude
- humidity
- Installation place and situation
- Rotation speed

Have to be overcome by a system and partner to perform the measurements satisfactory.

Different protocol types and the way to go for fully synchronized measurements

There are a lot of protocols available on the market. Thus, making this whole task even more demanding.

The aim for a fully synchronized measurement is clear. On a complex system as a rotorcraft or aircraft, it is very important to bring the different samples back to one master clock. Then being able to compare the parameters and visible conspicuous data.

IENA PTP v2 protocol

One of the most promising way to go is the IENA PTP v2 protocol accessible via ethernet.

The precision time protocol (PTP) allows to have one master clock e.g. GPS grand master and to synchronize every sample with this master clock.

By performing this every sample is defined in time with very high accuracy.

The time accuracy is about 10 ns and also depending on the sample rate.

Time stamping

The time stamping can be performed on the rotor side, meaning prior to the transmission into the stationary system. This is achieved by time stamping each sample prior to transmitting it.

A second possibility is to correct the time that is necessary for a sample measured on the rotor side to be transmitted to the stationary side. This time depends on filters and the transmission path but is constant for each system. This allowing a correction in time without loss of accuracy.

High flexibility in telemetry measurement systems

Prior mentioned the flexibility of a telemetry measurement system has many dimensions.

Once the project is planned, there is a set of measurement points that has been agreed on. Considering the lead time of a costume made telemetry systems not taking into account the certification for the measurement of critical aircraft systems (DO160 or CS29) may vary between 6 months and 2 years.

The problem with these systems often is that they are custom-fit and very inflexible. Often there is nothing that really can be changed after the delivery.

There is no such thing as adding a few more channels or changing filters or sample rates.

To overcome all these disadvantages and challenges there has been a development at MANNER.

A totally new generation of telemetry measurement systems designed to obey the

high flexibility demands of the industry has been realized.

Not only have been there met major goals for highest flexibility but also all these possibilities:

- Change of number of sensors
- Change of channel count by adding more modules
- Change of sensor type per channel (1/4 bridge, ½ bridge, full bridge, TC, PT100/1000, acceleration sensors and so on)
- Change of data rate and transmission technology
- Shutting off damaged channels
- Daisy chain and star structure
- Settings all changeable via software
- Calibration via software
- Data recording via software

Because of the high level of flexibility by software customizing the electronics, the system can be adapted to all of the needs.

There is no need to send the telemetry system back and change e.g. the configuration. To order more electronics and change software settings will solve the issue.

Accurate data without loss

Besides our radio telemetry solutions powered by batteries the majority of systems are engineered with our inductive telemetry.

The inductive transmission path is very robust and secure against disturbance or signal loss.

Due to the nature of an inductive transmission path there is no data loss.

High data rates

MANNERS new technology can handle up to 128 channels within one system data rates up to 50 Mbit/S

Conclusion

The high demands on measurement systems with the challenges that come with the environment, helicopters and other aircrafts operating often resulted in sacrifices. So far, a very custom specific telemetry system was feasible to engineer by an experienced manufacturer, but then the system was highly specific for one application or instrumentation and because of a huge engineering part, the lead time was long.

With new technologies developed by MANNER those systems are now highly flexible (number of sensors, sensor types, filter frequencies, data rates, transmission type and more) by software configuration and the modular structure. This is even accessible by the customer to change settings.

Amplifier modules with each 1 or 4 measurement channels onboard are cascadable in a bus structure but also in a star structure for applications where it is highly preferable to keep the bus running with as much channels working as possible in case of an unforeseen event e.g. a collision of the rotor.

The evaluation units of our system can be routed as a daisy chain and provide even more flexibility.

The measurement of the telemetry sensor can easily be compared to other measurements because of the time stamping and the use of a network protocol as IENA PTPv2.