CASE STUDY

Multi-Channel ADCs enable Machine Condition Monitoring for Industry 4.0

April 2020

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Inclusion of Teledyne e2v's versatile EV10AQ190A devices has proved pivotal in data acquisition boards used to assess the ongoing operation of video imaging systems.

"Provision to implement various configurations using a single ADC product has shown itself to be invaluable." Marc Stackler, Teledyne e2v.

Effective measures and procedural frameworks are needed at industrial sites to safeguard equipment against either the failure of vital components or any decline in their operational performance as they age. Through these, the threat posed by downtime may be mitigated. Factories and processing plants can thus keep running, so that throughput is maximised. Also it means that the products being fabricated will not be compromised and quality standards will remain upheld. In the past, this called for the putting in place of maintenance regimes where regular checks were done, which was of course both costly and time-consuming.

As we now enter the Industry 4.0/IoT era, and gaining access to key operational data becomes easier to achieve, there is the prospect of far more efficient methods via which to evaluate the health of complex systems right down at a granular level. The advent of machine condition monitoring (MCM) is already showing itself highly beneficial to industrial processing/manufacturing companies - giving them continuous streams of data about the status of their equipment in real time. From this, their staff are able to make well-informed decisions about where and when maintenance work might be needed, dispensing with the outdated preventative strategy and utilising a predictive one.

Through MCM, the particular places in which the effects of ongoing wear-and-tear are at their most acute can be identified, so that any necessary component replacements may be undertaken before actual failures occur. It means the working lifespan of the sophisticated electronic systems that have been invested in can be prolonged and the disruption relating to unscheduled repair activities avoided, while significantly reducing the day-to-day operational expenses too. Furthermore, potential injuries to the workforce caused by critical situations arising from component failures can also be averted. In the example described below, the objective of the MCM implementation is to carry out runtime verification of the machine vision systems in production facilities.

Located in Taipei, ZKey Technology is a highly successful design services company specialising in the creation of bespoke hardware solutions to meet challenging customer applications. These solutions are predominantly based on advanced programmable logic devices, along with accompanying firmware. In mid-2018, ZKey was approached by a leading systems integration firm to contribute to a large scale MCM project. It would be responsible for the development and supply of the data acquisition apparatus required.

Over time, the performance parameters of the image sensors in machine vision implementations can deteriorate - with the resolution, contrast and noise levels all potentially being effected. If such deterioration is not dealt with, it could lead to product quality issues going unnoticed (and whole batches needing to be scrapped) or serious operational situations not being reacted to early enough, with downtime costs being accrued or even human safety being put at risk.

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The project that ZKey became involved in would require the gathering and compiling of serial digital interface (SDI) signals concerning the functional characteristics of machine vision systems' image sensors. From this, the health of these systems could be determined, by comparing the data with expected behaviour profiles and trying to spot anomalies.

The capturing of analogue signals would be addressed by custom-built data acquisition boards constructed by ZKey's engineering department. High sampling rate data conversion ICs on these boards would then translate the received data into a digital stream - so that, after processing had been completed, in-depth analysis could be carried out. Due to the industrial environment they would be situated in, the data acquisition boards (and their constituent electronics) could be constantly exposed to vibrational forces and extreme temperatures. A considerable degree of robustness was therefore mandated. After lengthy evaluation of analogue-to-digital converters (ADCs) from numerous vendors, it was agreed that Teledyne e2v's EV10AQ190A 5GHz sampling frequency devices would be placed at the heart of ZKey's MCM data acquisition boards.

Teledyne e2v first became engaged in this project back in the spring of 2019. An initial consultation was done with its local distributor in the Taiwan region, before direct discussions with the in-house technical staff began. In the 70 years since the company's inception, Teledyne e2v has built up a great deal of expertise within the field of industrial sensing and monitoring (IS&M). It continues to introduce cutting-edge technology for this purpose (both at the component and sub-system level), and has played an important role in countless IS&M installations across the globe - with the EV10AQ190A ADC proving very popular in this context. Highly optimised from deployment in test equipment and instrumentation, this compact digitally-programmable 10-bit quad channel device possesses industry-leading signal integrity specifications, with a 68dBc spurious-free dynamic range (SFDR) plus a bit error rate (BER) of 1 x 1016 when running at full speed. Even when in quad channel mode, it is still able to sustain an impressive 53dB signal-to-noise ratio (SNR) and the >60dB channel-to-channel isolation ensures against crosstalk having a detrimental influence on the quality of the data captured.

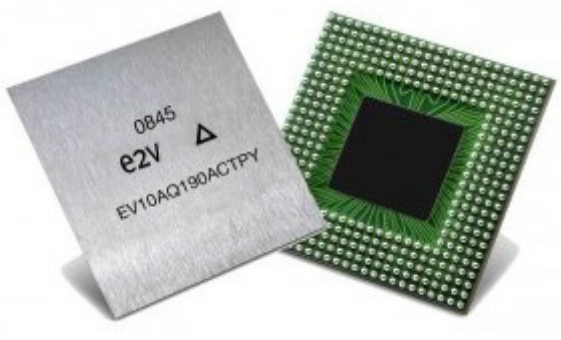

Figure 1: Teledyne e2v's EV10AQ190A ADC

The EV10AQ190A ADCs support quad channel operation at a 1.25GSamples/s sampling rate. When interleaved using their SPI interfaces, in conjunction with their built-in cross-point switches, they each offer a pair of channels running at 2.5GSamples/s or 5GSamples/s across a single channel. Through these devices, the data received by the ZKey boards gets converted into digital signals. The ADC on each board then feeds into its respective FPGA, so that initial processing can be executed. The high-end FPGA chips being used each possess almost 700,000 logic cells, along with 10MBytes of embedded RAM and extensive digital signal processing (DSP) resource.

Since the MCM runtime verification tests would be applied continuously, long-term operation of the data acquisition boards needed to be totally assured. The industry-leading mean time between failure (MTBF) figures of the EV10AQ190A ADCs gave the ZKey engineering team confidence that longevity would be achieved. Suited to deployment in uncompromising industrial settings, these devices can cope with operational temperatures up to 110°C.

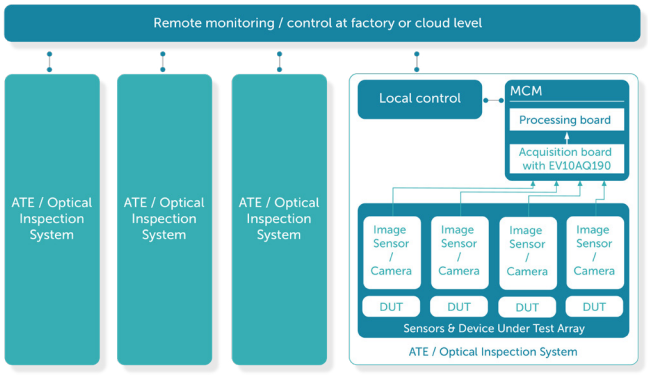

Figure 2: Block diagram of the system implementing the MCM acquisition board

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Although ZKey's engineering team had looked at the solutions available from other analogue/mixed signal IC suppliers, they could see real positives in specifying EV10AQ190A devices for this design. A notable differentiator here was the fact that, thanks to the cross-point switch incorporated in each ADC, the number of channels being utilised could be changed dynamically.

As well as saving valuable board space and reducing the overall bill of materials cost, there are other benefits that could be derived from this, since the EV10AQ190A would enable a platform approach to be taken (with one core design being applied to numerous different models). It presented ZKey engineers with far greater flexibility in terms of how the testing might be conducted by their client. Consequently, it would be straightforward to go from single channel to quad channel operation, while still using the same ICs as a basis for the data acquisition system. As Kevin Chiang, Chief Architect at ZKey, explains; **"This feature gave us the capacity to switch between having four channels operating at lower sampling rates or a single channel at elevated rates. Hence, we could adapt to what the performance demands dictated, but without having to make any fundamental alterations to the system itself."**

The whole development process for this project was, as a result, dramatically shortened and the associated logistics simplified substantially. It has also meant that ZKey's acquisition instrumentation is now fully future-proofed, so there is ample scope to deal with new application criteria as they emerge. **"Provision to implement various configurations using a single ADC product has shown itself to be invaluable to ZKey, as well as many other customers,"** states Marc Stackler, Teledyne e2v's Sales and Application Engineer for the APAC region. **"With just one sub-system arrangement, different channel requirements can be attended to, thereby minimising hardware complexity and enabling much greater design re-use."**

ZKey's systems integration client is already placing sizable orders, which will equate to approximately 2,000 data acquisition boards per year. In addition to this, the company is also aware of further opportunities opening up to apply derivatives of the data acquisition board to other areas. As well as this major endorsement for its EV10AQ190, Teledyne e2v is currently seeing a lot of traction within the industrial, telecommunications, avionics, space and defence sectors, for the newer EV12AQ60x ADC series. These devices have similar feature sets to the EV10AQ190, but with 12-bit resolution capabilities and a smaller footprint (thanks to inclusion of serial I/Os). They support 6.4GSamples/s across a single channel, 3.2GSamples/s over two channels and 1.6GSamples/s when in quad channel mode.

To learn how Teledyne e2v can assist with your IS&M project, visit: https://www.teledyne-e2v.com/contact-us/

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