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CASE STUDY

248.935.4237

15800 CENTENNIAL DR., STE. A
NORTHVILLE, MI 48168
WWW.SIGNALXTECH.COM

Measuring Magnetic Flux on HEV Rotor for Production Verification

Author:
Scott White – Signal.X Technologies, LLC

Contributions from:
Mark McPherson – Tengam Engineering, INC

Industry:
Automotive, Electric & Hybrid Vehicle Components

Products:
National Instruments (NI) LabVIEW, NI CompactDAQ, Kollmorgen AKM Servo Motor, AKD Drive

The Challenge:
Accurately measure magnetic flux on a permanent magnet electric motor rotor. Immediately process acquired data to make a determination on part quality in a production environment.

The Solution:
Signal.X Technologies worked with customer Tengam Engineering to develop a portable test stand for small sample production testing of permanent magnetic EV rotors. The portable stand spun the device under test (DUT) at a low RPM while measuring up to 16 channels of simultaneous analog data representing the magnetic strength (flux) of the part. Custom Signal.X software then immediately analyzed and displayed the data for a quick determination of part quality. By overlaying the data with a baseline of a known good part, a data-driven decision was reached within seconds of completing each test.

Overview:
Tengam Engineering uses a highly advanced injection molding process to create magnets. A new test process was needed to quickly verify part quality due to the complexity and cost of the part. Visual inspection was not sufficient to ensure parts were meeting specification. This test process, developed in order to verify that proper molding conditions were achieved, resulted in a properly produced magnetic assembly. Signal.X worked with Tengam to develop this test process, making this a mutually valuable partnership.

Test Stand Overview:
The primary functional elements of this test stand are the controls, acquisition and analysis. The software user interface, designed by Signal.X, is where these elements were blended seamlessly for the end user.

Controls:
- Operator enters the relevant test information and initiates test with a button click.
- Test PC communicates with the Kollmorgen AKD motor drive via Ethernet I/P.
- Motor drive spins DUT at a steady, low RPM to one full revolution.

Acquisition:
- A high-resolution simulated encoder output from motor drive acts as the data acquisition trigger. This ensures exact spacing of samples in the angle domain, with resolution at a thousandth of a degree.
- NI 9220 16-channel input module reads the output from the Hall effect sensors as the part spins. This module enables high accuracy with a 16-bit analog-to-digital converter.
- Thermocouple measurement with a surface probe correlates part temperature with magnetic strength.

Sensors Used:
To measure magnetic strength, a low-noise, high-precision linear Hall effect sensor was chosen. This sensor was integrated into an evenly spaced 16-sensor array so the DUT could be measured along the entire surface. The test stand acquires all 16 channels simultaneously using hardware-timed data acquisition driven by the encoder.

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The Data:

After testing the first part on the new test stand the customer immediately noticed its superior level of accuracy, speed and ease of use compared with prior testing methods. Other types of testing were unable to show the impacts to magnetic performance resulting from changes to the molding parameters. An example of the multiple channels used and the resulting trace is shown below in Figure 1. Each pole of the magnet is either above or below zero with the generated curve indicating both peaks and the area under the curve indicating overall magnetic strength.

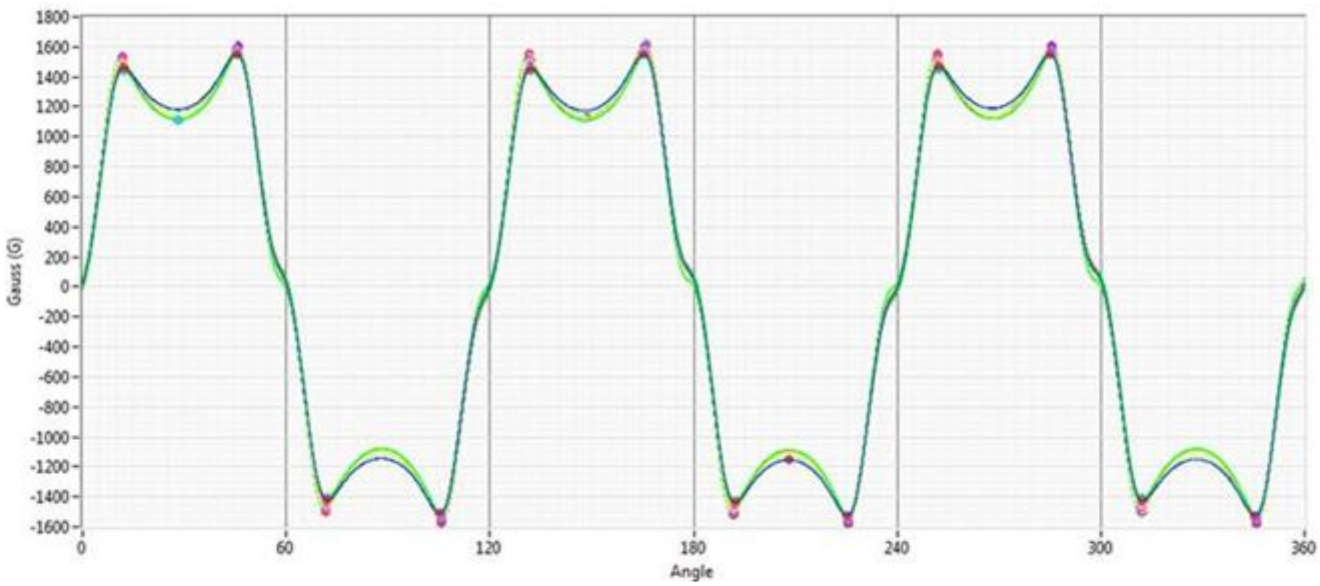

Figure 1 - Gauss vs Angle Graph

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Data Analysis:
Tengam sought to measure the area above and below zero on the curve. Areas relatively consistent across the poles indicate a well-made part. To help speed up this analysis on the plant floor, Signal.X developed a color-mapped table in LabVIEW where the background color of the cell corresponds to its value. The positive and negative poles are grouped together for more clarity. The Signal.X software automatically generates this table from collected data when a test is completed. In addition to the values, any out-of-place color shade will immediately cue the operator that an issue could be present.

	Pole 1	Pole 3	Pole 5	Average		Pole 2	Pole 4	Pole 6	Average
Channel 1	781.0	792.0	786.0	748.8		-780.0	-788.0	-787.0	-747.6
Channel 2	769.0	752.0	761.0	Min		-761.0	-752.0	-750.0	Min
Channel 3	740.0	732.0	735.0	700.0		-748.0	-725.0	-741.0	-700.0
Channel 4	700.0	708.0	713.0	Max		-704.0	-711.0	-709.0	Max
Channel 5	710.0	700.0	719.0	800.0		-704.0	-709.0	-716.0	-799.0
Channel 6	730.0	734.0	732.0	Std Dev		-732.0	-739.0	-738.0	Std Dev
Channel 7	768.0	768.0	772.0	31.3		-759.0	-761.0	-759.0	30.7
Channel 8	798.0	787.0	779.0			-781.0	-799.0	-799.0	

Figure 2 - Area Under the Curve Color-Shaded Table

The Bottom Line:
This application rapidly progressed from concept to turnkey solution by utilizing an established Signal.X software architecture in LabVIEW and NI CompactDAQ hardware. According to the customer, “Prior to Signal.X involvement part testing was laborious and had much lower levels of fidelity.” Signal.X will take the lessons learned on this project and apply them to helping Tengam develop its next-generation production test stands.

Author Information:

Scott White
Senior Development Engineer
Signal.X Technologies, LLC
15800 Centennial Dr., Suite A
Northville, MI 48168
scottcwhite@signalxtech.com
signalxtech.com

With Contributions From:

Mark McPherson
General Manager
Tengam Engineering, INC
545 Washington Street
Otsego, MI 49078
mark@tengam.com
tengam.com