Valve Monitoring

- ALD

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Problem Statement

- A fault in valve can damage the gas pipeline system which will impact production and cause expense and also leaked gases through the valves can harm the human due to its poisonous
- Therefore, **valve monitoring** is a crucial part in ALD based semiconductor processes in order to ensure safety of human and machines
- So, need to monitor the valves in real time whether there is any faults or leakage occurs and inform to the user

Solution

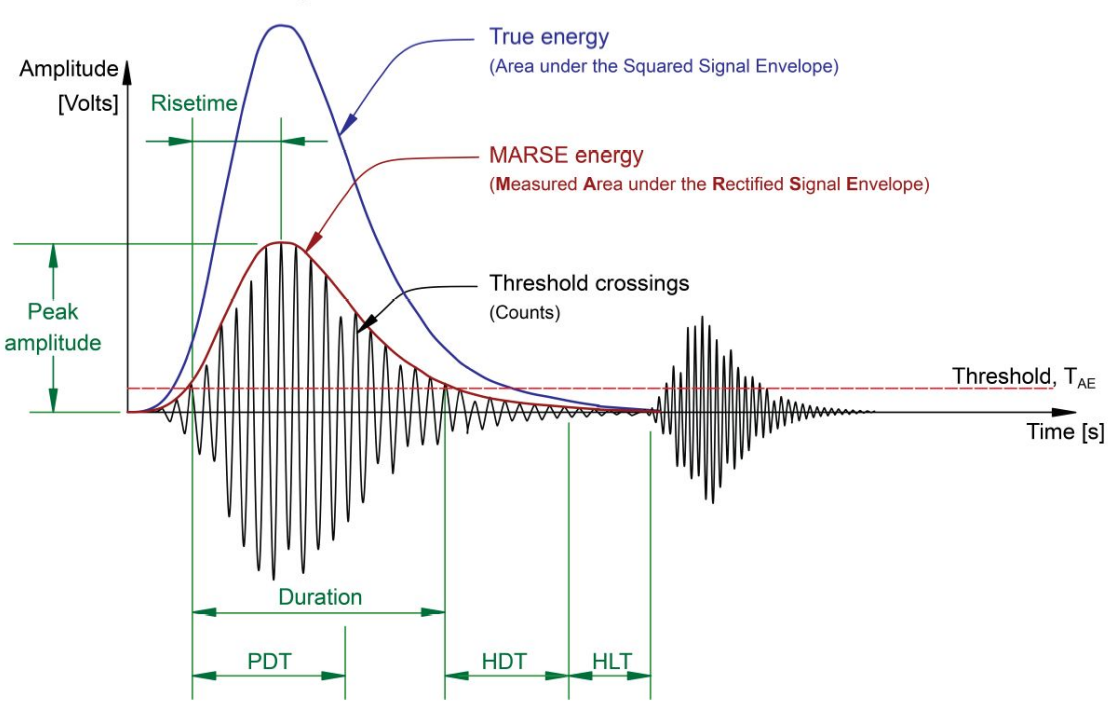
- A clamp on hardware system to acquire the Acoustic Emission Signals. The hardware system includes;
  - AE sensors
  - SMA - BNC cable
  - Sensor - ADC interfacing circuit
  - STM32 Nucleo F410re board as ADC
  - Raspberry Pi 4B as an intelligent data acquisition board (Data acquisition and Machine learning modelling)
- These acquirable AE Signals are continuous signals. So, hit from the continuous signal is detected. Then the hit features are extracted from this hit signals.
- The features are used to predict the fault and leakage lrate using a model from Machine Learning
  - Fault detection is a classification problem
  - leakage rate is a regression problem

SOFTWARE stuffs

- A dataset consisting of 7 Faults and 1 Healthy condition dat format preprocessed signals are used to do a classification
  - 1800 files (225 dat files * 8states) consists of samples of signal at 50kHz for 1s (50,000 samples)
  - WPT (Wavelet Packet Transform) with consisting of 255 nodes are extracted from every signals
  - 254 Features for classification are selected by the power of the WPT nodes except root node
  - Accuracy from these features give above 99%

- By extracting the hits from the continuous signals can detect the faults and leakage rate in very close to real time using the hit features

- AE signals are generally contains the frequency in the range of (100kHz, 1MHz). Therefore sampling at a rate of at least 2MSPS will represent the signals exactly and for accurate hit features



specifications of HARDWARE SYSTEM

- GIS150 AE sensors are integral preamp sensors. So, we need to power the sensors in the same line where AE signals also passing.
- In order to power the AE sensors and for integrating the sensors with ADC we need an interfacing circuit
- This circuit contains two sections; one is the power supply circuit with 5V DC supply voltage and the other is simple passive voltage shifting circuit for shifting +/- 5V to 0 - 3.3V.
- To achieve at least a sampling rate of 2MSPS and a real time communication the STM32 Fucleo F410re boards can be used. left side Morpho connectors (male) section of Nucleo board is plugged with the female holes in the interfacing circuit. For three AE sensors, 3 ADC pins from the morpho connectors and two power supply pins (5V, Ground) are used.
- STM32 Cube IDE software can be used to program the Nucleo board. Pins can be assigned graphically in the IDE and able to generate the code from it. Additional required functions can be added in the source code using C language.
- For the acquisition of digital data from the ADC for detect the faults or leakage rate using Machine learning models, Raspberry Pi 4B board can be used. SPI communication at a speed of 30Mbps is used to communicate between the two boards
- In the testing phase, acquired data in Raspberry Pi 4B is transfered to PC at 1Gbps using ethernet cable and further analyzing will be carried out.
- In the final product phase, Raspberry Pi 4B is used as a standalone PC with remote accessible facility

HARDWARE SYSTEM Diagram

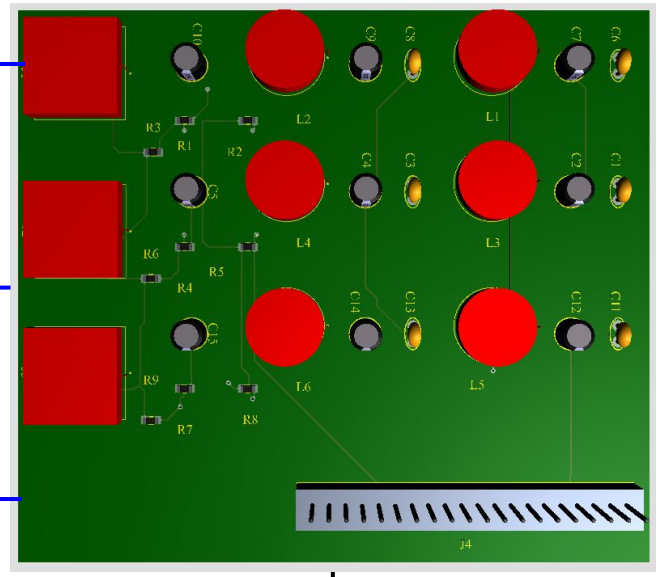
Raspberry Pi 4B

GIS150 AE Sensor 1

GIS150 AE Sensor 2

GIS150 AE Sensor 3

SMA _ BNC Cable



Interfacing circuit

STM32 Nucleo F410RE

THANK YOU

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