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Effect of 24 V Control Pulse on the Data Acquired In a Pulse Detonation Engine Test

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Abstract: A pulse detonation engine test rig has been set up in Aerospace engineering department at PEC university of Technology Chandigarh. The performance parameter measurement tests have been conducted for single shot firing of the pulse detonation engine. Ni data acquisition with strain gauge type pressure sensors were used for initial testing for establishment of the phenomenon of pulse detonation. The present paper discusses about the data acquisition system and the noise due to 24 V signals for operating the test rig, around the signal cables.

Key words: Data acquisition system, load cell, pressure sensor, noise, pulse detonation

I. INTRODUCTION

The data collection hardware comprises of a low resistance (.06 ohm/m) cable of 16 metres length, a NI DAQ system, a USB carrier, 4 pressure sensors 3 thermocouples, 3 load cells. The engine and support equipment in test cell was controlled by a National Instruments (NI) Real-Time VI software program installed on a personal computer. The PC was linked to a NI PXI-1000B controller. The program controlled engine operation by managing engine supply gas operation via ball valves located in the test cell. A BNC pulse generator located in the control room controlled timing of trigger signals sent to both the fuel injectors and TPI via electrical relays located within the test rig. Also located within the control room were 24 VDC and 220 VAC master power switches, and an emergency shutoff button. The electrical switches controlled electrical power within the cell for engine control and instruments. The power supply to the load cells and pressure transducers is 5 V which comes from the PCI card. The power supply for gas valves and ignition system is 24 V from an external source. The paper is organised in the following way. After introduction in section –I the different setup of the experiments are given in section II. Results are then analysed in the section III. Conclusion in section IV and ends with references after acknowledgement.

II. SETUP OF THE EXPERIMENT

A Setup-1

The fig. 1&2 below shows the pressure-1, pressure-2, load-1, load-2 versus time acquired from the data acquisition system. at one location in the pulse tube. The shielded cable in this case was containing all the wires of pressure sensors, all the wires of load cells and the triggering wire for solenoid valve and spark plug.

B Setup-2

Out of all the wires including signal from the sensors and relay control for solenoid and spark plug which were taken through 25 core low resistance wire, the triggering wires were disconnected from the main 25 core shielded cable and a separate connection was made directly from the power supply through and the relay control valve. Few more tests were conducted and data collected for the same.

C Setup-3

This time the triggering wire was sent through different rout away from the shielded cable. The distance between the shielded cable carrying signals from pressure sensors and load cells more than 1 m.

D Setup-4

This time the wires distance was increased and shielding plates were kept between the 24 V and signal cables.

III . EXPERIMENTAL RESULTS

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The test run was done for each setup with plotting of the curves for pressure and thrust v/s time AS Shown in the figures 1 through 4.

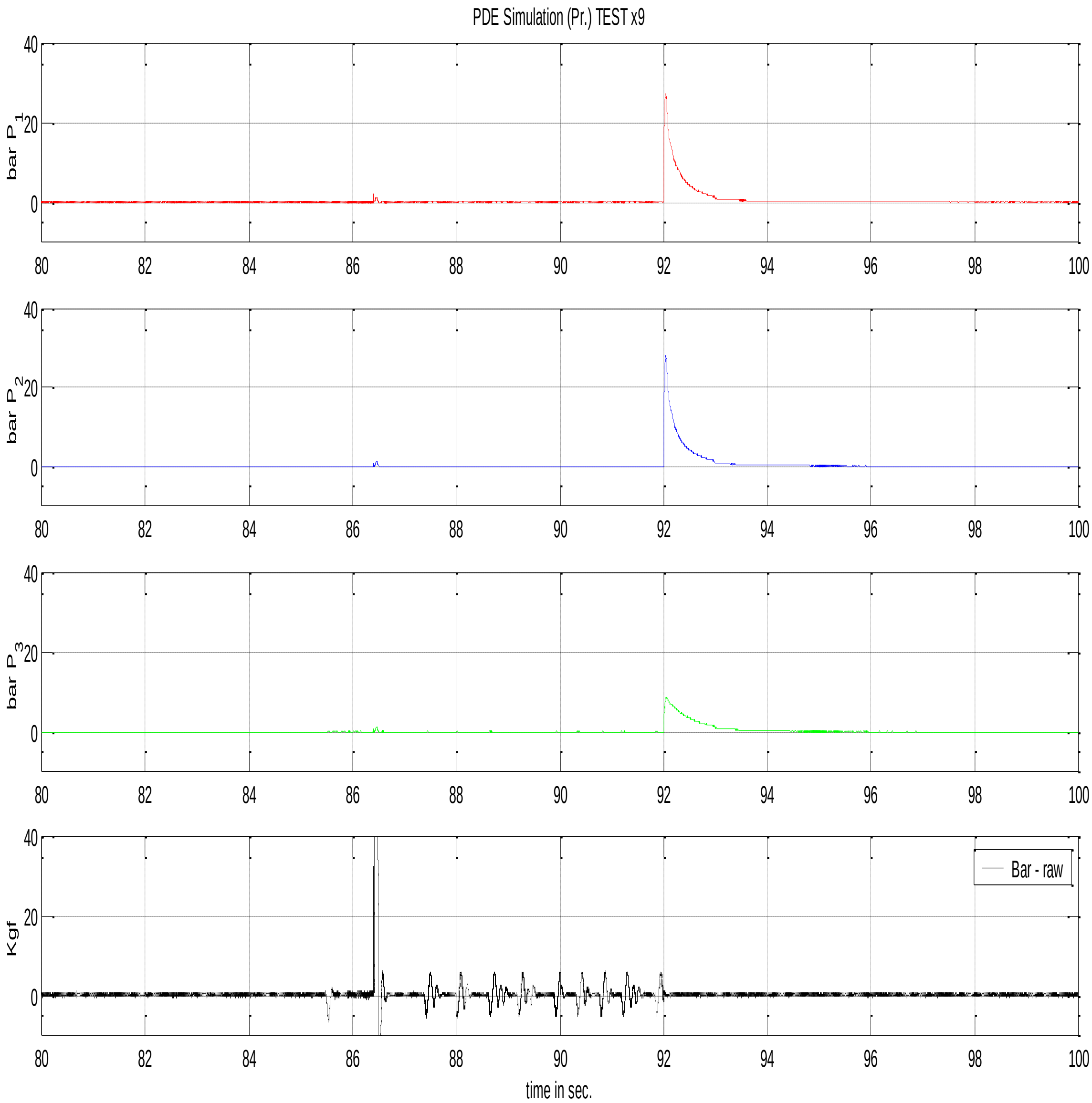

Figure-1 P1, P2, P3 and L1 v/s time for test-1

The fig.1 above shows red, blue and green curves for the pressures measured by the three pressure sensors located at three different position downstream for the setup-1. The 4th from the load cell connected for measuring thrust developed by the engine.The pressure has been picked up by the sensors. Small kink near 86.5 on the time line is visible. The load cell showed large amount of noise near the solenoid pulse and failed to capture the thrust signal. Few experiments were conducted but the problem could not be identified. After very careful investigation of data from all the channels and comparing with the reference time it was observed that the problem in the signal was for a few milli second just at the time of opening solenoid valves for gas supply meaning thereby that the kink is due to the electromagnetic pulse generated by the solenoid valves. The efforts were than made to rectify the problem with the modifications in the setup-2.

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The fig.2 shows the results from the setup-2. This time again the pressure was measured cat the appropriate time but the load cell measurement again could not pick up the pulse in time. It is clearly visible that a strong pulse in the figure must have come due to the spark generation in the spark plug. Thereafter the signal was not picked up by the load cell. P3 clearly shows two pulses one for the solenoid and the second very small for the spark plug ignition. The Setup needed to be changed again.

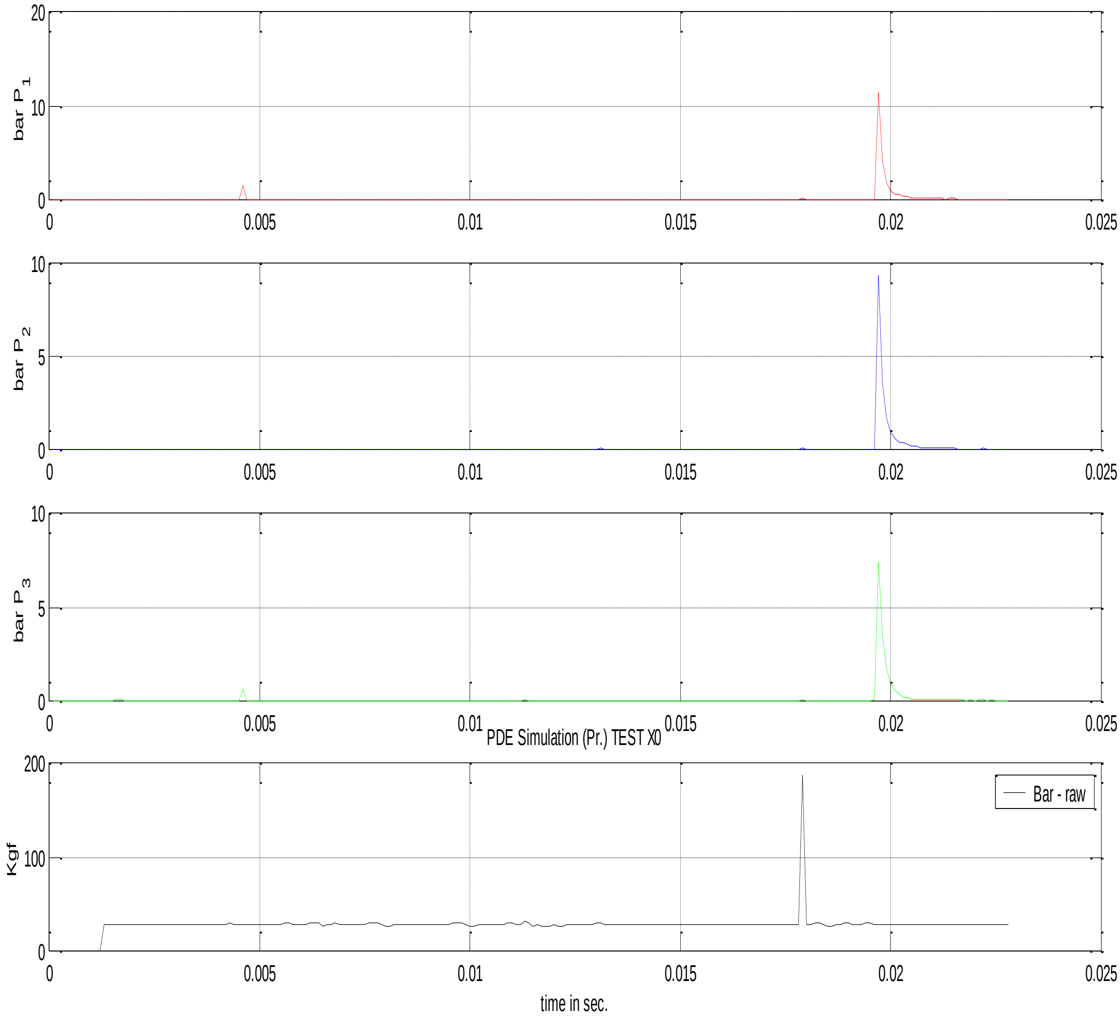

Figure-2 P1, P2, P3 and L1 v/s time for test-2

The fig.3 shows the results from the setup-3. This time again the pressure was measured at the appropriate time but the load cell measurement though picked up the signal but to some extent. The thrust measurement was not upto the mark. It can be seen that the load cell again got disturbed is clearly visible that a strong pulse in the figure must have come due to the spark generation in the spark plug. Thereafter the signal was not picked up by the load cell. P3 clearly shows two pulses one for the solenoid and the second very small for the spark plug ignition. The Setup needed to be changed again.

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Fig.4 shows the results for P1,P2,P3 and Load cell for the setup-4 in which the 24 V suuply cable was routed through different way. It is seen that P1,P2 and P3 are clear of the interference but load cell though picks up the signal in time has some noise. It is now felt that the there has be complete isolation of the 24 V signal pulse in order to stop the interference and get pure signal. At multiple shot experiments this has to be seen again.

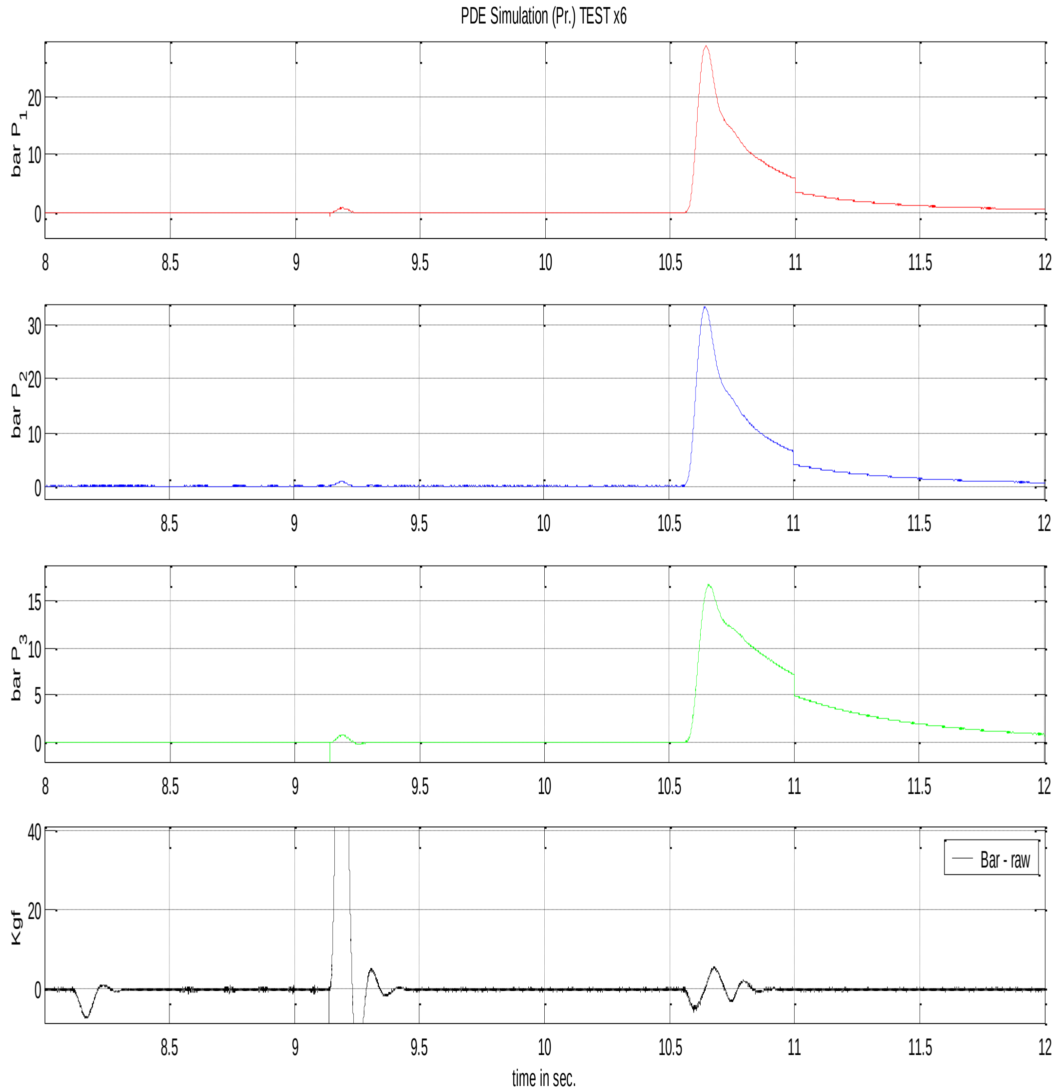

Figure-3 P1, P2, P3 and L1 v/s time for test-3

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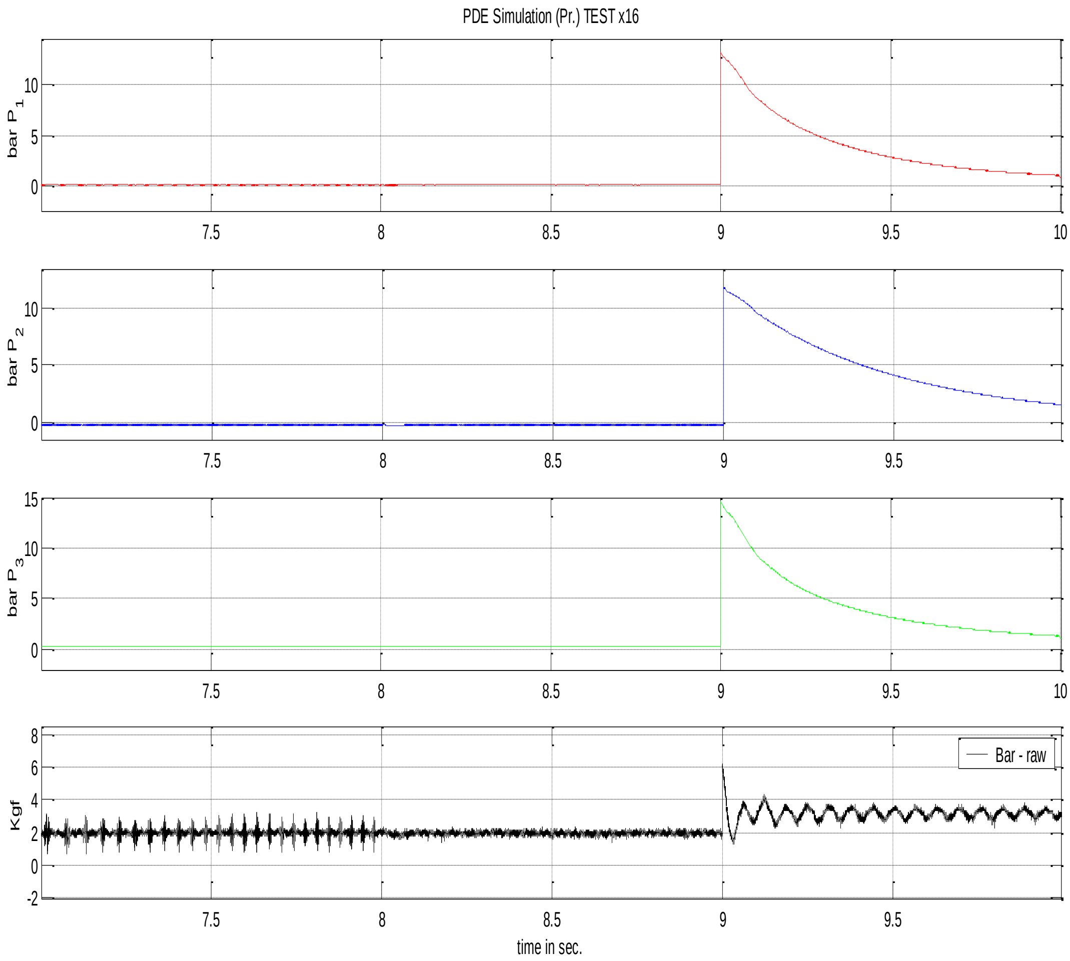

Figure-4 P1, P2, P3 and L1 v/s time for test-4

IV. CONCLUSION

The EM interference pulse if not completely eliminated can be managed and taken into account. In the case of single shot firing or firing with low frequency it can be helpful in consideration for high frequency testing the effect has be seen practically. The high voltage signals should be isolated from the data acquisition system to get accurate signals.

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Biography

The Author, **Dr. Tejinder Kumar Jindal** is a faculty member Working as Assistant Professor in Aerospace Engineering Department in PEC University of Technology, Chandigarh for the last more than 23 years. He is an Aeronautical Engineer working in the field of Wind energy, Solar Energy, Cryogenics and Pulse detonation. He has guided 11 M.E students and 5 PhD Students. He has over 30 publications in the areas of research. He is the member of Institution of Engineers (India), Life member Indian Cryogenics Council, Life Member Aeronautical Society of India and Life member Solar Energy Society of India. He has participated in many national and International conferences and seminars. Presently he is actively engaged in the area of Pulse detonation propulsion an area of International importance.