

# Reconfiguring a TUP Impact Tester for LabVIEW-USB Control and Acquisition

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## ABSTRACT

A TUP impact tester records the resisting pressure of a plastic material under sudden impact conditions. Time profiles of the pressure provide important information on fracture resistance behavior and limits as well as energy absorption by the impacted material. Impact resistance properties are of course strongly correlated with the chemical and physical composition of the material. In this work we describe the conversion of the electronic and computer interfacing components of an older TUP system (Dynatup® 8200 High Capacity Impact Test System) to a LabVIEW® (National Instruments) operating environment. Two important parts of the conversion involved switching from an AT plug-in board for an old PC 386 system to a National Instruments CompactDAQ USB-based system, and use of the stand-alone executable file feature of LabVIEW 8 to create a control program that will run on any USB Windows environment.

## PROCEDURE

Figure 1 shows the TUP apparatus. A piece of plastic (white square in the figure) is securely clamped. A catch is released to allow the yellow block to drop along the polished stainless steel guide rods. A pressure transducer mounted inside protruding black probe tube on the lower side of the yellow block records the pressure signal as the probe hits the plastic. The typical impact duration is 10 msec. A slotted metal piece on the side of the yellow block passes through an optical interrupt as the head falls, providing a start signal for the pressure record and a head velocity signal.

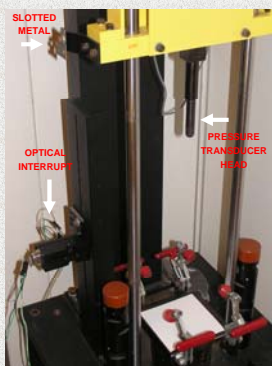


Figure 1.

The optical interrupt section of Figure 1 depicts an intermediate stage of the project when we were designing a revised version of the electronics. Ultimately the new electronics were all located in a small black project box seen in Figure 2. The original AT board for the 386 system provided a +5 V supply for both the optical interrupt and the transducer. The transducer signal was passed into an analog to digital converter on that same board and then processed by proprietary software on the system. When the control computer and its board failed, the system was rendered obsolete unless the computer components could be upgraded.

The electronic conversion requirements were rather simple once the original features were deciphered. In the new system, the +5 V supply consisted of a nominal 120V AC/+12V DC wall plug supply passed through a LM7805 voltage regulator (ref. 1). This supplied both the transducer and the optical interrupt. We also replaced a failed optical interrupt IC on the old system (ref. 2).

The transducer and optical interrupt signals were acquired at 0.02 msec intervals using a National Instruments 12 bit  $\pm 5V$  range PCI 6024E IO board in the original revision of the TUP system. For the final version, the PCI board was replaced with a newer more flexible option: the National Instruments CompactDAQ USB system with a NI 9215 16 bit 100 kHz  $\pm 10V$  range module.

Figure 2 shows these newer control components, including the black "project box" noted earlier containing the 5 V power supply and connections for the optical interrupt and pressure transducer signals. The two BNC connectors to the 9215 AD module pass the interrupt and pressure signals to the larger USB crate in the Figure, and these are then sent to a USB 2.0 port on the computer.



Figure 2

The main part of the controlling LabVIEW program is shown in Figure 3 below. LabVIEW tools allow one to set the voltage ranges and timing within each block. The acquired signals are stored in spreadsheet format in a later step. Our version of LabVIEW 8 allows the creation of an "executable" version of the program. Users cannot modify the executable version, but this does allow operation of the program, and thus the complete TUP system, by others without purchasing the LabVIEW development software.

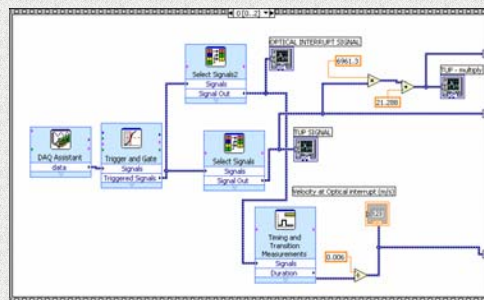


Figure 3

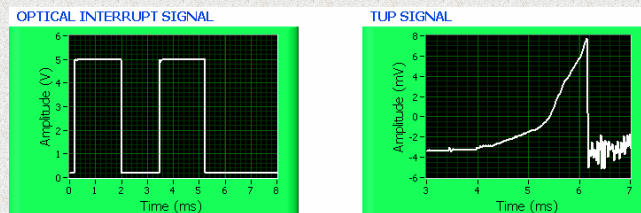


Figure 4: Front panel LabVIEW display of the optical interrupt and TUP signals. The time gap between the interrupt peaks is used to calculate the TUP head speed and to determine the starting time of the TUP signal.

Figure 5  
Impact on hard plastic surface.

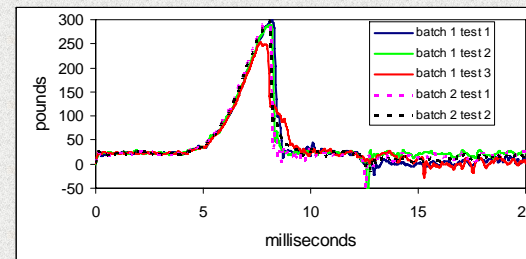
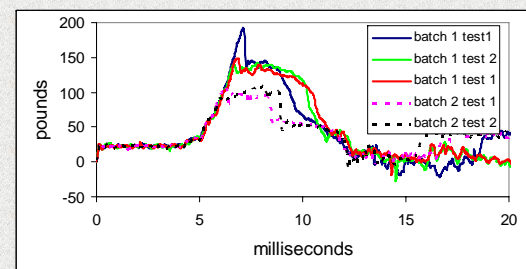


Figure 6  
Impact on soft plastic surface



Figures 5 and 6 show TUP results for a composite plastic with hard and soft layers on opposite sides. Figure 5, for the hard side up, shows a rapid rise in the force on the TUP head followed by quick collapse as the plastic breaks at around 8 msec. Figure 6, for initial impact on the soft side, shows cushioning of the force prior to breakage around 9-11 msec. The repeat traces for two different batches (from different manufacturers) illustrate the level of reproducibility of the technique. Batch 2 is very similar to batch 1 on the hard side, but demonstrably different on the soft side.

## CONCLUSIONS

We successfully converted a TUP system controller from an older non-working dedicated computer with proprietary software to a USB-based IO system controlled by a LabVIEW (National Instruments) program. This cost-effective solution to an obsolescence problem, coupled with the option for creating an exportable "executable" version of the control program provides a system that can be readily used with any USB-capable computer.

## REFERENCES

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2. [www.fairchildsemi.com](http://www.fairchildsemi.com), data sheet DS300294, Fig. 9, p. 7 5/29/01

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