

UNIVERSITY OF DAYTON
ENGINEERING TECHNOLOGY DEPARTMENT
300 College Park, Dayton, OH 45469-0249

PROPOSAL FOR AN ECETDHA MINIGRANT

Project Title:

Development of a Low-Cost Amplifier and Signal Conditioning Module

Project Director:

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Abstract:

As engineering technology programs expand the use of computer data acquisition systems, signal conditioning modules are required that allow students to obtain reliable data from transducers and sensors. Single channel commercial modules are available at a cost that is excessive (\$200 - \$500) for an educational laboratory with multiple workbenches and setups that can contain several sensors.

This proposal will fund the final development and initial fabrication of a basic, very low cost, single channel amplifier and signal conditioning module. A bread board prototype of the amplifier and signal conditioning module has been constructed and its performance analyzed. The prototype module provides satisfactory performance for educational use, as demonstrated through this initial assessment. Final electrical design modifications for manufacturability will be made by an engineering technology student and incorporated into a final working prototype implemented using the in-house printed circuit board (PCB) mill. A base for the module will be designed and prototyped using an in-house rapid prototype machine (RPM). Final module verification will be performed against a variety of sensor technologies. After this final design and analysis step, the modules will be made in quantity using an outside PCB manufacturer, a local machine shop for base fabrication, and an engineering technology student for final construction and testing. The final module plans and bill of materials will be distributed so other institutions can construct copies for their own laboratory uses.

Justification:

Traditionally, product and manufacturing systems design has been a common career area for engineering technology graduates. To follow suit with the growing use of sensors in these systems, engineering technology programs have been strengthening their facilities and curriculum related to instrumentation. This includes adoption and integration of the widely used LabVIEW software and related National Instruments hardware products.

In laboratory experiences, students use sensors that convert a physical quantity, such as temperature, strain, displacement, acceleration, flow rate, etc., into an electrical quantity. This electrical output is in the form of an analog signal, which is continuous and time varying. Normally, the sensors signals are not in a convenient form. They are typically in the millivolt range and often made in the presence of electric and/or magnetic fields which can superimpose noise on the measurement signals.

Prior to implementing computer data acquisition, engineering technology laboratories had dedicated transducer displays and bridge amplifier meters. These devices have sophisticated scaling and filtering capabilities which can minimize the effects of noise. In moving to computer DAQ systems, this functionality must be replaced.

Commercial strain gage, or transducer, amplifier and signal conditioning modules are available, but at substantial cost (\$200 - 500). Purchasing these commercially available modules can be excessive for an educational laboratory needing to support multiple workbenches which, for some experiments, may involve multiple sensors.

The project proposed would enable an interdisciplinary team of engineering technology faculty members and students at the University of Dayton to finalize the design of and construct a low cost amplifier and signal conditioning module. Several faculty members and students have already collaborated on a preliminary circuit design and have finished initial prototype evaluations. Since the initial results are satisfactory, funding to finalize the design and for construction of PCB prototypes and several copies is desired. Funding would also support the design and fabrication of a base to secure the modules.

Intended Report:

A report will be generated that summarizes the details of the design, including the electrical schematic, PCB layout, mechanical assembly, and bill of materials. All performance evaluations and student feedback will also be documented. The intent is that other institutions can construct their own modules. It is anticipated that this information will also be disseminated through papers in ASEE conferences and other venues such as the Technology Interface of the Journal of Engineering Technology.

Time Line:

Manufacturability Design of the Board/Module	February, 2009
Prototype PCB Fabrication and Analysis	March, 2009
Procurement of Boards and Components	April 2009
Final Module Assembly	Summer Semester, 2009
Implementation into Student Laboratories	Fall Semester, 2009
Preparation of Report and Article for Publication	December, 2009

Budget:

Engineering technology students under the guidance of faculty members will perform the final manufacturability design and PCB and mounting base prototype tasks. The students will perform this work in an independent study course. All materials needed during these tasks will be funded through the mini-grant. The estimated prototype material list is as follows:

Prototype PCB Materials(copper board, end mills)	\$ 150.00
Electronic Components (ICs, passives, connectors, etc)	\$ 50.00
Mounting Base Materials (ABS)	\$ 50.00
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	\$ 250.00

The developed amplifier and signal conditioning modules are intended to equip a laboratory with 12 benches. Advanced experiments performed within this laboratory can require up to two modules per lab bench. Therefore, a total of 30 modules will be fabricated to support all laboratory experiments and provide some spares for use with other courses as needed. Students will perform the final fabrication of the modules as student employees funded through the UD Engineering Technology Department. The estimated module fabrication cost for 30 units is:

Student labor (40 hrs @ \$8.50/Hr.)	\$ 340.00
Component Costs (itemized below)	\$ 1,350.00
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	\$ 1,690.00

The material cost for the first ten modules will be funded through the mini-grant with the remaining material costs funded through the UD Engineering Technology Department. Preliminary component cost estimates for a single module are as follows:

Printed Board	\$ 10 .00
Electronic Components (ICs, passives, connectors, etc)	\$ 27.00
Mounting Base	\$ 8.00
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	\$ 45.00

The overall project cost is \$1,940 with \$700 being requested from ECETDHA and \$1,240 being funded internally through the UD Engineering Technology Department. The complete budget is included on the next page.

		Unit Cost		
	Task Description	UD ETD	ETECDH	Total Cost
1	Prototype Material Costs			
1.1	Prototype PCB Materials(copper board, end mills)		\$ 150.00	\$ 150.00
1.2	Electronic Components (ICs, passives, connectors, etc)		\$ 50.00	\$ 50.00
1.3	Mounting Base Materials (ABS)		\$ 50.00	\$ 50.00
2	Module Fabrication Costs			
2.1	Student labor (40hrs @ \$8.50/Hr.)	\$ 340.00		\$ 340.00
2.2	Module Component Costs (30 units)			
2.2.1	Printed Board	\$ 200.00	\$ 100.00	\$ 300.00
2.2.2	Electronic Components (ICs, passives, connectors, etc)	\$ 540.00	\$ 270.00	\$ 810.00
2.2.3	Mounting Base	\$ 160.00	\$ 80.00	\$ 240.00
TOTALS		\$ 1,240.00	\$ 700.00	\$ 1,940.00