To: TI, Senior Project Advisors
From: Team 04
Raymond Montgomery
Eric Taylor

Date 11/12/2014
Subject: System Proposal 2v0

Executive Summary

The purpose of this project is to provide both hobbyists and professionals with an oscilloscope that they can use for their day to day projects. Current options are fairly expensive in the above $100 range and can be too expensive for the common hobbyist. To make this scope we want to make a BoosterPack for a common TI LaunchPad so the user would just have to buy the BoosterPack and attach it to the LaunchPad to have a high performing scope. The BoosterPack we are designing would consist of a high performance Analog to Digital Converter that can sample at high rates to measure signals up to 6.5MHz, and also include a colored screen. The user then can control the two channels on the oscilloscope with mechanical buttons and knobs attached on the LaunchPad. Overall, the results of this project could be useful to a wide scope of engineers and provide a price under $50 and a reliable measuring tool that they can use on their projects.

Project Walkthrough

The client, Texas Instruments, wants a BoosterPack for their LaunchPad series that can function as an oscilloscope. This BoosterPack would be available to both hobbyists and professionals so they can easily buy and attach the BoosterPack to a current LaunchPad board. This BoosterPack must be high performance so it is better than a typical microcontroller and be a cheap oscilloscope. To do this we will use a TI ADC that can sample at 65 MSPS. This BoosterPack must have two channels that are able to measure signals and display them on a touchless colored display. The BoosterPack will be powered by a 5V source converted from wall power. The user should also be able to input using mechanical switches that exist near the edge of the display. Standard 1MΩ 10x probes can be attached through a BNC connector for the user to measure signals. The input signals range from +15V to -15V for signal data and up to 6.5MHz in frequency. The client would like all of the hardware design files, microcontroller software, and a user's manual. TI would also like a working prototype to show off the feasibility of the project.

Stakeholder Analysis

Stakeholder Name	Level of Importance	System Event Definition
Oscilloscope User	***	The consumer who purchases and operates the oscilloscope product.
Oscilloscope Manufacturer	**	The manufacturer who assembles the parts and subsystems for the oscilloscope.
Oscilloscope Programmer	*	Updates software.
Client	***	Trey German, Texas Instruments.
Retailers	**	The dealer who sells the oscilloscope.

Feature Name	Feature Definition
Measurement Accuracy	The oscilloscope will be able to get full 10-bit accuracy of the ADC.
Power Consumption	The oscilloscope runs only when plugged into the wall.
Ease of use	The oscilloscope's operation should be understood by college students, hobbyists, and professionals.
User's Manual	The manual should be readable by college students, hobbyists, and professionals.
Updateable Programming	Software can be updated with Energia by the user.
Price Limit	Final product price should be less than $50 at 1k units. This is production price since TI makes the parts used in the design.
Signal Measuring	The Oscilloscope BoosterPack adequately functions like an oscilloscope.
Math functions	Signals from channels can be added, subtracted, multiplied or divided together.

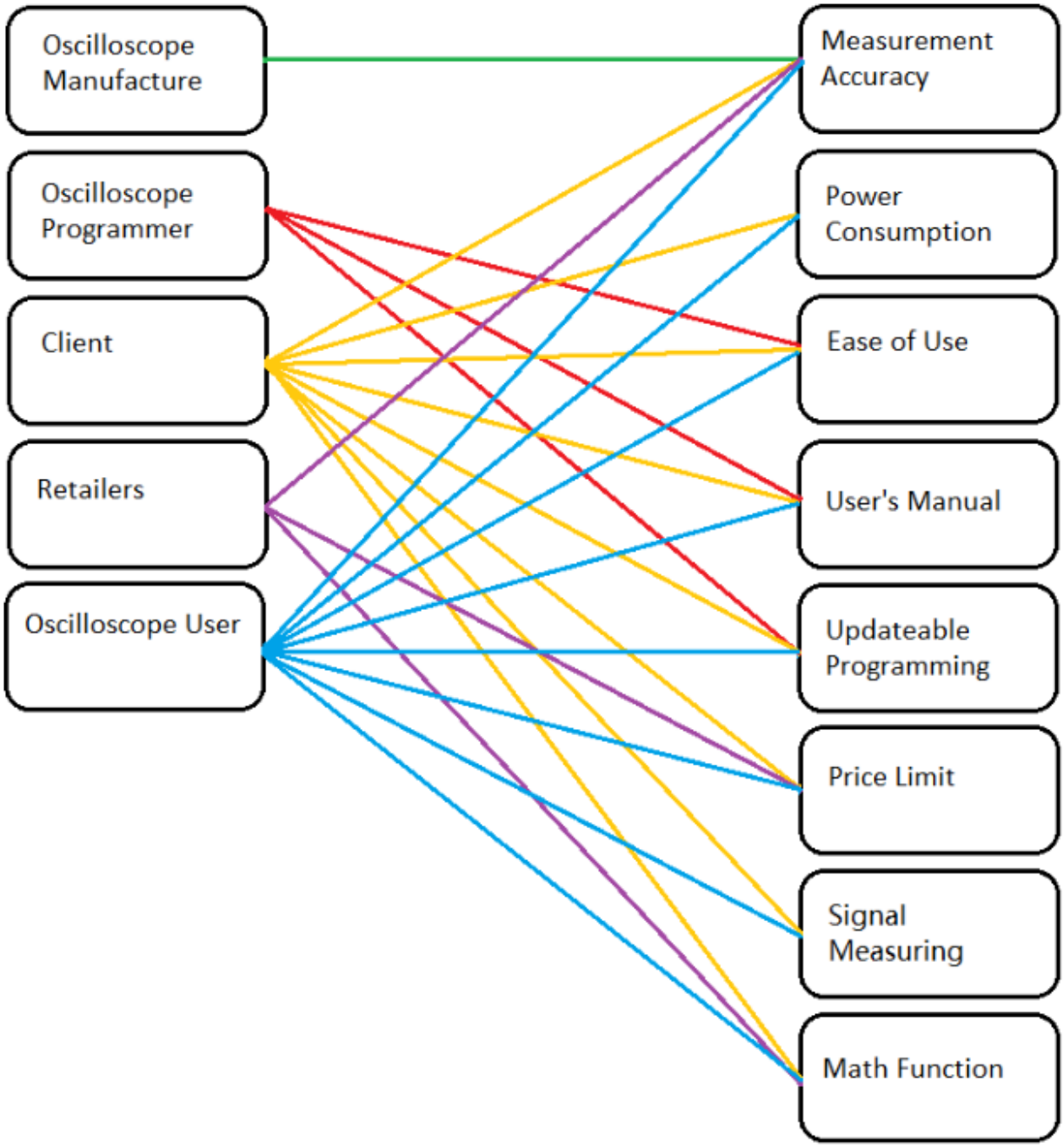

Figure 1. Features matching Stakeholders

Domain Analysis

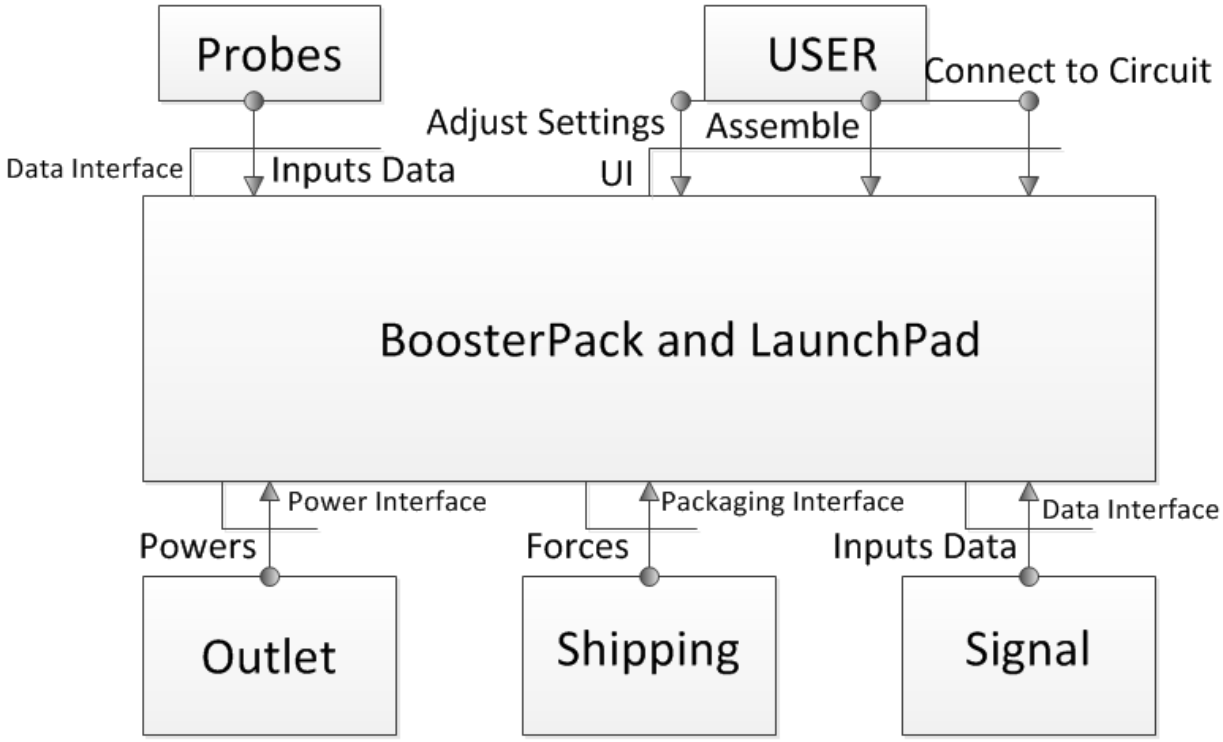

Figure 2. Domain System Diagram

Actor Name	Definition
Outlet	The power source for the oscilloscope will be from a wall port because USB might not be able to provide enough power.
Shipping	Shipping invokes forces on the external casing of the oscilloscope and the components inside it.
User	The user is the hobbyist or professional using the oscilloscope. They both will have the same requirements of the scope.
Signal	The inputted signal can have a wide array of attributes from different frequencies to different amplitudes.

I/O Name	Definition
Assemble	The BoosterPack should have minimal assembly and be able to attach to the LaunchPad without difficulty for the user.
Adjust Settings	The user should be able to change the settings, such as the time scale, voltage scale, cursors, and signal trigger.
Connect to Signal	The user also needs to input the signal to the scope through a device, such as probes.
Signal input	The restrictions on amplitude and frequency of the input signal should be considered while the scope is reading the signal.
Power	The display, microcontroller, and ADC need to be powered. This will come from an outlet.
Forces	Forces will act upon the BoosterPack, LaunchPad, and other subsystems. These parts should not receive major damage through typical use.

Logical Model Analysis

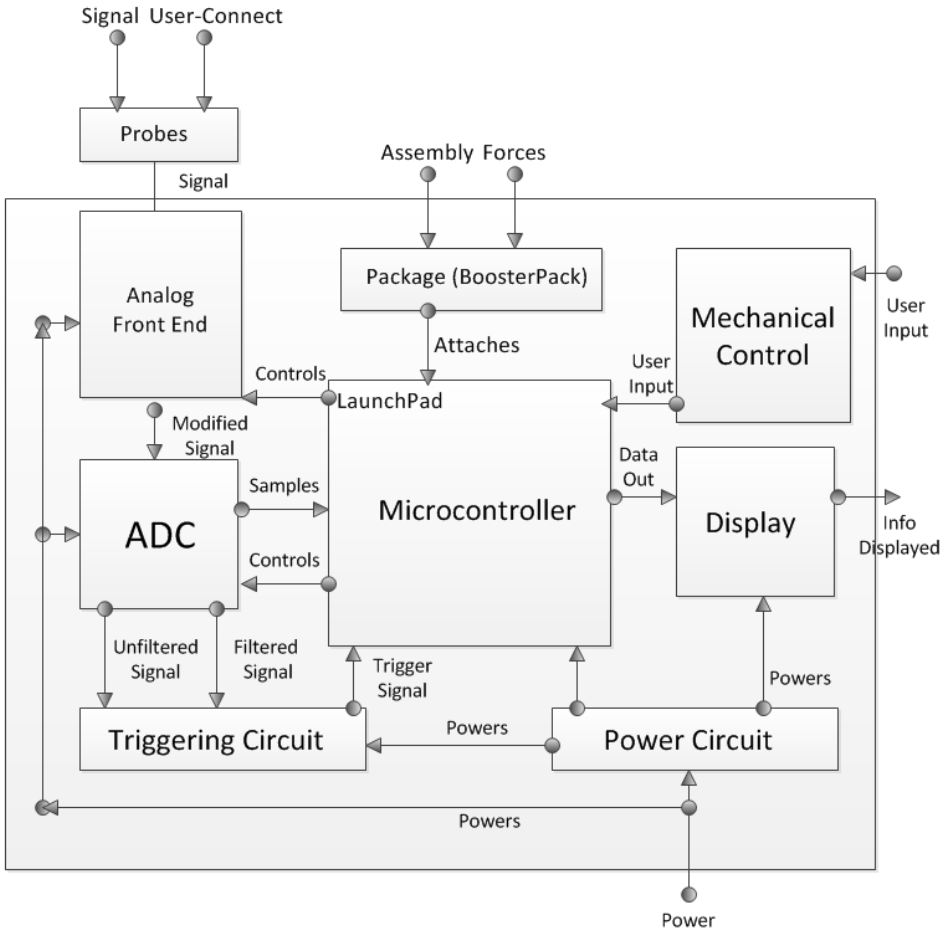

Figure 3. Logic System Diagram

Block Name	Definition
Analog Front End	The analog front end is able to provide gain for small signals or attenuate large signals so it can be read by the ADC.
ADC	The ADC converts the analog signal to a digital signal by producing 65 Msamples/s and sending them to the microcontroller.
Microcontroller	The microcontroller contains the software that can process the samples and output information to the display. It also should be able to change how samples are processed for the displayed input. Finally the micro controller will change settings of the front end so the signal is properly attenuated or amplified.
Display	The display shows the data from the microcontroller and allows the user to view settings.
Power	The power block changes the received voltage, if need be, to supply the ADC, display, and the microcontroller. This will be done through the LaunchPad itself.
Package	The package is the mechanical structure of the BoosterPack so it can withstand forces and function properly. The physical aspect holding the parts together.
Triggering Circuit	This block takes in a filtered and unfiltered signal and uses them to compare to a set trigger level. This sends a signal to the microcontroller to tell it when to start displaying samples.

Internal I/O	Definition
Power	The power should be able to be delivered at the correct voltages to each of the blocks.
Micro to ADC	The microcontroller must provide the ADC with a clock to tell it what speed to samples at.
Micro to Front End	The microcontroller must tell the analog front end how much to attenuate the signal or how much to amplify it.
ADC to Micro	The ADC sends the 10-bit samples to the microprocessor to be processed. This connection can be through a parallel interface.
Micro to Display	The microcontroller sends data to the display to show the sampled signal. The parallel interface is used to keep a high speed transfer.
Mechanical Control to Micro	The mechanical switches send the user input to the microcontroller to change how the signal is processed.
Probes to Analog Front End	The probes input the raw signal into the front end.

Trigger Signal	The signal sent from the triggering circuit to the microcontroller to tell it when to start displaying samples.
Analog Front End to ADC	The front end adjusts the signal so it is able to be read by the ADC.

Interactions Model

Interactions	Descriptions	Involved Actors and Blocks	Features
Change Oscilloscope Settings	The Oscilloscope User uses the mechanical switches to interface with the Oscilloscope Control System, allowing the user's input to browse and customize various settings.	• User • Oscilloscope Control System • Display	• Ease of Use • Languages • User's Manual
Change Power Mode	The Oscilloscope User is able to turn on the oscilloscope with a mechanical button, turning on the Power Supply.	• User • Oscilloscope Control System • Power Source • Mechanical Package	• Power Consumption
Measuring Signals	Using a channel probe, the Oscilloscope Control System takes measurements from the input signal and sends information to the black/white screen.	• Signal • User • ADC Converter • Oscilloscope Control System • Probes	• Measurement Accuracy • Signal Measuring • Updateable Programming

Assembly and Gathering of Parts	The components are shipped from manufacturers to be assembled into the oscilloscope Booster-Pack. The user attaches preassem-bled BoosterPack to the LaunchPad	• Mechanical Package • User • Oscilloscope Control System • Shipping	• Measurement Accuracy • Price Limit • Easy to Manufacture • Lightweight and Small Packaging
Mechanical Packaging Suffers Damage	If components become misconnected then it is up to the Oscilloscope user to decide to keep or discard contents of the BoosterPack	• Mechanical Package • User • Shipping	• Price Limit • Lightweight and Small Packaging
Program Installation	The program is downloaded from an open source and is installed on the Oscilloscope Control System on the LaunchPad	• User • Oscilloscope Control System	•

State Model Diagram

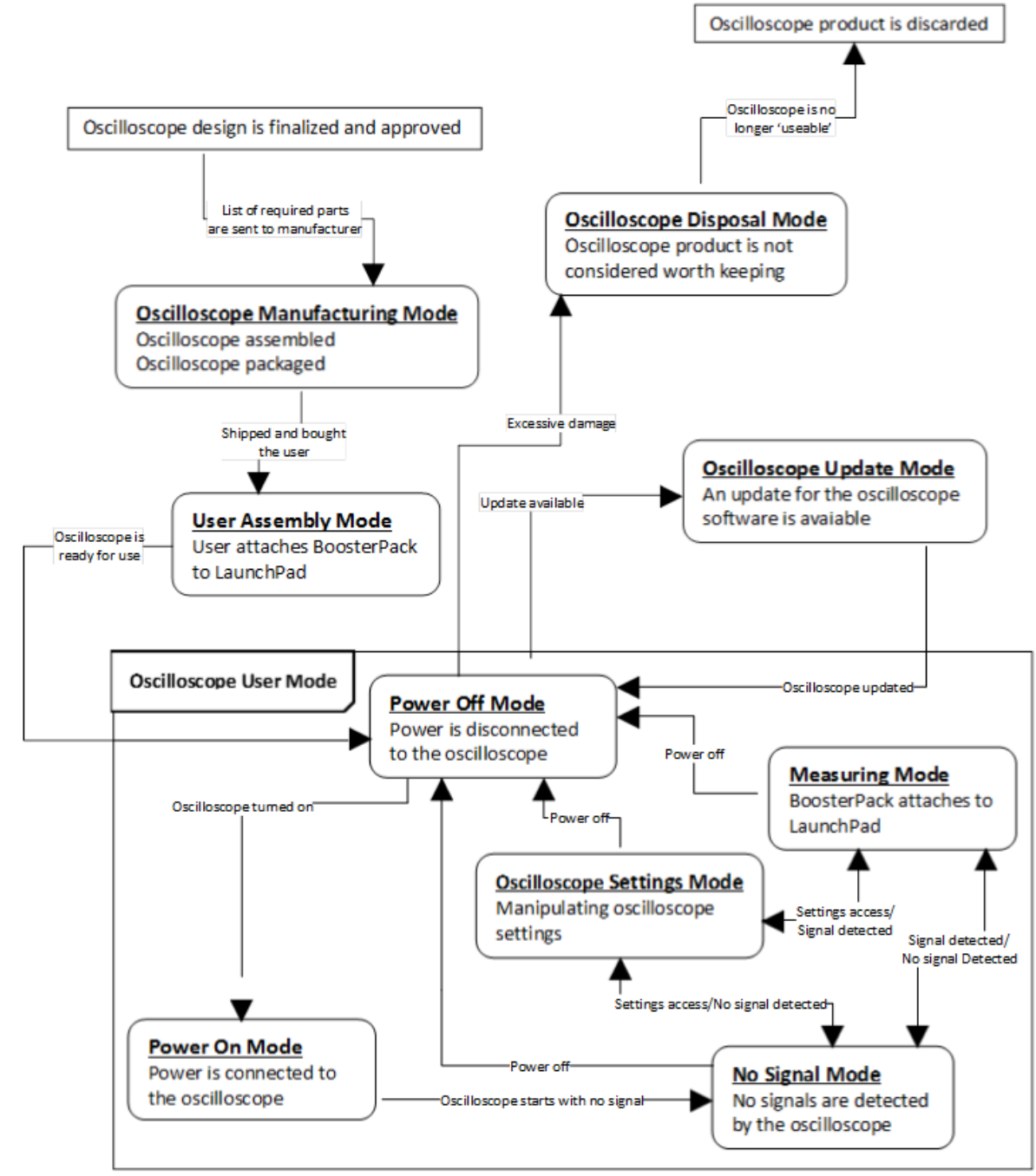

Figure 4. System Mode Diagram

System Mode Name	System Mode Definition
Oscilloscope Manufacturing Mode	Texas Instruments manufactures individual parts and assembles them into sub-systems that are needed for the oscilloscope.
Power On Mode	The oscilloscope initiates its setup and loads default settings.
Oscilloscope Settings Mode	Oscilloscope has sub-menus for signal functions, screen captures, and adjusting various parameters to help with measurement.
Measuring Mode	A signal is detected by the probe(s) and the measurements are shown on the display.
Oscilloscope Update Mode	Updates for the oscilloscope's software can become available and the updates are ready to be installed on the oscilloscope.

System Event Name	System Event Definition
Settings Access/ No Signal Detected	Settings can be changed and viewed concurrently with the oscilloscope notification that there is no signal detected.
Settings Access/ Signal Detected	Settings can be changed and viewed concurrently with the oscilloscope measurements.
Signal Detected/ No Signal Detected	A signal can either be detected or undetected by the oscilloscope.
Excessive Damage	The oscilloscope unit has enough physical damage to operate inefficiently.
Oscilloscope is no longer 'usable'	The usefulness of an oscilloscope unit is determined by the user. Software can be fixed but physical damage is tedious to repair.

Signature Block

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