

*Spangler Prototype Inc. (SPI) specializes in assisting companies to prepare and place electronic products into production. SPI focuses in motor control, battery charging, and lighting systems. We work with manufacturing engineering and contract manufacturers as well as with regulatory testing agents ie. UL and for FCC compliance. SPI began as a contract engineering firm in 1980, designing electronic fluorescent ballasts, many of which went into high volume production.*

## WHAT WE DO

As an engineering design house with decades of experience, we can support small projects or large scale programs to support your product going into production. Please contact us today to discuss your immediate needs.

### Prepare Designs for High Volume Production

Let us help you prepare your design for high volume production. We work with inventors, consultants and semiconductor companies; starting with application notes, demo boards or even engineering concepts.

- PC Board Layout using Altium, the most advanced and innovative PCB design applications
- Prepare PC boards for pre-compliance testing to pass FCC, UL, and other regulatory agencies
- Generate a bill-of-material (BOM) with alternative source

### Preproduction Analysis & Component Selection

Prior to production, we can analyze a product to determine if there are any flaws that prevent the product from obtaining an agency approval due to electrical shock, over-heating, or causing electrical radiating interferences.

- Perform thermal analysis, for pre-compliance test using both thermal couples and IR imaging
- Perform worst case analysis over temperature for components
- Investigate and perform a failure mode analysis on various components to determine if there is a possible fire or electrical shock hazard to the user (required for some UL products)
- EMI-FCC pre-compliance testing to meet the US FCC (Part 15, 18) and European CISPR (22) standards

## Inductor & Transformer Specification Review

Power electronic systems convert energy from one form to another, accomplished through devices like power transistors, transformers and inductors. The design and selection of the inductors and transformer is critical for performance and system efficiency. We can help you identify and analyze trade-offs for cost and performance, and find an optimal solution for high volume production.

- Perform frequency sweep to determine losses at the operating frequency
- Characterize transformers
  - Leakage inductance and coupling coefficient between the various windings
  - Primary and secondary inductance
  - Determine the intra-winding capacitances between windings and parasitic parallel capacitances
  - Calculate the area product (AP) for transformer and inductors in order to obtain optimization for power loss and cost of the inductors and transformers
- Provide guidance for wire selection used in transformers
  - Triple insulated (Rubado) wire to eliminate spacing and smaller AP cores for size reduction
  - Litz wire, insulated magnet wire twisted for lower, high frequency winding losses
  - Insulation on leads to meet 5000 Vac Hi-Pot between primary and secondary, and exposed metal, like the case.
  - Multifilar winding
- Core Material selection
  - Ferrite
  - Powdered Iron
  - Sendust
  - Silicon steel (if desired)

## Stability Analysis

We use a Bode 100 network analyzer to determine the stability of feedback loop. This injects a small control perturbation in the feedback loop that shows both phase margin and gain margin of the system. Good phase margin and gain margin helps maintain the output voltage, current, speed, power and light remain within the defined limits during transients.

## MANUFACTURING PROCESS

SPI's decades of experience in the electronics industry with consumer and automotive products, This means SPI understands the manufacturing process. SPI can become involved in any stage, so let's talk about how we is able to help you when and where you need it.

- **Marketing Concept**

Written specification of what is desired in the product: involves management and marketing to set realistic and obtainable objectives for the new product.

- **Engineering Concept**

A proof of concept or functioning circuit allowing preliminary test to be preformed for functionality. This is referred to as a kluge, breadboard, cut-up unit or proof of concept unit. The circuit is built with lab parts, demo boards or parts available from distribution i.e. Digikey, Mouser, etc.

- **Alpha Prototype**

First pc board layout with an attempt to define components, including input/output ports for microcontrollers to be programmed. Limited thermal rise data is gathered for power semiconductors, inductors, transformers, resistors, and packaging requirements are considered. This phase can take several iterations, where time is spent defining custom components: the case or enclosure, inductors, transformers, heat-sinks, mounting of components, connectors, placement of cables and power sources. A Bill of Material (BOM) is generated which can be used to determine a preliminary cost.

- **Program Review**

A major milestone for any project where engineering (electrical & mechanical), manufacturing, production, and marketing perform cost review for a program status. A review and modification of specification to meet management's objectives at this stage. The review occurs after functional testing of the Alpha prototype.

- **Beta-1 Prototype**

First attempt to have all the components fit into the desired package using the custom parts (BOM) defined in the Alpha prototype phase. A pc board layout is a critical part of this phase for thermal design and EMI interference issues. Final thermal rise data is collected on components inside a case. Assembled and functional units are ready for testing with some units set aside for pre-compliance testing: UL/CSA standards, FCC, power factor correction (PFC), radiated and line conducted FCC (parts 15 and 18), and or European CISPR 22 standards.

- **Beta-2 Prototype**

The second attempt of the Beta-1 prototype phase is used to correct any items that cause the system to fail. Cost reductions are often added in this stage with re-testing required to verify functional operation. This is a second pc board layout which should be very close to production.

- **Pre-Production**

Units are built using production parts. Samples built are used for regulatory agency testing. Marketing and advertising data is collected using these units. This is often the third pc board layout. The final BOM is created and major purchase orders are issued for components.

- **Production**

The product is placed into production.

- **Cost Reduction / Feature change / Obsolete Parts / Conversion from through-hole parts to surface mount technology (SMT):**

Over time a product may have to be redesigned for any number of reasons depending on the life cycle of the product and the life-cycle of the semiconductors and custom components such as inductors and transformers used in production. SPI is open to having a discussion for a product redesign.

## OTHER SERVICES

Contact us if you need an "on-call" Project Engineer for limited time for a program, a competitive analysis for your products, or if you have a special project in mind.

### Staff Engineer

SPI can perform the work of a Staff Engineer on a limited time hourly basis per month or per week, from four hours a month to a much as forty hours per month.

### Competitive Analysis

SPI performs competitive analysis for products including making purchases of the required products, creating a BOM, schematic or block diagram and estimated costing using catalog distributor pricing. Performance measurements can be made so that competitors will not be aware their product is under investigation. This keeps confidential what is being researched for new products until management desires to disclose the project.

## OUR NETWORK AND AFFILIATES

### Heavy Power and RF Projects

SPI works with other independent contractors specializing in heavy power and RF projects. Projects include wireless security systems, microwave transmitters, and extreme high voltage and high power ultraviolet and infrared sources for industrial products.

### Microprocessor & Microcontroller Projects

SPI works with other independent consultants who specialize in programming of microcontrollers and the like; SPI specializes in analog and power circuit designs.

### Mechanical Designers

SPI works with other engineering firms to solve problems.

## REPRESENTATIVE PROJECTS

Jim Spangler, President of SPI, and a Field Applications Engineer for Motorola Semiconductor, On Semiconductor and other employers' has provided professional engineering design services to a number of companies. For your review, below is a sampling of representative projects.

- I designed demo boards for variable speed universal wound motor controls used in kitchen appliances.
- I designed a brushless dc motor system used for starting a three horsepower four stroke gasoline engine that that used the back-emf to charge the 12 Vdc gel-cell. In addition dynamic braking was incorporated to stop the engine rapidly.
- SPI redesigned an Automotive Truck Cabin Fan Controller using a dc brushed motor that developed a constant motor voltage over varying battery conditions. The redesign allowed the controller to be used for 12 Vdc or 24 Vdc automotive systems. The redesign was required due to obsolete power semiconductor devices.
- A one horsepower three-phase induction motor control with variable speed controller, from 5 Hz -120 Hz, PhD thesis, using V/Hz control with CW and CCW open loop control was designed, built and tested. Three, 208 Vac three-phase induction motors were characterized providing per-phase parameters.
- Several brushless dc motors were analyzed, that are used for electric steering for their winding technique and magnet placement to provide low torque ripple, as part of a cost reduction program for high volume automotive applications.
- I designed electronic fluorescent ballasts for various types of lamps, including F40T12, F32T8, F96T12, F26T5, F54T5, and numerous compact florescent lamp ballast systems that went into volume production.
- I designed demo boards and wrote applications note for LED Power Supplies using 12 Vdc and 120 Vac - 277 Vac power systems with PFC for industry publications. Some designs are in volume production.
- SPI designed a USB cell phone and tablet battery chargers. One of these is in volume production.

## CONTACT

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