

# Programmable Electron Beam Sweep Controller

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SRQ Technology, in cooperation with two other local companies, recently developed a full-featured X-Y sweep controller. Its purpose: to control the electron beam's movement in a vacuum deposition system. Developed for Island e-Beam, Bradenton, FL, you can see it at their web site, [www.islandebeam.com](http://www.islandebeam.com). Look under the *Control Electronics* tab.

## *The application.*

In vacuum deposition the material to be deposited is vaporized by bombarding it with a high-energy electron beam. The beam is swept over and around the target in a controlled fashion, uniformly heating and vaporizing the material. Its motion is directed by electromagnetic coils, one each for the X and Y positions, much like the beam of a cathode ray tube. The sweep controller's job is to supply and control the two coil currents.

## *The project.*

Island e-Beam's expertise is vacuum deposition, including the coils and magnetic structure, but not electronics. When the controller they had been using was discontinued they contacted their Bradenton business neighbor, JH Technology ([www.jhtechnology.com](http://www.jhtechnology.com)), about providing a replacement. JH Technology is an electronics company focusing on industrial measurement instrumentation, but for this project they turned to SRQ Technology, Sarasota, FL, an electronics consulting and design company ([www.srqtechnology.com](http://www.srqtechnology.com)). SRQ and JH have co-operated on previous projects; in fact, the owner of SRQ Technology was the founder and original president/chief engineer of JH Technology. SRQ Technology designed the electronics and programming while JH Technology designed the enclosure and physical assembly. Island e-Beam recommended the features

needed, provided the test facilities and worked with the others on development testing. JH Technology now manufactures the sweep controller for Island eBeam. In addition to providing it to their own customers, Island e-Beam is promoting it to others as an updated, state-of-the-art replacement for the now-discontinued controller.

## *What it does.*

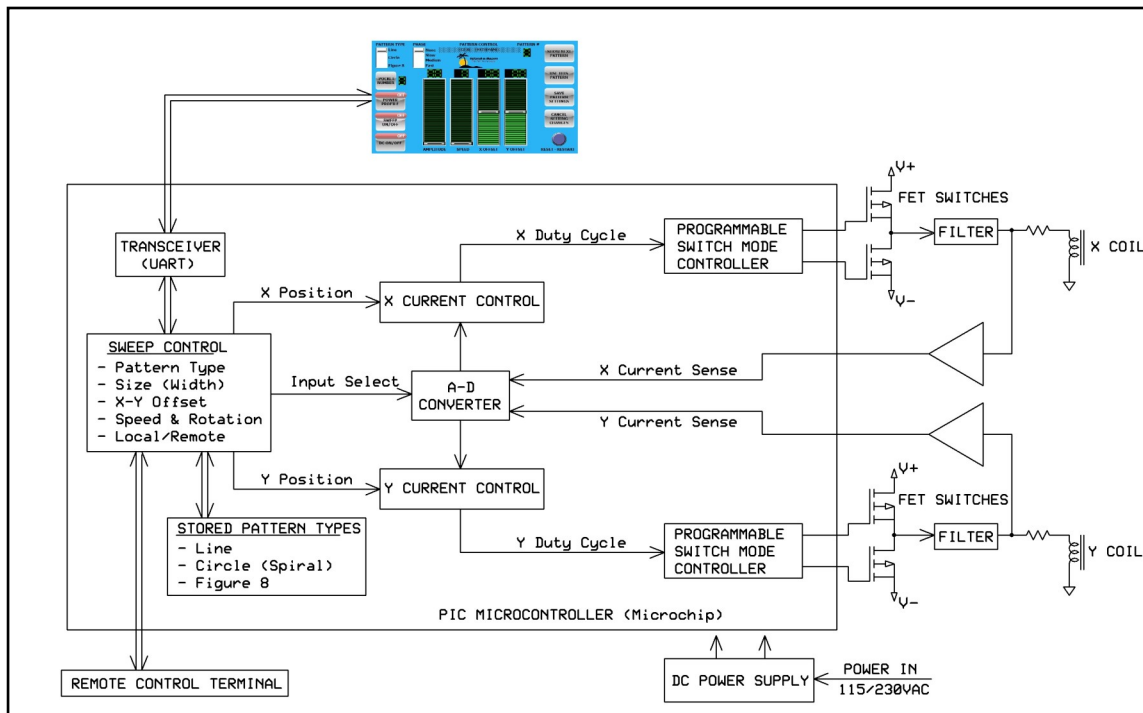
Different applications require different sweep patterns. The controller provides four basic pattern types: a straight line, a spiraling circle, figure 8 or a stationary dot. All except the dot may be stationary or rotated. The pattern size can be varied small to large, the sweep rate can be slow or fast and the pattern can be offset in both the X and Y directions. Up to seven pattern settings—combinations of type, size, sweep rate and offset—can be stored. All settings are selectable from a touch screen panel: there also is a rear-panel connector that allows remote on/off control and choice of pattern setting.

In operation, the controller supplies and varies the X and Y coil currents per the pattern settings. The coils can get hot and usually are water-cooled: a safety interlock stops operation if the coolant system fails. A second safety feature prevents operation if the coils are not connected.

*How it works.*

The program is contained entirely in a Microchip ([www.microchip.com](http://www.microchip.com)) PIC™ microcontroller. A gen4™ touch screen display from 4D Systems ([www.4dsystems.com.au](http://www.4dsystems.com.au)) provides the user interface. Remote control connections are on the rear panel. The 4D display offers significant high-level programming and control capabilities but in this design is used simply as a “dumb” terminal. See the block diagram.

Sweep Control repeats at a rate determined by how fast the pattern runs. Each time through, it uses the current pattern settings to compute the next X and Y beam positions. Current Control takes those positions plus feedback from the current sensors and computes the duty cycle settings for the X and Y switch mode controllers. They, in turn, control the “on” and “off” times of the FETs. Current sense feedback from the two coils keeps the currents constant



Several sub-programs are included in the PIC operating system. Sweep Control is primary. It sends each X-Y point to Current Control which, in turn, converts them to duty-cycle settings for the switch mode controllers. The patterns—line, circle and figure 8—also are stored as sub-programs. Other sub-programs not shown here handle additional details. The microcontroller itself provides a number of peripheral functions: the switch-mode controllers, an analog to digital converter, a transceiver (UART) used for display communication, two signal amplifiers (op amps), a precision voltage reference and others.

despite variations in the coil resistances.

*Conclusion.*

The sweep controller’s design combines user-friendly touch screen control with up-to-date microprocessor technology for precise operation. By combining SRQ Technology’s design and programming expertise with Island e-Beam’s vacuum deposition knowledge and experience and JH Technology’s design and manufacturing capabilities the three companies have created a modern, updated replacement for a discontinued controller.