Autoloader Control Electronics

The autoloader control electronics were designed with the aim of linking the mechanism and firmware elements with low-risk, proven technology at low cost. The main controller printed circuit assembly is a through-hole design with a shape to suit the space available. The space envelope for the printed circuit assembly was derived directly from the mechanical CAD model because it was so tight. Control of the mechanism is managed by a Hitachi H8/325 microcontroller with on-board one-time-programmable (OTP) and RAM memories, nearly 90% of the pins being available for I/O. Logic-level pulse width modulation signals generated by the microcontroller control the dc motors and their integral gearboxes. Two-level motor current sensing is used to detect mechanical jams or excessive motor loading. The four motors and the picker solenoid are powered from the 12V supply available in 5¼-inch peripheral slots.

The state of the mechanism is determined by optical means. For each motion, a mechanical part has a rib that is made to pass through slotted optical switches. The rib has slots at datum positions in the motion that are detected by the optoswitch. The width of each slot is calculated to reflect the mechanical tolerance of the particular motion so that the firmware can guarantee a particular mechanical position as long as the optical switch is open. An important philosophy here was to position each slotted rib (comb) at the "point of action" (the farthest point from the motor drive) so that backlash does not compromise the accuracy of the position detection.

By using relatively large (and inexpensive) motor drive ICs operating well within their thermal specifications and mounting the printed circuit assembly vertically for optimum convection cooling, thermal problems were avoided. For the picking action, an oversized solenoid is operated conservatively so that it does not get too hot. The solenoid delivers a relatively large force for the picker fingers but for short durations (less than two seconds).

The front-panel printed circuit assembly is connected to the main controller printed circuit assembly by a flexible circuit. Mounted on the front-panel printed circuit assembly are the three front-panel switches, the door open optoswitch, three LEDs, and the LCD. The LCD is a custom design procured with a standard driver IC on its flexible circuit, which is soldered to the front-panel printed circuit assembly. All of these components were physically modeled in the HP ME30 CAD system to integrate the electrical and mechanical designs.

An important design goal was ease of access to the printed circuit assembly since the firmware is stored in an OTP device that must be replaced if firmware upgrades are necessary. To this end the board is fully connectorized and fixed by a single screw. No adjustments or calibrations to the printed circuit assembly are needed, so complete printed circuit assemblies can be swapped in if necessary. The layout of the printed circuit board is heavily influenced by the flexible circuit designs and a lot of time in the early stages of the project was spent on the topography of the flexible circuits, their routing, and the effect of the positions and direction of entry on the printed circuit assembly layout. In particular, to keep the cost of the flexible circuits as low as possible they were all designed as single-sided circuits. This dictated pin ordering on the printed circuit assembly, which also needed to have minimum layers to keep it low in cost. The final printed circuit assembly has just four layers including power and ground planes covering 90% of the board area. There are four flexible circuits connecting the motions and the front-panel printed circuit assembly. Their physical layouts were modeled on the HP ME30 system and also using paper mock-ups to check for control of their positions when moving, as well as track layout.

Greg K. Trezise
Development Engineer
Computer Peripherals Bristol