Overview
A SmartTrac system was connected to an injection press molding a BMC circuit breaker housing. SmartTrac uses in-mold sensors to monitor the cure rate and automatically adjust the cure time. SmartTrac delivered the following results in this application:

- Reduced the cure time from 15 seconds to 11.7 seconds, representing a cure time savings of 22%.
- Automatically detected and accounted for temperature variations affecting the cure rate.
- Ensured no under-cured parts were produced.
- Demonstrated a full return on investment in less than one year.

Problem
A manufacturer of BMC circuit breaker housings used cure time safety margins to prevent scrap caused by process variability. Cure time safety margins are a standard practice of thermoset molders, who sacrifice productivity to ensure quality parts are shipped. This safety margin adds variable cost to the part, reduces throughput, and lowers the return on capital equipment. Safety margins are often 15% of the cure time or greater, but still don’t account for process upsets, causing further productivity loss from scrap and machine downtime.

Solution
A SmartTrac system was connected to the press with an impedance sensor mounted in the mold. The sensor measures the dielectric properties of the BMC, which change as the part cures. Unlike cure time safety margins, SmartTrac’s real-time cure monitoring allows it to adjust and optimize each cycle. SmartTrac receives a signal from the press to start monitoring, analyses the in-mold sensor data to determine the proper time to end the cure, and sends a signal to the press to end the cycle.

Results – Typical Impedance Sensor
The graph below displays a typical impedance signature from this application. The signature immediately drops at the start of the cure cycle as the cross-linking reaction begins. As the cure reaction completes, the impedance stabilizes.
Adequate cure occurs when the impedance signature flattens. The figure above shows that at nominal conditions, the flat is reached well before the normal end of cure. However, the cure curve changes on every cycle due to heater cycling, batch differences, and other process variations. The normal fixed time is longer than the optimum time to ensure good parts from cycles in which the cure rate is slower than normal.

Results – SmartTrac Production Run
SmartTrac reliably shortened the cure time without sacrificing part quality during a 980 cycle production run. The last 391 cycles of the run used the fastest control settings. The run chart below shows the optimum cure time produced by SmartTrac over the last 391 cycles.

The run chart shows SmartTrac reduced the average cure time more than 3 seconds from a normal fixed time of 15 seconds. No defective parts were found from the 980 produced in the SmartTrac controlled run. In addition, the chart shows cure times fluctuated cyclically around the average. These oscillations were caused by the mold heaters cycling on and off to maintain the mold temperature. The oscillations demonstrate SmartTrac’s ability to detect and account for even minor variations in the cure rate.

Summary
- SmartTrac reduced the cure time by 22% in this application, while simultaneously assuring no parts were under cured.
- SmartTrac automatically detected and accounted for normal process variations. This ability increases throughput by reducing scrap and increasing machine utilization.
- SmartTrac provides a full payback in less than 12 months based on cure time savings alone.