

## Ensuring hospital robots stay 100 % reliable

### Application Note

#### Testing Functions Case Study



Founded in 2002, Aethon Inc. of Pittsburgh, Pennsylvania developed and produces the TUG® automated courier system now used in more than 100 hospitals. The TUG robot delivers and tracks the location of instruments, medications, meals, lab specimens and other important cargo anywhere in a facility. TUG attaches to and pulls hospital carts up to 500 pounds and has the unique ability to move from floor to floor using an existing elevator system.

Each TUG robot has a base station related to its application. For example, a robot assigned to deliver drugs is sited in the pharmacy area. Physicians enter orders for prescriptions into the hospital's computerized physician order entry (CPOE) and medication administration system. The order is sent to a pharmacist who fills it and places it in the robot's delivery tray and selects the robot's destination. The robot then navigates the hallways, opens automatic doors, operates elevators, delivers the drugs, and then returns to its home base.

By taking care of mundane delivery chores, these robots free up healthcare providers to spend more time with patients and perform other healthcare-related tasks. "This automated technology platform helps increase productivity and staff satisfaction,

while saving hospitals time and money," said Barry Skirble, Aethon's Chief Information Officer. "And the nice thing about the robot is, it doesn't matter whether it's raining or snowing or whatever, it gets its job done."

#### Keeping robots running 24x7

Patients and healthcare providers depend on the reliability of TUG robots to provide deliveries on a continuous basis without interruptions or downtime. Aethon takes this responsibility very seriously and is continuously working to improve the already extremely reliable performance of its courier robots. One of the people on the front lines of this effort is Jesse James. His official title is Systems Engineer with Aethon but he calls himself a "cleaner," because the most important part of his job is to



**Tools:** Fluke 179 Digital Multimeter, Fluke 123 ScopeMeter® Test Tool

**Operator:** Jesse James, Systems Engineer, Aethon Inc.

**Measurements:** Monitoring voltage to evaluate switch function and position indicators; Min/Max voltage across a resistor; checking motherboard power supplies.

ensure that the TUG runs as perfectly in the real world as it does in the lab. Jesse diagnoses each problem and determines how to prevent it from affecting other TUG users.

Jesse says that his most valuable diagnostic tool is the Fluke 179 Digital Multimeter. "Fluke multimeters match our robots in their extreme reliability," says Jesse. "In the decades I have used them, I have never experienced a failure. Fluke also has the ruggedness to protect me from shock in the event that an unexpectedly high voltage appears across the meter."

### Providing reliable elevator operation

In one example of Jesse's troubleshooting work, Aethon's robots were being integrated with a new elevator controller model. In order to operate an elevator, Aethon connects a control unit to the elevator control panel and its courier robot communicates with the control unit using wireless transmissions. The inputs to the control unit are the door open limit switch and the floor position indicator, and the outputs are the car call and the door open.

When the robot arrives, it sends a signal to call the elevator and the control unit issues the command to the elevator control panel. When the elevator arrives at the robot's floor, the door opens and a limit switch on the outside of the door closes and sends a signal to the control unit. When the robot receives this signal, it gets on the elevator.

The robot is designed to share the ride with human passengers. When it gets on the elevator, it says: "Please press your floor button," and waits to see if a

button is pushed. If a button is pushed, the robot rides along to the human's destination and only takes control of the elevator after the human has left. At that point, the elevator no longer responds to calls from other passengers. While the robot is riding the elevator, it waits for a signal from the control unit that the elevator has reached the proper floor and also for a second signal from a limit switch that the door is open. At this point, the robot leaves the elevator.

During integration testing, intermittent problems were seen where the elevator arrived and opened its doors but the robot would not get on and also where the elevator would take the robot to the proper floor and open its doors but the robot would not get off. Jesse used the Fluke 179 multimeter to measure the signals coming from the control unit. Jesse connected the Fluke multimeter to the contacts on the control unit and operated the elevator. The first thing he noticed was that the limit switches were not consistently closing as the doors opened. The robot had no way to know that the doors had been opened, so it naturally would not get on or off the elevator as expected.

Jesse also determined that the position indicators in the elevator control panel were also operating intermittently, so the robot was at times unaware that it had arrived at the proper floor. The diagnosis indicated that the robot was operating perfectly but there were problems with the elevator controls. Jesse prepared a report for the elevator service technician, the elevator service technician corrected the problems, and the robot operated perfectly from that point on.

### Tough applications create battery challenges

In another test, Jesse was investigating why the robot's battery life was less than expected and the servo motors that drive the robot were prematurely burning out using a newly designed motor controller board. Jesse had previously built a small device that he uses to measure the power being delivered by the battery. This device places a 1 kΩ resistor in series with the battery cable. Jesse used the Fluke 179 Multimeter to measure the voltage across the resistor and stored the maximum voltage in the meter using its Min/Max/Average feature. Jesse then used



Troubleshooting controls on the tow-unit that the robot pulls.





Evaluating power signals with his ScopeMeter.

Ohm's law to calculate the power provided by the batteries. He let the robot proceed through its rounds but stopped it every 50 feet to determine the maximum amperage provided during that period. Over the vast majority of the route traversed by the robot, Jesse determined that the amperage was normal.

But he saw that in one particular area where the robot passed on nearly every route, the amperage spiked to dangerously high levels. Jesse identified two obstacles in this area that were difficult for the robot to traverse. One was an expansion joint, and the second was the border between a tile and a carpeted floor. Jesse addressed

this challenging terrain by reprogramming the robot with a maximum torque value of 90 percent compared to the normal maximum value of 70 percent. After he made this change, the robot easily traversed the difficult area, the battery life returned to normal, and the motor problems disappeared.

### **Helping a robot keep the right time**

In another case, the robot was not keeping the correct time. This is important because the robot generates regular reports that help track the status of materials in the hospital. Every time the robot turned off, the clock reset back to March 2003.

Jesse suspected a problem with the robot's battery, but it tested fine. Then, since the timing is maintained on the motherboard, Jesse checked each of the power leads running to the board. He used the Fluke TP920 push-on test probe adaptor set.

"The TP920 includes long needle-like probes that are ideal for inserting in Molex type connectors that power many boards," Jesse said. "This job would have taken considerably longer without them because I would have had to remove and replace the connector on each power cable in order to test it." Jesse tested each of the power cables and discovered one that was shorted to ground. He replaced the cable. This fixed the problem and the robot worked perfectly from that point on.

"We understand the importance to our customers of keeping our robots running 24x7," Jesse concluded. "That's why on any given day you will find me creating and diagnosing unusual situations. My goal is not only to fix the problem but also help prevent it from happening on site or in future-development. My Fluke 179 Multimeter plays an important role by providing the ability to perform virtually any electrical measurement with a high degree of reliability that helps me get the job done right the first time."

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