Keysight Technologies
Maintenance of Electronic Factory Equipment and Process Line

Handheld test tools that enable troubleshooting
and repair personnel to respond quickly and effectively

Application Note

Unlocking Measurement Insights

Introduction

Factory assembly and test processes can vary in the degree of automation that can be implemented. Some factories choose manual processes due to a high mix of products and low volume output. However, some processes can be completely automated due to high volume output, for example, processes related to IC fabrication and packaging.

Factories normally have dedicated, or sometimes outsourced, equipment maintenance personnel to attend to the assembly and test equipment. The main role of the maintenance personnel is to keep all the equipment running in tip-top condition and to support the goal of maximizing the production line uptime.

This application note describes how handheld measurement tools are used to maintain several key equipment and processes in an electronics factory. Figure 1 shows an example of the typical equipment found on a maintenance lab bench.

Figure 1: Typical equipment maintenance lab bench

Productive Maintenance on Assembly and Test Equipment

In electronics factories with a high level of automation—enabling a high production throughput measured in units per hour, the production line is optimized for speed and accuracy. The production line is a highly refined process where parts are modified and improved as they pass along the line. Multiple parts go through this process, in a concurrent manner, until they reach a final assembly stage. In light of the significant efforts made to ensure the production line operate efficiently, any interruption to the production can mean significant loss in revenue to an electronics factory.

This chapter highlights the use of handheld devices to perform test and measurement tasks for the following instances when a production line may be interrupted:

- Equipment breakdown due to power related issues such as blown fuses, tripped circuit breakers, and faulty power line protection circuits
- Planned setup time for production or configuration changes

The challenge for the maintenance personnel is to ensure the maintenance activities cause minimal delay to the operation of the production line. To help them perform their tasks efficiently, Keysight has a series of handheld digital multimeters and handheld oscilloscopes that speeds up identifying and troubleshooting equipment issues.

Performing fundamental checks on fuses, circuit breakers, and power line protection circuits

When a production line is interrupted because of equipment or line process failure, maintenance personnel equipped with key troubleshooting tools are alerted to identify and troubleshoot the fault. One of the initial fundamental checks they perform for faulty assembly or test equipment is to check the main fuses, circuit breakers, and power line protection circuits.

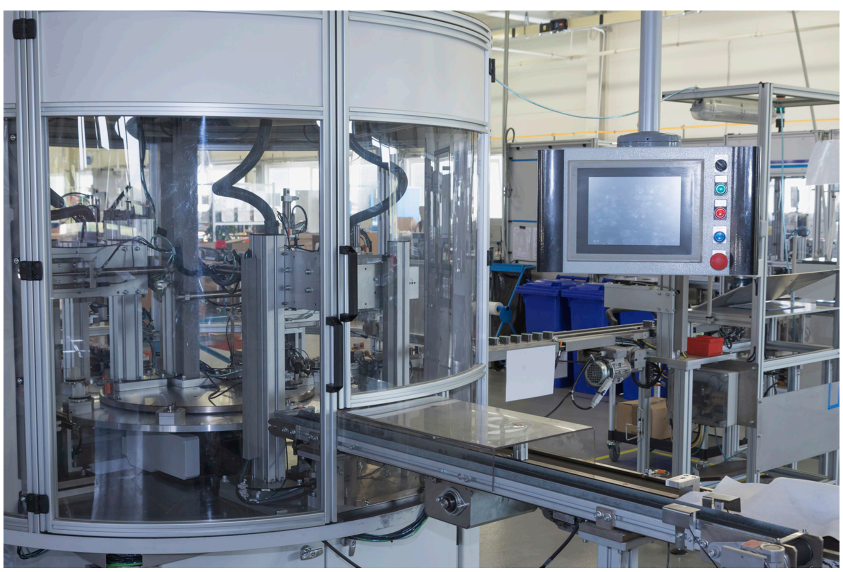

Figure 2: Example of an assembly and handling production line

However, a production line with automation is not a convenient environment to perform these tests. An example of an assembly and handling production line is shown in Figure 2. Clearly, there is very little space for large test tools for the maintenance personnel to identify and troubleshoot the assembly and test stations. In such situations, handheld digital multimeters and handheld oscilloscopes, paired with a Bluetooth remote link and a data-logger solution, provide maintenance personnel with the necessary electrical troubleshooting capabilities. These handheld devices, with their compact form factor and rugged build, are versatile tools that enable maintenance personnel to perform the initial fundamental checks even in hard to reach areas. For example, the Keysight U1280A series handheld digital multimeter, with its 800-hour battery life, enables the maintenance personnel to perform their tasks in the factory without being restricted by a power cable. Furthermore, it is IP67 certified dust and water-resistant, which makes it rugged enough to withstand the harsh conditions in the factory. For difficult to reach areas, the U1280A provides programmable and remote test capabilities using the Keysight U1117A IR-to-Bluetooth adapter.

The maintenance personnel can use software reporting tools from the handheld digital multimeter and handheld oscilloscope to analyze the fault. The software reporting tool can generate trend charts, measurement table, and distribution charts (histograms). For example, the distribution chart is especially useful for analyzing intermittent or tolerance related issues. Figure 3 and Figure 4 show examples of the reporting capabilities of the Keysight Handheld Meter Logger software.

With this information, the maintenance personnel can effectively communicate their findings across departments or management. By understanding the issue, informed decisions can be made to assess the potential impact of an interruption to the production line and determine the severity of any loss in yield.

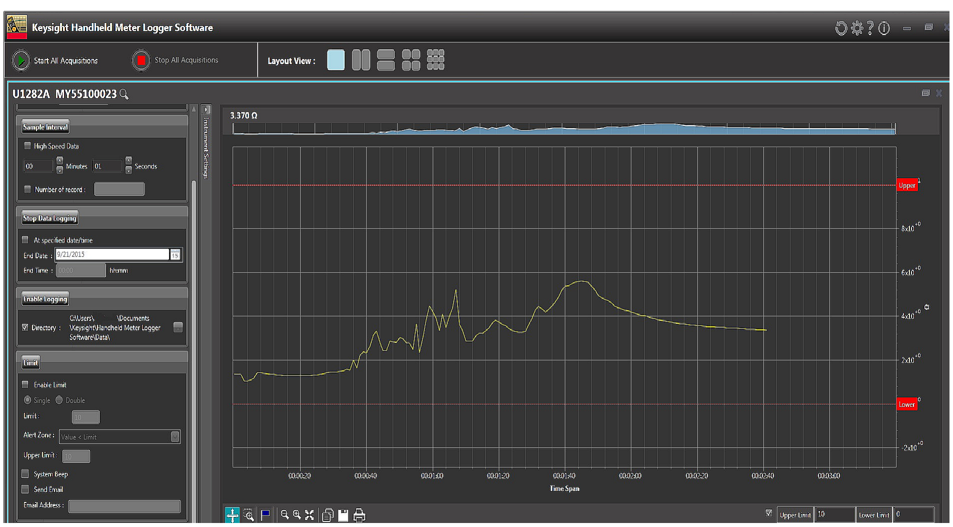

Figure 3: Trend chart from the Keysight Handheld Meter Logger software

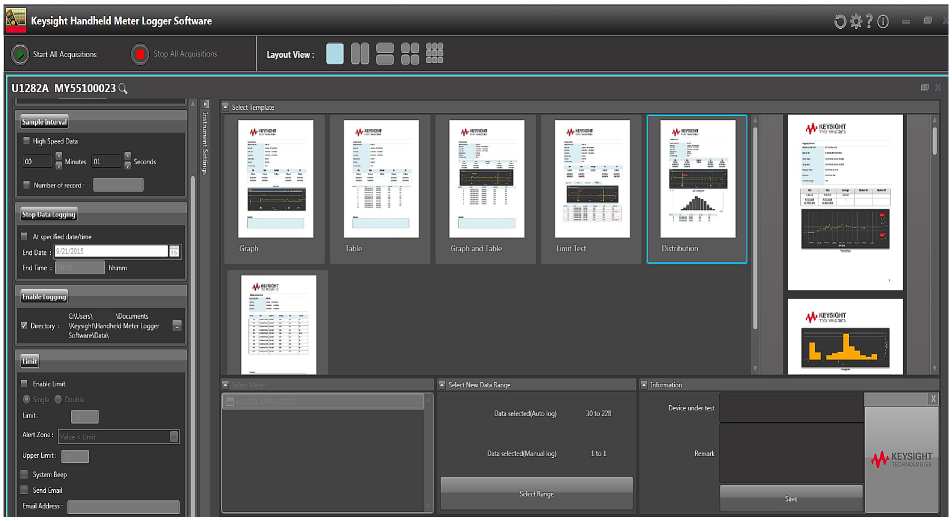

Figure 4: Report generation tool in the Keysight Handheld Meter Logger software

Checking setup processes during production or configuration changes

There comes a time when the production line is intentionally interrupted in order to configure and set up for a change in the production. This scheduled interruption in the production line is called a changeover, and the changeover time can last a few minutes or longer, depending on the extent of the change. The changeover time allows production shift changes, product model build changes, and configuration changes. The setup processes normally follow predefined standard operating procedures, where technicians must execute flawlessly within a specific downtime period.

Among the checks performed during this time includes checking the assembly and test equipment thoroughly in order to ensure there is no impact to the production yield and throughput. This is because a production line is more than its individual parts. It is a single system that if a point in its process has a fault, the repercussions of that fault propagates from that point forward to the rest of the system.

For example, checking the integrity of power lines to the assembly and test equipment is one of the key fundamental checks during setup. Because the power lines drive the input modules, output modules, and controllers, this check is critical in order to avoid any wrong or bad power connections that may cause catastrophic failures to the products under assembly. Bad power connections could be in the form of wear and tear close to the ends of the cable connectors where they are subjected to significant bending (see Figure 5).

Figure 5: Example of a broken cable close to the connector end

Identifying and Troubleshooting Components of Process Automation

To enhance efficiency and productivity in electronics factories, repetitive tasks are identified and streamlined by introducing automated processes. For example, processes in inventory warehouses and manufacturing lines can be automated with conveyors, multi-level storage and retrieval carousels, sensors to detect presence and displacement of objects, image sensors for machine vision applications, machine test automation, and more.

Because every inch of the factory floor is valuable space, typically the process automation equipment is built to take up as little floor space as possible (see Figure 6). This result in cramped working environment should a component fail. Therefore, a technician requires tools that are designed to be compact and mobile without sacrificing measurement accuracy and performance.

Figure 6: Example of a fully automated test process system

Locating faulty sensors and actuators

An automation setup comprises sensors and actuators that perform the precise and rapid assembly tasks. This section highlights examples of tasks technicians perform in order to ensure the production line operates at its full potential:

- Ensuring the return voltages of sensors are according to specifications
- Applying proper voltages to solenoid actuators to check for correct operation

Ensuring the return voltages of sensors are according to specifications

There are many types of sensors used in automation. To name a few, there are photoelectric sensors mostly to detect presence, laser/LED sensors for accurate displacement measurements, image/vision sensors for automated visual inspection, and ultrasonic sensors to detect transparent/glass objects.

These sensors function by returning different voltages—either logic high or logic low voltages, or a range of voltages that can be translated into displacement measurements, i.e., the measurement of the dimension of the object in addition to the distance between the object and a point of reference—as they detect their surroundings. Most sensors with a range output employ the industry standard 4–20 mA current loop as the analog communication interface to the analog input of controller boards. Add a resistor load of 250 Ω to convert the sensor output to the voltage range of 1–5 V, enabling handheld digital multimeters to detect the return voltages (see Figure 7). This allows the maintenance personnel to troubleshoot the sensors.

Actuators in factories are typically electrically controlled solenoid valves that turn on or turn off pneumatic or hydraulic flow; these are called pneumatic actuators. There are also the ultrasonic actuators, which vibrate continuously to move objects or other tasks. Pneumatic and hydraulic powered actuators require proper positioning sensors to close the loop with the controller boards.

To determine the fault in the positioning sensors of an actuator, the handheld digital multimeter is again the ideal tool to troubleshoot the controller, the actuator, and the sensor loop

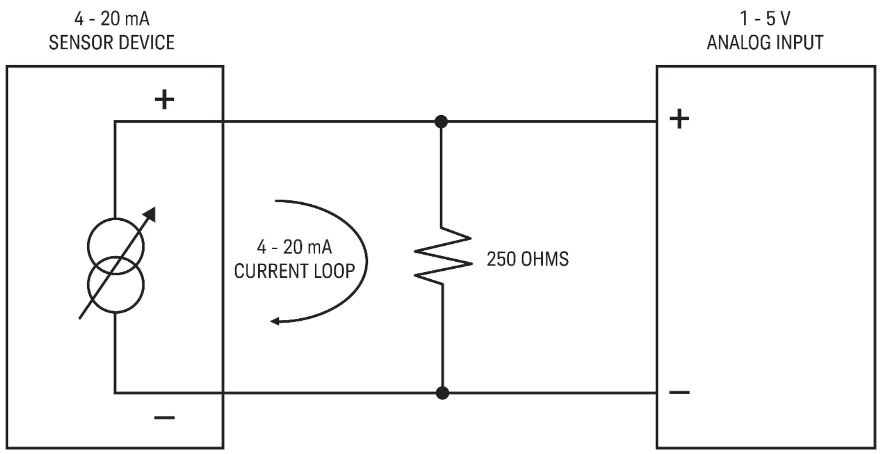

Figure 7: Using a 250 Ω test load to convert 4–20 mA to 1–5 V analog measuring range

If the sensor has a linear output, you can easily perform quick minimum point, mid-point, and maximum point checks to determine if the sensor is functioning properly.

However, if the sensor has a non-linear output, you will need to refer to the manufacturer data sheet to check the characteristics of the sensor to ensure it is functioning properly.

Applying proper voltages to solenoid actuators to check for correct operation

Solenoid actuators can potentially fail if proper voltage is not used according to manufacturer's specifications. Voltage to the coil should be at least 85% of the rating shown on the valve's nameplate.

Undervoltage means potentially the coil cannot be energized to turn on in order to make the valve to switch position. Alternatively, overvoltage can cause the coil to burn out. Check for any blockages at the valve or for anything that can cause pressure differentials that are too high for the valve to open. These events produce high inrush current that eventually causes the coil to burn out.

A handheld digital multimeter can be used to check the voltage at the coil. Normally, solenoid actuators are placed throughout conveyors and inside equipment. These are difficult to reach areas, which makes handheld digital multimeters the ideal tool for the task.

Troubleshooting PLC, microcontroller cards, and power sources

Programmable Logic Controller (PLC) is a fully integrated and easily programmable system that is widely used in factory automation and many other industrial automated systems. An example of a PLC and Servo drive controller are shown in Figure 8.

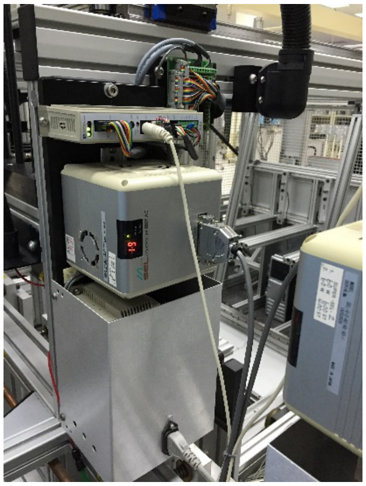

Figure 8: Example of a PLC for factory automation

The following is an example of a procedure to inspect a PLC—which includes the micro-controller cards, input and output modules, and power sources—for proper operation.

Step 1
Check the electrical integrity of the power and ground of the PLC. Use a handheld digital multimeter to measure if there is any voltage present between the PLC ground and a known good ground. The AC and DC voltages should be zero.

Step 2
Check the power to the PLC is within the recommended range. Check the battery voltages in the system and make sure they are within recommended values (see Figure 9).

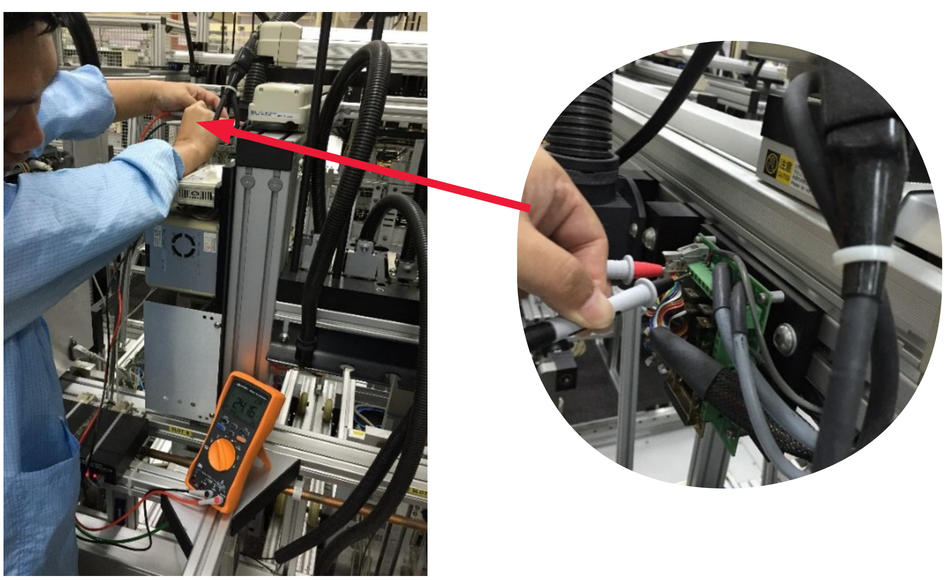

Figure 9: Assistant Engineer checking the voltage output of a 24 V supply

Step 3

Check for any external Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) noises in the surrounding area close to the PLC main controllers. The presence of EMI and RFI noises may cause erratic behaviors and false triggers when these noises are coupled as feedback into the PLC. Sources of EMI may be from large noisy motors, old switching power supplies, and electronic circuit boards with improper or degraded EMI shielding. RFI sources, on the other hand, may be from old noisy handheld radio transmitters. The Keysight U1600 series handheld oscilloscope enables the measurement of feedback signals to roughly determine if there are EMI or RFI noises being coupled into the PLC.

Step 4

Troubleshoot digital or analog input modules. These input modules typically measure a range of voltages or some threshold level to determine ON/OFF or HIGH/LOW modes. However, if the PLC does not register the correct logic as expected, there could be several reasons for the failure. One possible reason could be a fault in the power that drives the input module. The fault could be due to a blown fuse, a tripped circuit breaker, bad wiring, or some connected devices causing intermittent power interruptions. If the power to the input module is functioning correctly, use a handheld digital multimeter to verify that the state changes as expected when the field devices change states. By eliminating all possible external faults to the input module, then a conclusion may be made that the digital or analog input module itself may be defective.

Step 5

Troubleshoot digital or analog output modules. It is important to verify if the power supply driving the output module signals is working properly. For the purpose of trouble-shooting, first verify that the signals from the output modules are functioning properly by forcing an expected output state such as ON or OFF. If the voltage output is as expected and the field device is not responding, then it could be possible that the field device is faulty. However, if the voltage output state of the module is not as expected, then there could be something wrong with the field wiring. Disconnect the field wire and connect a test load directly to the output module to verify if it is working properly. If the voltage output state is still not as expected, the output module is likely to be the root cause of the problem. Variable Frequency Drive (VFD) output modules are common to control motors for various automation applications. An example block diagram of a typical back-to-back converter for VFD is shown in Figure 10.

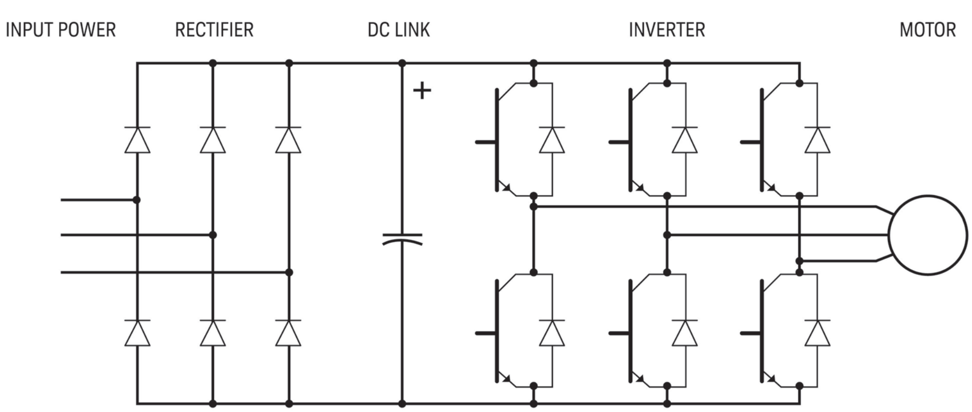

Figure 10: Example block diagram of a typical back-to-back converter for VFD driver

The Keysight U1270A and U1280A series handheld digital multimeters have a built-in low-pass filter to measure the VFD output voltage. For more information on trouble-shooting VFDs with low-pass filters, refer to the application note publication number 5990-9182EN (http://literature.cdn.keysight.com/litweb/pdf/5990-9182EN.pdf).

The Keysight U1600 series handheld oscilloscope is also useful for viewing the VFD voltage output. For information on troubleshooting VFD with the Keysight U1610A/U1620A handheld oscilloscopes, refer to application note publication number 5991-1537EN (http://literature.cdn.keysight.com/litweb/pdf/5991-1537EN.pdf).

Conclusion

Keysight Technologies has a comprehensive handheld solution that will meet the requirements for identifying faults and troubleshooting issues affecting the automation equipment and processes in an electronics factory.

For more information on Keysight Technologies handheld tools, please visit: www.keysight.com/find/handheld-tools

References

Troubleshooting PLCs, Electrical Construction & Maintenance, Ryan G. Rosandich, refer to the ECM webpage.

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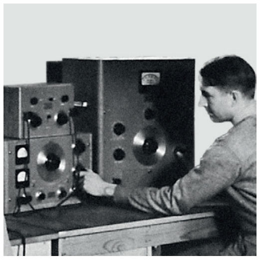

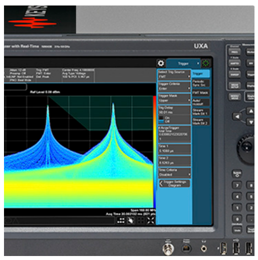

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