EE Evaluation Engineering
Instrumentation Test Report
Written by Engineers...for Engineers

Detecting Counterfeit Electronic Components

by Joseph Federico, NJ Micro Electronic Testing

Imposters seem to be creeping into all facets of our life: fake IDs, knock-off designer handbags, and now even into our electronic components supply. But thanks to a program originated at NJ Micro Electronic Testing (NJMET), the imitation electronic devices that began infiltrating the industry close to a decade ago now can be detected.

NJMET created Mission Imposter®, the first program that detects counterfeit electronics before they find their way into customers' products. The process begins with analyzing the shipping and packaging. It continues with the parts undergoing several levels of inspection including marking and dimensional checks, internal visual analysis, several levels of material analysis, and electrical testing to determine as well as ensure authenticity. In total, there are 14 options in this process to uncover counterfeit or cloned devices.

Incoming Inspection

The inspection starts with checking the boxes for shipping damage or evidence of a counterfeit or suspect barcode label and moves on to the component level after the packages are opened. An in-depth, near 100-point inspection process via a detailed checklist of suspect error types and optical microscopy (digital imaging) is performed to verify the component part number, marking, lead straightness, color, or any anomaly related to the integrity of the devices such as cracks, dents, scratches, mechanical anomalies, spelling errors, suspect date codes, suspect manufacturers' logos, breaks, or corrosions.

ESD Surface Inspection

Because ESD is one of the most serious problems facing the electronics industry today, a trained staff of operators thoroughly examines the components and packaging to detect evidence of plastic, Styrofoam, rubber bands, cardboard, scotch tape, or other substance capable of inducing static electricity to the product. Although ESD may seem harmless, it can damage electronic components and their assemblies when not packaged or handled properly.

Physical Dimensions

The height, length, width, and depth as well as arc angle, curvature measure, and pin-count of the devices are checked. This ensures all data meets the manufacturer's specification and that there is no evidence that the components have been altered.

Marking Permanency

The purpose of this test is to verify that the markings will not become illegible on the component parts when subjected to solvents (**Figure 1**). Various military standard procedures are used that incorporate several chemicals mixed appropriately and in detail in accordance with the specifications. These chemicals consist of aliphatic alcohol, mineral spirits, ethyl-benzene, organic solvents, deionized water, propylene glycol monomethyl ether, or monoethanolamine.

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Once the chemicals are mixed, the components are submerged in a three-phase process and analyzed in accordance with MIL-HBK-130 to uncover evidence of damage to the device and any specified markings. The analysis includes missing markings in whole or in part or those that appear, faded, smeared, blurred, or shifted to the extent that they cannot be readily identified from a distance of at least 6 inches with normal room lighting and without the aid of magnification.

In some cases, a strategic acetone wash will be used to reveal sanding marks and facets of previous markings. Over the past few years, new techniques of blacktop marking have been discovered that could easily pass the MIL

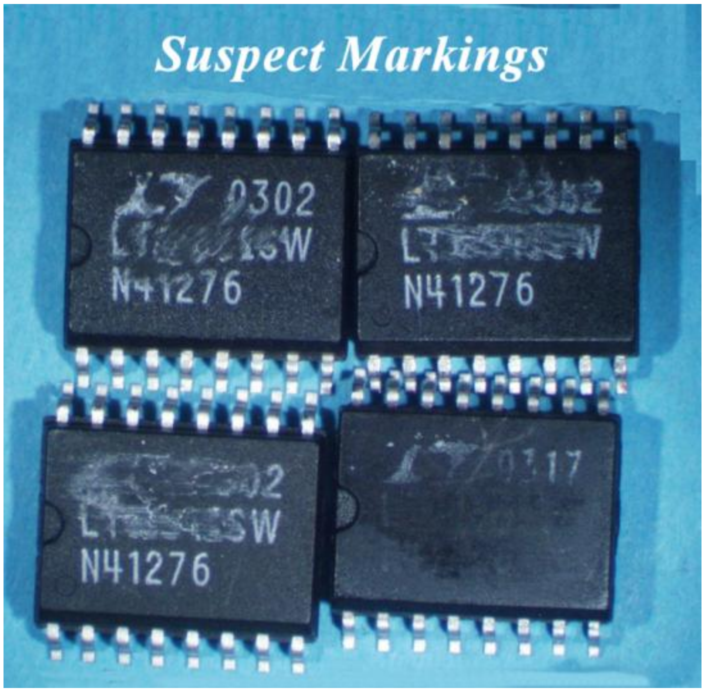

Figure 1. Example of Suspect Markings

Handbook resistance to solvents criteria.

Radiographic Inspection

Real-time X-ray and shadowgraph X-rays are performed to observe evidence of counterfeiting by analyzing the die size and wire bonding and to uncover any possible delaminations.

Internal Visual Verification

Component samples are delidded, and an internal inspection is made. The die is checked for defects, and the manufacturer's logo on the die must match that on the lid of the component. The die topography also is analyzed to see if it meets the outline of the manufacturer's requirements.

The component is placed under a high-powered microscope and verified against the manufacturer's specifications. Photographs of this process are taken each step of the way. In the event of insufficient verification data, engineering consultation will refer to other methodologies in the process to uncover counterfeit or cloned devices.

Group A Electrical Testing

Group A testing is industry terminology for testing the component device's full functional and parametric requirements at the recommended manufacturer's or specific industry extreme operating temperatures as presented in Table 1.

Industry	Temperatures	Test Objectives
Commercial	0°C to 70°C	DC, AC functional and parametric testing
Industrial	-40°C to +85°C	DC, AC functional and parametric testing
Automotive	-45°C to +110°C	DC, AC functional and parametric testing
Military/ Aerospace	-55°C to +125°C	Subgroups 1, 2, 3, 4, 5, 6, 7, 8A, 8B, 9, 10, 11
Space	-65°C to °+150C	Subgroups 1, 2, 3, 4, 5, 6, 7, 8A, 8B, 9, 10, 11

Table 1. Group A Tests

The test objectives are to exercise the DC and AC functional and parametric requirements as indicated on the industry specifications. In cases of military, aerospace, and space design, the respective subgroups contained in those documents would suffice for the objective tests.

Material Analysis

A four-point inspection of the device die, leads, bond wire, and packaging is performed to verify material authenticity. The following tests are conducted separately or together:

Scanning Electron Microscopy

SEM analysis uses a focused beam of high-energy electrons to generate a variety of signals at the surface of the specimens. The signals that derive from electron-sample interactions reveal information about the sample including external morphology, chemical composition, crystalline structure, and orientation of materials that make up the sample to see if these structures meet the manufacturer’s requirements (**Figures 2a** and **2b**).

Energy-Dispersive X-Ray Spectroscopy

EDXRS is an analytical technique used for elemental analysis or chemical characterization to see if the elements are verified in accordance with the manufacturer’s requirements.

Fourier Transform Infrared Spectroscopy

FTIR spectroscopy is used mostly for identifying chemicals that are either organic or inorganic, especially for indicating polymer, coatings, and contaminants that help identify counterfeit electronic products.

Energy-Dispersive X-Ray Fluorescence

Energy-dispersive XRF is performed to characterize individual particles to verify they meet manufacturing criteria both quantitatively and qualitatively.

C-Mode Scanning Acoustic Microscopy

CSAM is a screening technique that can uncover anomalies in device package and construction. It has been most reliable in finding distinct differences in device surface coatings that have identified many counterfeit devices.

Accelerated Life Testing

In recent years, much useful methodology has been developed to predict the life of electronic microcircuits using environmental-accelerated steady-state life testing. Such acceleration testing can be vital in predicting the operational future and functional performance of either hermetically sealed or plastic-encapsulated microcircuits. Testing such as component temperature cycling or burn-in has been paramount in exposing counterfeit devices.

Engineering Consultation

While all the methodologies are not needed to resolve each suspect device, it is important to understand that tests such as electrical testing, marking permanency, and internal visual verification may not uncover the high-tech clones that have invaded the market. Engineering consultation provides in-depth research on the history of each project to devise a strategy for future testing based on the 14 options.

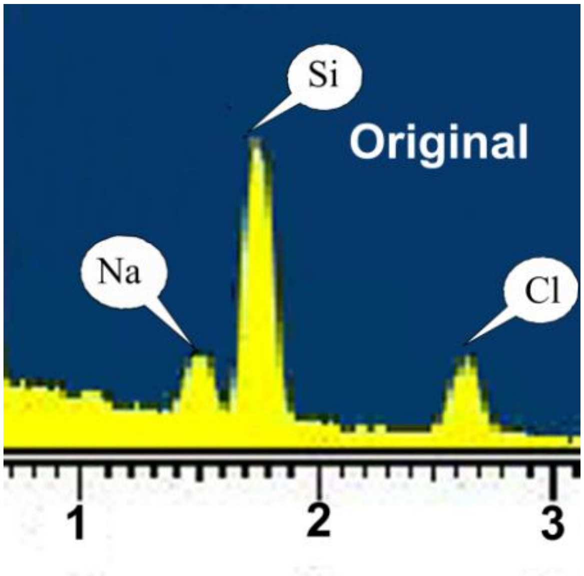

Figure 2a. Original Device

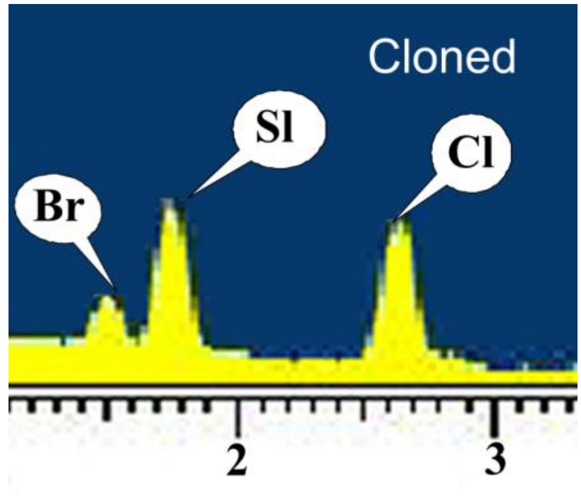

Figure 2b. Cloned Device

And the solutions do not stop there. Engineering consultation will support additional experienced recommendations including legal and industrial advice as well as expert-witness testimony.

Since the conception of Mission Imposter in 2003, this process has benefited the electronics industry and saved lots of money.

Acknowledgement

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About the Author

Joseph G. Federico is the vice president and director of operations at NJMET and has more than 30 years of laboratory testing experience. He has received various laboratory inspection certification titles from the Department of Defense as well as bachelor's and associate's degrees from Fairleigh Dickinson University and the Metropolitan Technical Institute in electronics engineering. Mr. Federico presented Mission Imposter to the Israeli Military and Aerospace Industry where he received the Diamond Award for project awareness. NJ Micro Electronic Testing, 1240 Main Ave., Clifton NJ 07011, 973-546-5393, e-mail: joef@njmet.com