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HOW CAN V-I CHARACTERISTICS HELP IN COUNTERFEIT COMPONENT DETECTION

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INTRODUCTION

We can encounter counterfeited products at various complexity levels and in various product commodities. We are unfortunately encountering also counterfeited electronic components in a dramatically increasing rate in course of recent years. The counterfeit components types range over the passive and active components from stable precise resistors up to complex integrated circuits. A substantial part of counterfeit components is represented by refurbished components originating from electronic scraps. Their packages and leads are finished, and the components are labelled according to the customer´s interest (Hammond, 2010). The counterfeit components penetration in supply chains threatens not only consumer electronic products quality and reliability, but also all sensitive systems in medical electronics, automation and control systems, weapon systems, civil and military aviation systems, space research systems etc. (M. Crawford, et al., 2010). The counterfeit component infiltration in product assemblies are influenced and promoted by several factors. Accessibility and price are playing a very important role. The unexpected ordered component supply cancelation for small companies can also open chance for counterfeits.

COUNTERFEIT DETECTION METHODS

Destructive Detection Methods

Destructive methods require special equipment and tooling, for example a de-capsulation set for component package opening to find out whether the circuit system type and origin corresponds with the package labelling.

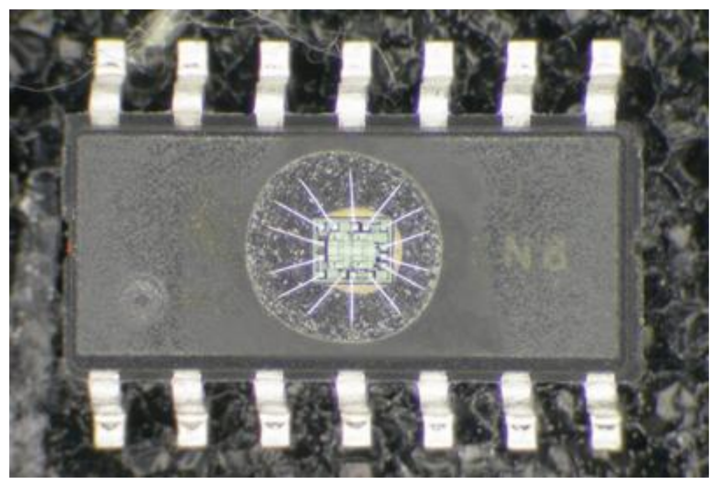

Fig.1. De-capsulated package above the chip

Non-destructive Detection Methods

Non-destructive methods encompass mainly costly analytical equipments like micro-focus X-ray units, ultrasound scanning microscopy and others (Schoppe & Robertson, 2010). We need reference original component sample for comparative analysis for majority of these methods.

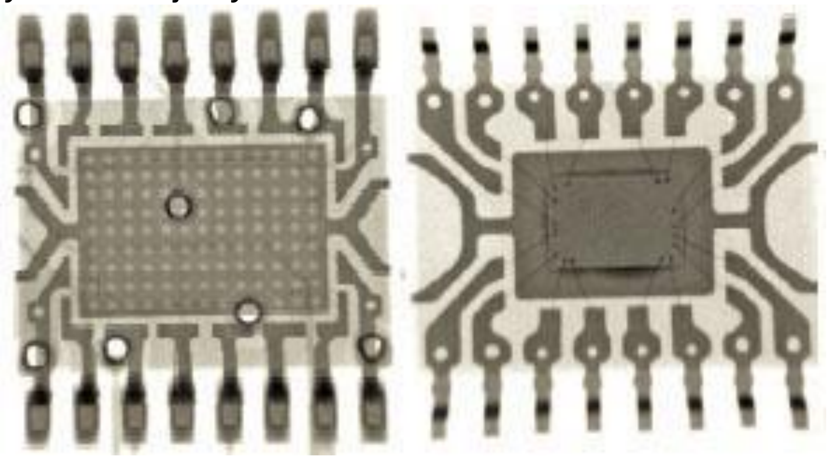

Fig.2. X-ray image of two identically labelled packages

Just V-I characteristics comparative analysis offers an interesting preventive method for relatively quick, simple and accessible new source component evaluation. Moreover, that methods is still applicable for a standard diagnostics studies of technological and mistreatment consequences for a component with model V-I characteristics recorded in advance.

COUNTERFEIT DETECTOR APPLICATION

We are using the Sentry counterfeit IC detector by ABI Electronics Ltd. in our diagnostic laboratory. That device has 256 independent and identical measurement channels which can be arbitrarily contacted to all component pins providing their count is not higher than 256. In case of pin count higher than 256, the measurement performs successively in more than one step. Components with smaller pin count can be analysed in corresponding groups at the same time. There exists a wide range of package contact adapters for THT and SMD package components (ABI Electronics, 2011).
We can choose from more variants for component pin combination at the Sentry device. The Normal Mode combines all pins with the common pin like V_{ss} or GND pin at integrated circuits. Transistors are free to choose any pin as the common pin. We talk about referring all pins to a chosen one. The Matrix Mode creates all possible pin combinations in successive couples.

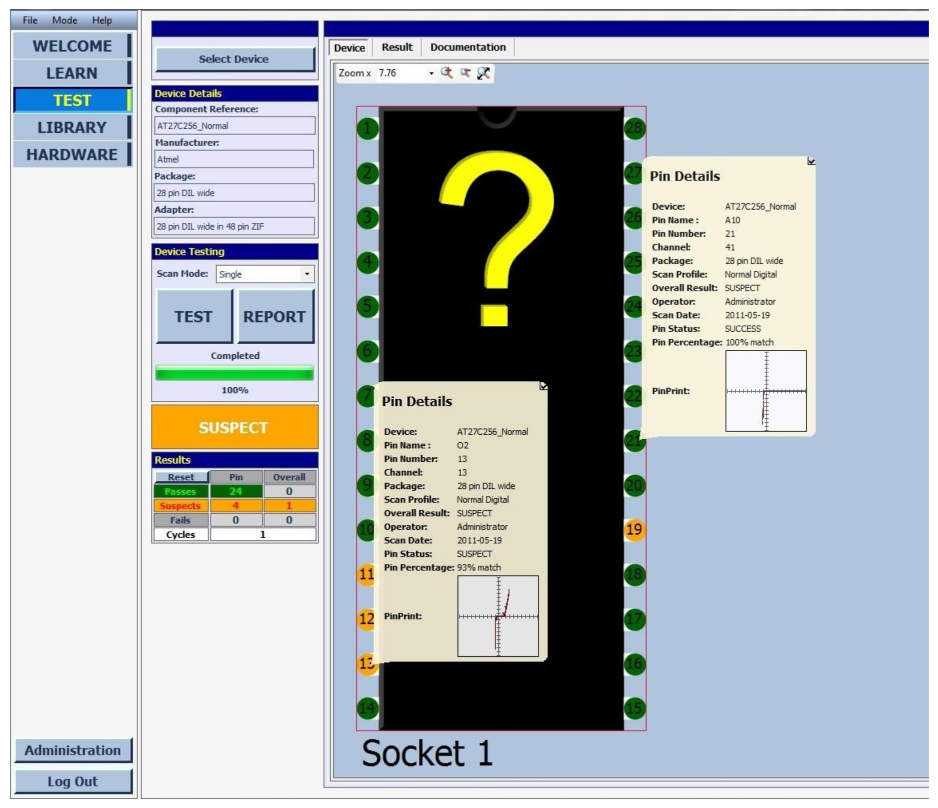

Fig.3. The result screen for a component under test

The preference for the Normal Mode or for the Matrix Mode depends on the particular component type and its production technology. The basic criterion for such choice is the higher sensitivity for V-I characteristic change.

MEASUREMENT RESULTS 1

Scan Profile	
Voltage Range:	±10V
Waveform:	Sine
Source Resistance:	100 kOhm
Frequency:	100 Hz

Tab. 1. Scan profile for MOSFET transistor

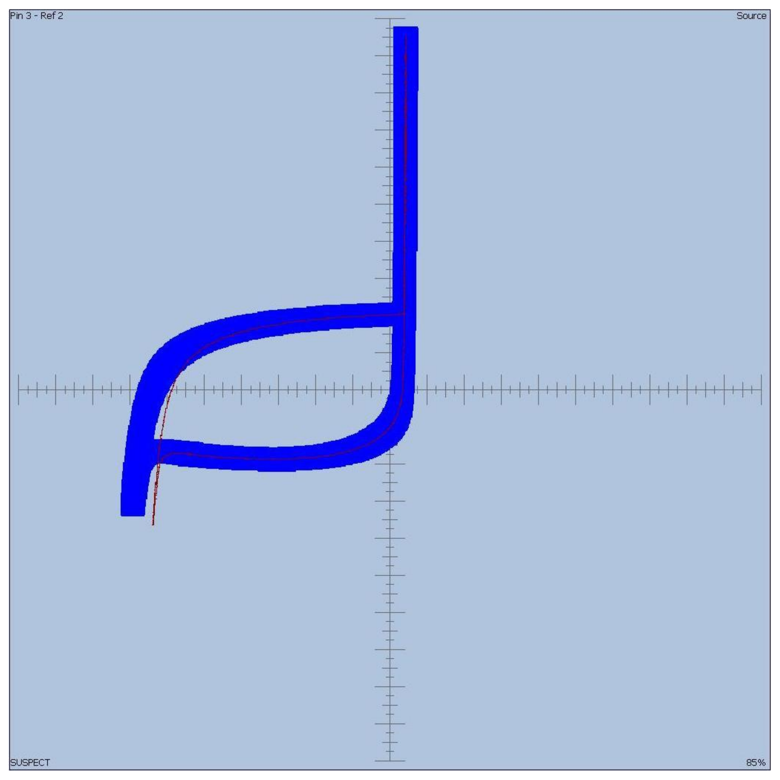

Fig.4. V-I characteristic for Source pin referred to Drain pin

The presented result for the MOSFET power transistor illustrates the V-I characteristic comparative analysis possibilities for detecting and monitoring differences caused by diverse reasons and influences. Such differences can be caused by natural technological process dispersion at the same producer, by parameters variations among different producers, by differences caused by latent or apparent damages, and frequently also differences caused by a certain sort of the counterfeiting process.
Following tables and figures illustrate results of our experiment with MOSFET power transistors, Zener-diodes and other integrated circuit samples analysis referred to the master transistor determined by the cooperating company.

D4NK50ZD				
Sample	NORMAL MODE Ref – 2			Result
	Pin1	Pin2	Pin3	
1	100	100	100	Ref.
2	100	100	85	fail
3	100	100	85	fail
4	100	100	100	ok
5	100	100	100	ok

Tab. 2. Comparison results

MEASUREMENT RESULTS 2

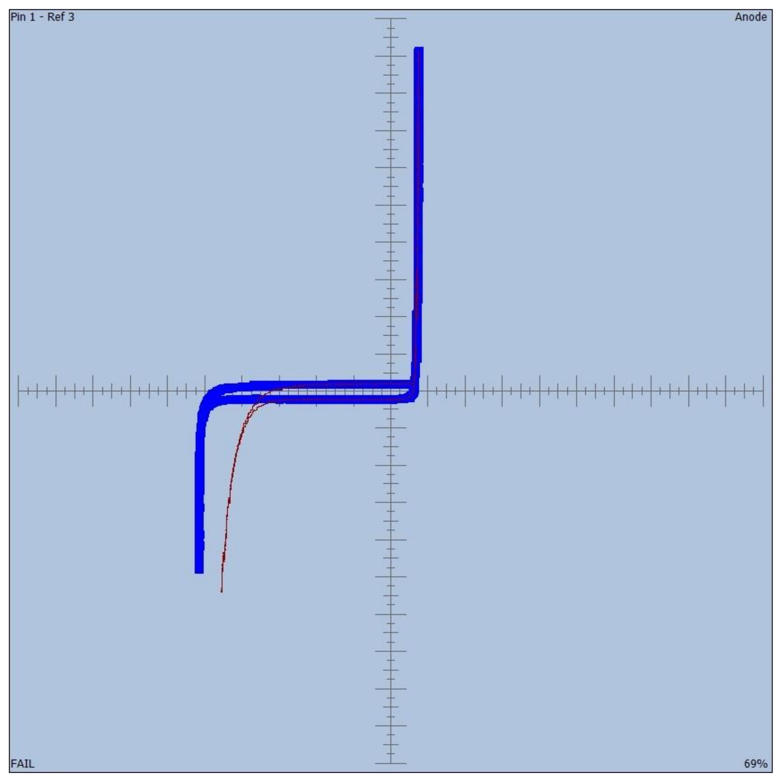

Fig.5. Zener-diode Anode referred to Cathode V-I characteristic

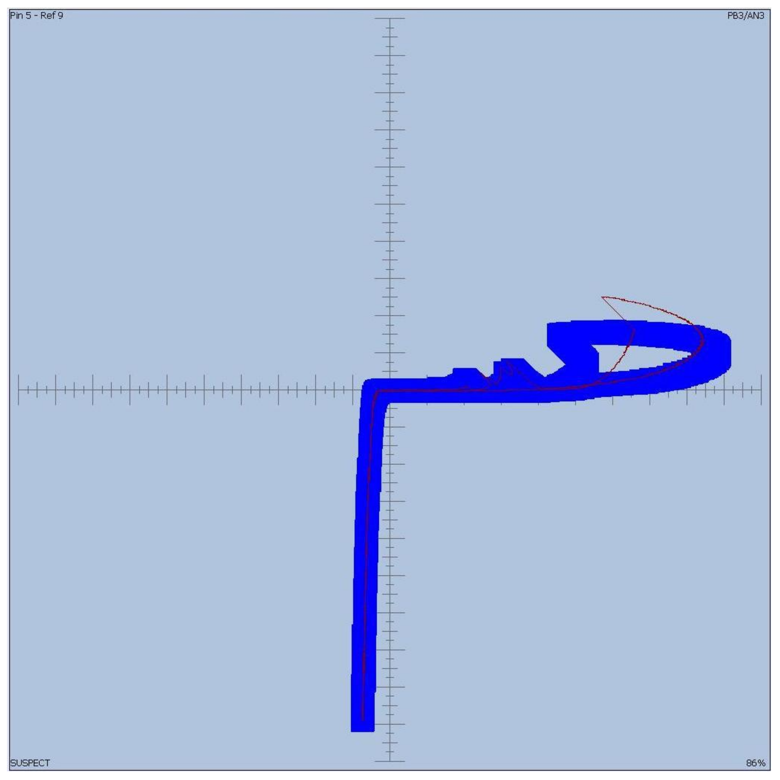

Fig.6. HT46R47 pin 5 referred to pin 7 V-I characteristic

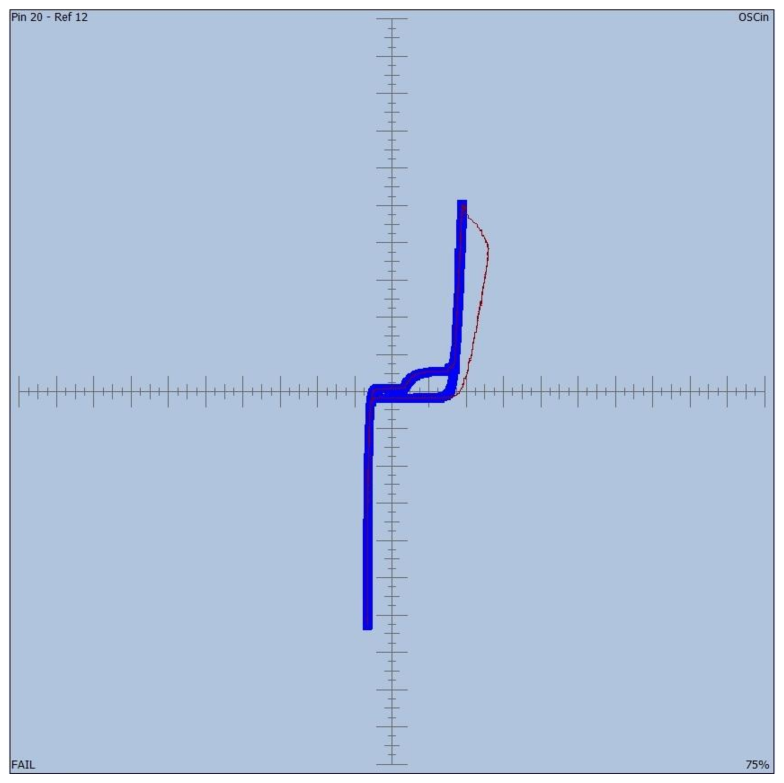

Fig.7. ST62T65C pin 20 referred to pin 12 V-I characteristic

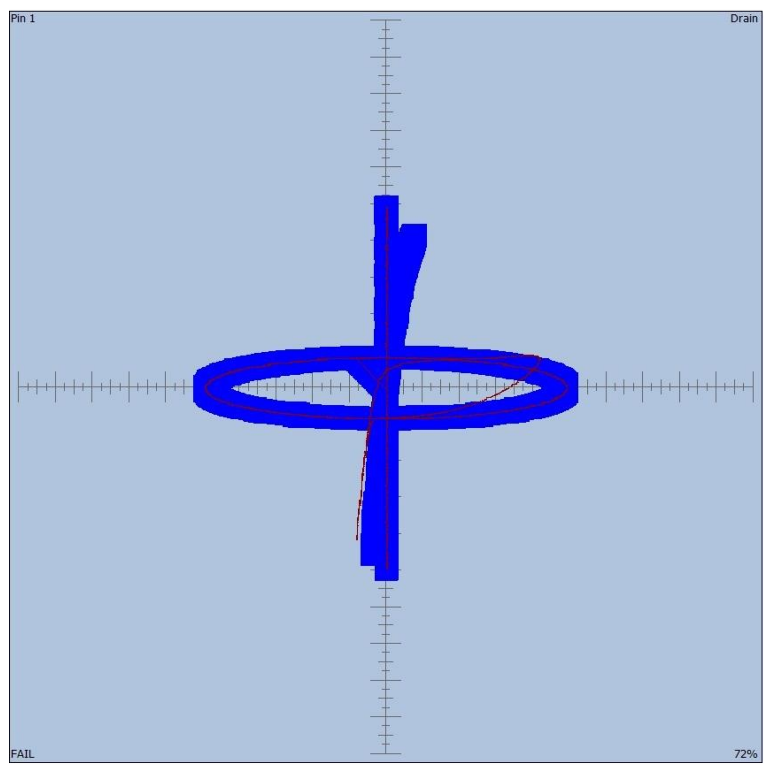

Fig.8. Pyro-sensor pin 1 Matrix V-I characteristics

CONCLUSION

We plan to continue in various components pin print study. Our aim is to extend the pin print database for various component types as a guide for potential users. We aim at current component samples from industry area, and preferably at suspect components from new supply sources to document the real differences..