Tear-down Report for Motorola W178g Cellular Telephone Handset

Prepared for
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Introduction

Objective

To document internal components and PCB layout for Motorola W178g cellular telephone handset.

Summary

A Motorola W178g cellular telephone handset produced for TrackFone Wireless Inc. provider was procured from a commercial source and disassembled to evaluate source of components and layout of the printed circuit board (PCB.) Enclosed with the handset was a Subscriber Identity Module Card (SIM card.) The card was de-processed to ascertain structure, design, technology node, and layout of thin films forming the semiconductor device die within. A separate report was generated to describe technology node and manufacturing processes used to build the SIM card integrated circuits. That study required a multi-step chip de-cap process and documentation of layout of the circuitry with optical (OM) and electron microscopy techniques (SEM, FIB and TEM.)

Outline

Approach

- Document serial number identification codes and labels on packaging, handset and SIM card.
- Disassemble the handset into primary components and document layout
- Disassemble SIM card preserving semiconductor die within.
- Document layout of the die using OM and SEM
- Identify major components such as: bond pads, SRAM array, FLASH array, microprocessor, etc.
- Obtain cross-section (mechanical polish with FIB cleanup) through the center portion of the FLASH memory array using Optical Microscopy, SEM
- Obtain TEM cross-sections to identify film composition
- Identify elemental composition of thin films present on the device, discern inorganic from organic films – SEM-EDS and TEM-EDS on the cross-section
- Compare contact pad structure to ascertain interconnect layers process flow and transistor design

Equipment

- Optical Microscopy
- Leica Polyvar-SC optical microscope with 20MPX Imaging Planet digital camera
- Scanning Electron Microscopy
- Hitachi S4700 SEM
- Philips XL-50FEG SEM with EDS
- Focused Ion Beam
- FEI-Altura-835 DB-FIB
- FEI-Strata-400 DB-FIB workstation with Omniprobe-200 in-situ TEM sample extraction system
- Transmission Electron Microscopy
- FEI-Philips CM300 S/TEM with EDS
- X-Ray Energy Dispersive Spectroscopy
- Thermo-Fisher NSS-analysis software and NSS-analyzer operating with SEM and TEM mounted Noran X-ray detectors.

Analysis of Devices

Identification of Part Numbers

Motorola W175g cellular handset was purchased at Target Inc. store in Redwood City, CA on November 10, 2008. The device was packaged for and marketed by TrackFone Wireless Inc. as a pay-as-you-go cellular telephone device. Photograph of packaging and the receipt for purchase of the handset is shown in Figure 1.

The headset supports the following features: color screen, Crystal TalkTM voice enhancement technology, voicemail access, call waiting feature, caller ID, hands-free speaker, text messaging, vibration alert, an alarm clock, a phone book with up to 500 entries, and is preloaded with multiple ring tones.

Figure 1. Packaging of TrackFone Motorola W175g cellular telephone and the receipt for purchase of the handset at Target Inc. store.

The package contained handset, back cover, manuals, Li ion battery pack, and charger compatible with standard electricity outlet configuration in USA. Contents of the package are shown in Figure 2.

Figure 2. Contents of Motorola W175g package.

The handset module was marked with manufacturer name and the model number as Motorola W175g and International Mobile Equipment Identity (IMEI) number: 011555006570360. Figure 3 illustrates the label attached to the telephone handset within the battery compartment. Handset was manufactured in China perhaps in work week 19 of 2008. This presumption is based on the notation "(G 8/19)" imprinted on the label.

Figure 3. Photograph of identification label attached to the disassembled cellular handset.

Major Components of the Handset

Handset was disassembled by removal of screws securing together two sets of outside covers, unlocking tape seals, and removing keyboard and display panel from the main printed circuit board (PCB). The board was manufactured by Compeq Manufacturing of Taiwan using six-metal level process as illustrated in Figure 6. Compeq Manufacturing operates assembly plants in China, Taiwan, and USA.

The touch pad assembly also included display screen cover and speaker unit. The display unit was attached to PCB with flexible push in ribbon cable, the electrical switches for touch pad were permanently attached to back of the PCB and the components had imprint markings indicating assembly of that unit in work week 16 of 2008. Back of the PCB also had the microphone unit attached to it. The disassembled handset was photographed. Close-up images were taken of each semiconductor device attached to the PCB. Major components of the handset are illustrated in Figures 4 and 5.

Figure 4. Three major components of the W175g handset: back-cover with identification label, front cover with speaker and touchpad assembly, and main circuit board with attached switches for keyboard and Liquid Crystal Display unit.

Figure 5. Major components of the W175g handset: cover, speaker/keyboard module, PCB with heat sink, and LCD display.

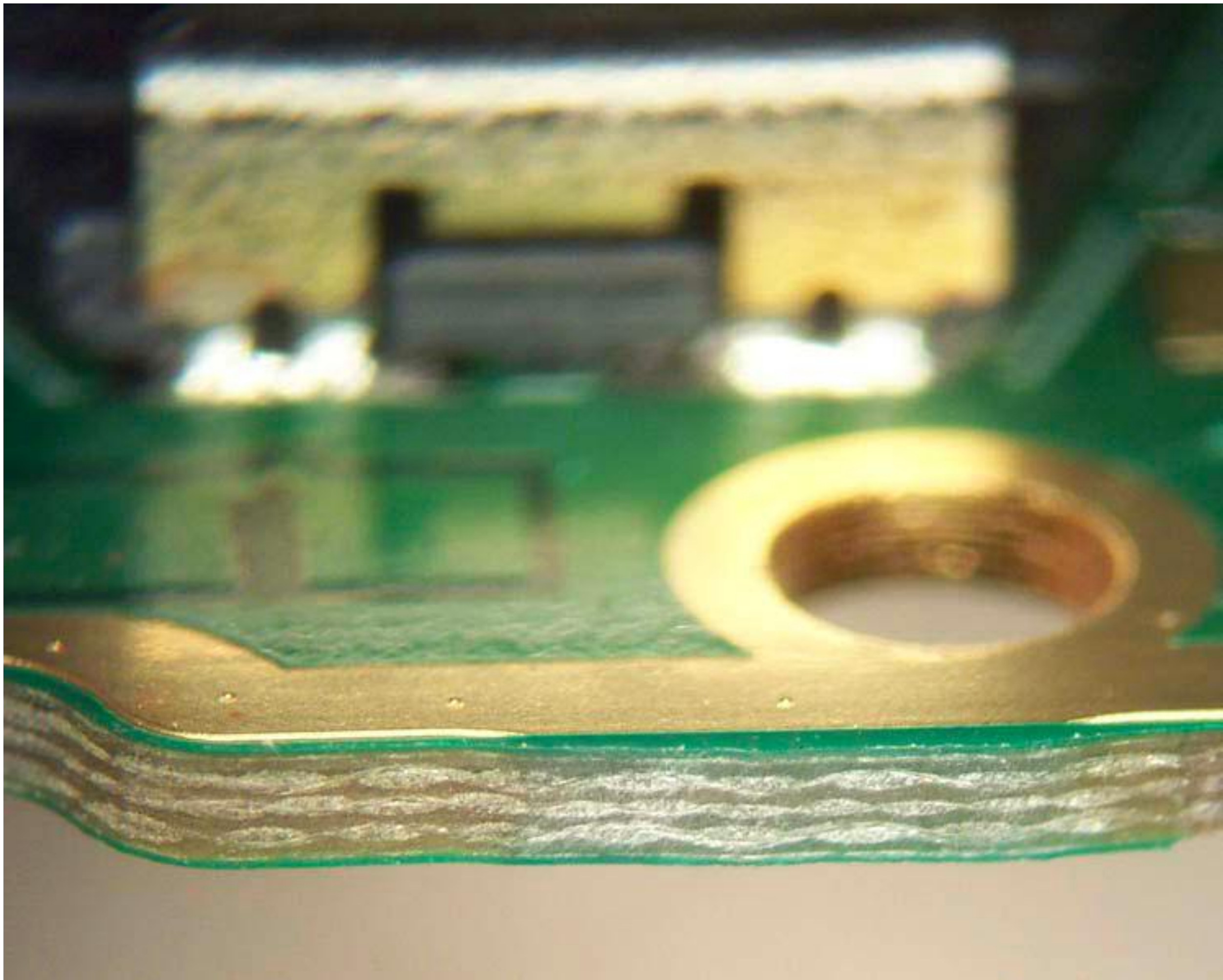
Figure 6. PCB layout detail illustrating 6 metal layer processes.

PCB Layout and Electronic Devices

The integrated circuit devices attached to the main circuit board were enclosed under metal heat-spreader/-sink soldered to the PCB. To uncover these components it was necessary to cut and remove the heat-sink. The LCD panel connector, headphone jack and microphone assembly were located outside of this heat sink. The components of the headset (see Table 1) followed reference design of a low-cost GSM/GPRS wireless headset platform designed by Texas Instruments: LoCosto™ Solutions: TCS2300GSM. A detailed description of features of this design is available at Texas Instruments Inc. website (http://focus.ti.com/docs/solution).

The two largest devices visible in Figure 7 are the Texas Instruments DRP™ singlechip technology GSM/GPRS solution D65538UN7 and a power management solution T3031FZPH device. The handset also uses NOR-Flash FBGA memory module from Intel PN: 2030W0YUQE and SkyWorks SKY77517 dual band iPAC™ FEM for Dual-Band GSM/GPRS module.

Based on documentation published by TI and available in the public domain, this is a basic mobile phone platform capable of delivering excellent voice quality at affordable price due to combination of RF transceiver, analog codec, and digital baseband into one highly integrated die produced at 90nm technology node.

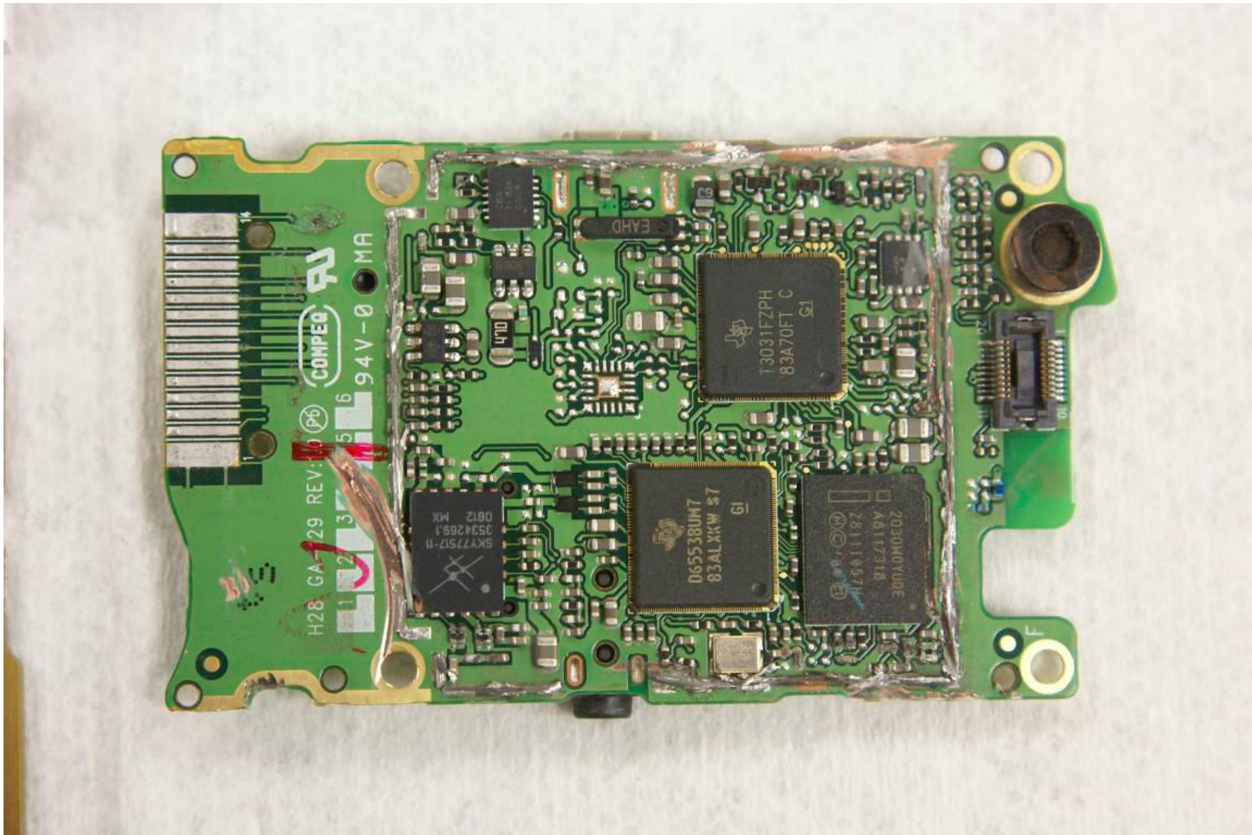

Figure 7. PCB extracted from Motorola W175g handset after removal of heat-sink.

Package ID	Manufacturer	Description
T3031FZPH	Texas Instruments	Power Management module
D6553BUM7	Texas Instruments	DRP™ single-chip GSM solution
T82K	Texas Instrument	Keypad encoder 8-bit
A8117318	Intel	NOR-Flash
SKY77517-11	SKYWorks	RF module
WD-Y1212VP-6CLWi	Wintek Corp. – Taiwan	RGB LCD Panel 128x128TFT

Table 1. Semiconductor devices included in Motorola W175g handset.

Additional Data

This report contains selected photographs to provide an overview of the fuse structure design features. Additional data, micrographs, raw EDS data files, EDS spectra and maps extracted from spectral images were acquired in the course of this study. These data are available for download from Cerium Labs database system Lab Collector. The following link can be used to directly access the secure records web page (log-in required):

https://lims.ceriumlabs.com/ceriumlabsauditor/2008-3559/

Please do not hesitate to contact the laboratory if further analysis or discussion of data is needed.

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