Application Note

DA1458x WLCSP Package Light Sensitivity

AN-B-021

Abstract

The DA1458x Bluetooth Smart device in a WLCSP package shows sensitivity to direct sunlight and light from halogen lamps. Fluorescent tubes and UV lamps do not affect the chip's operation. Infrared lamps have the same effect on the DA1458x WLCSP device as halogen lamps. Various methods for blocking light are discussed: coatings, molding compounds and light blocking tapes.

This is applicable to the following devices in WLCSP: DA14580, DA14581, DA14585.

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1 Terms and definitions

BLE	Bluetooth Low Energy (now: Bluetooth Smart)
DTM	Direct Test Mode
IR	Infra-Red
UV	Ultra-Violet
WLCSP	Wafer Level Chip Scale Package

2 Introduction

The DA1458x Bluetooth Smart device in a WLCSP package shows sensitivity to direct sunlight and light from halogen lamps. Fluorescent tubes and UV lamps do not affect the chip's operation. Infrared lamps have the same effect on the DA1458x WLCSP device as halogen lamps. Various methods for blocking light are discussed: coatings, molding compounds and light blocking tapes.

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3 DA1458x WLCSP light sensitivity

3.1 Observations when light enters the BLE WLCSP device

During BLE operation the DA1458x in a WLCSP package may stop operating when exposed to direct sunlight. This effect can be reproduced by holding a 42 W halogen lamp at a distance of approximately 40 cm: the BLE WLCSP device stops advertising immediately.

During BLE RF testing with the DA1458x WLCSP device in Direct Test Mode, or Non-Link Test Mode, it was impossible to stop the DA1458x WLCSP device by exposing it to light from the halogen lamp, even when it was held very close to the device.

3.2 Measures to block the light

Several materials and methods were tested in order to block light from the DA1458x BLE device. Some good and bad examples will be described.

3.2.1 Glob Top compounds

It was shown that a low viscosity epoxy Glob Top type resulted in a (too) thin layer over the chip, causing some devices to fail the halogen lamp light and direct sunlight tests. For blocking light the use of this low viscosity type is not recommended.

A high viscosity polyurethane type of Glob Top performed better, but in our test still did not show a 100 % working solution for blocking light. However, when applied under well controlled conditions as to the amount of Glob Top and the area, high viscosity polyurethane Glob Top will be a good choice.

At least a 1 mm thick layer of this epoxy compound should be applied, taking care that the top and the sides of the DA1458x WLCSP device are well and equally covered, and that the directly surrounding area on the board is covered with a 1 mm thick layer of Glob Top.

Figure 1: A failing DA1458x board with a low viscosity epoxy type Glob Top

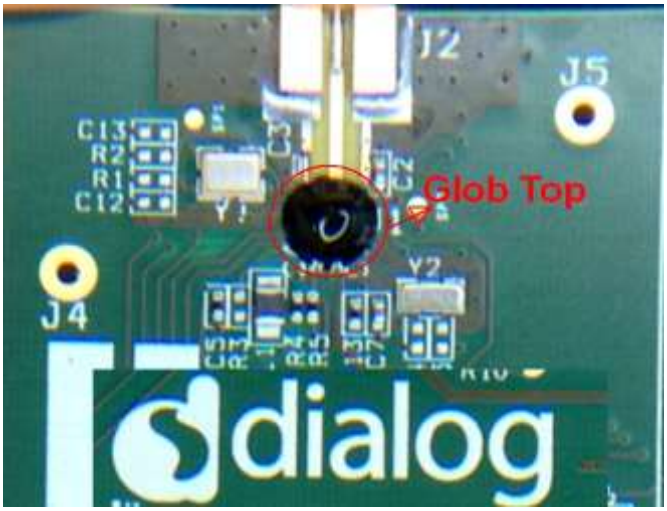

Figure 2: A passing DA1458x board with a high viscosity PUR type Glob Top

3.2.2 Dam and Fill compound

A test was executed on >200 boards using resin-based Dam and Fill material. All these boards passed the halogen lamp test and the 10 boards that were subjected to the outdoor direct sunlight, passed this test as well.

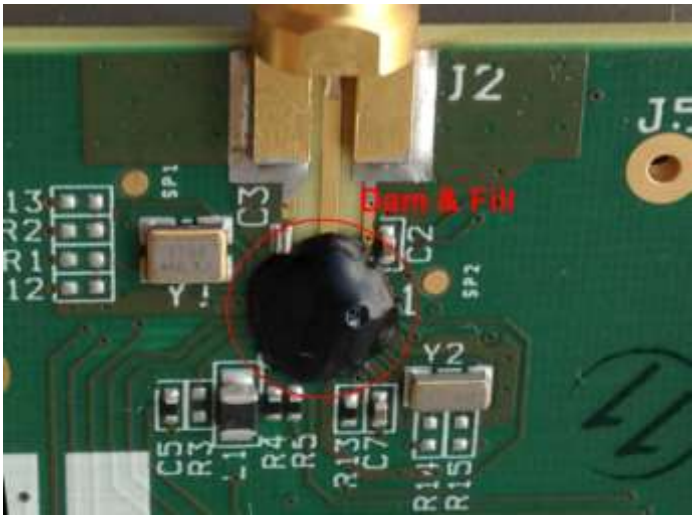

Figure 3: DA1458x board with Dam and Fill compound

The Glob Top and Dam and Fill compounds that were used, are listed in Appendix A.

3.2.3 Light blocking tapes

Several types of self-adhesive tape have been tested on their light blocking properties. Two types of tape were found to be equally effective as the Glob Top or Dam and Fill compounds:

- Tesa 7160: 60 µm single sided self-adhesive solid black filmic tape
- 3M 471: 130 µm self-adhesive black vinyl tape

Both tapes have good adhesive strength. When cut into 10 mm by 10 mm squares, they adequately cover the DA1458x WLCSP and protect the WLCSP device well against light.

Two boards were tested in outdoor direct sunlight as well and continued to operate without problems.

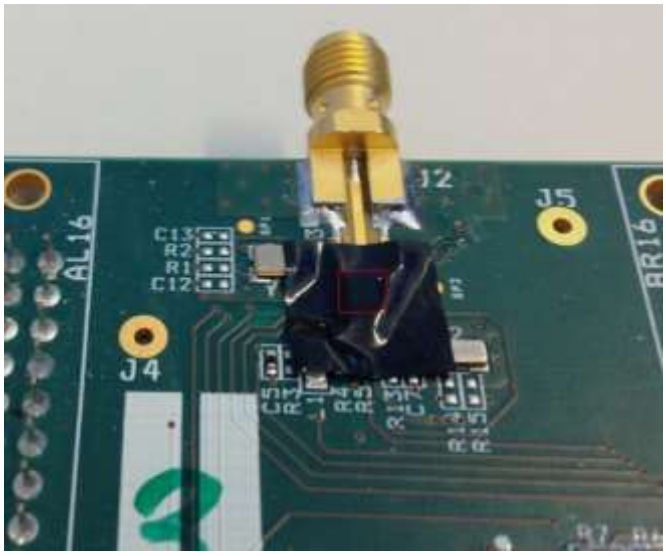

Figure 4: DA1458x board with light blocking black tape

More details on these tapes can be found in Appendix A.

4 Testing for sensitivity to light

4.1 Lamp tests

The halogen lamp test appears to be a good discriminator for checking light sensitivity. The boards that pass this halogen lamp test also pass the direct sunlight test and vice versa: the boards that fail this halogen test also fail the direct sunlight test.

Uncovered DA1458x WLCSP devices also fail directly under light coming from an infrared lamp. Well treated Glob-Top and Dam and Fill boards pass the IR light test.

Testing with an UV lamp did not reveal any sensitivity of the WLCSP device to this short-wavelength type of light.

Figure 5: Halogen lamp test setup (10 cm above DA1458x board)

Please see Appendix B for irradiance graphs of the tungsten lamp, halogen lamp and the IR lamp.

4.2 Determining the sensitive wavelength

Using a 100 W xenon lamp and a prism to split the incoming white light into a wide spectrum, it was found that the most sensitive wavelength of the DA1458x WLCSP device is between 675 nm and 750 nm. This represents just visible, near infra-red light. See the light spectrum in Figure 7.

Figure 6: Dark red light falling on the WLCSP

It appeared that the sides of the WLCSP device are the most sensitive parts to light.

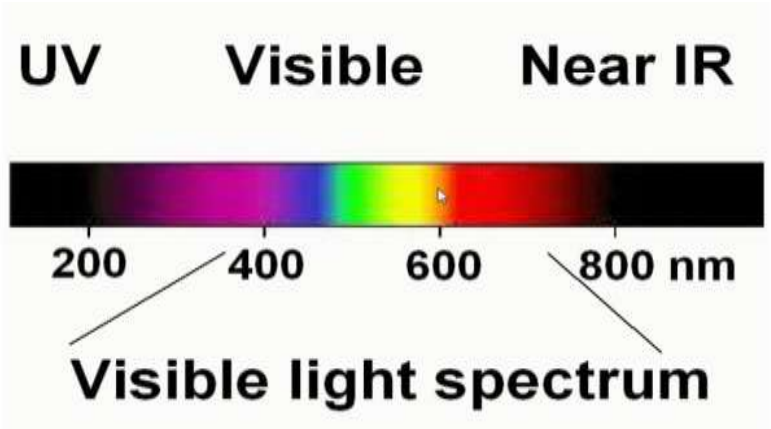

Figure 7: The light spectrum

5 Conclusions

The DA1458x BLE WLCSP device is sensitive to sunlight, halogen-lamp light and infrared light. The dark red, near infrared part of the light spectrum is the wavelength to which the DA1458x WLCSP device is most sensitive.

The DA1458x WLCSP BLE device needs to be protected against light using a coating, a mold compound or a light blocking tape. Also.take care that the sides of the WLCSP are well covered. Discuss with your manufacturer which products are available and specifically check for red/IR light absorption.

The proposed process flow is to build a test batch and test the light sensitivity of the application with a halogen lamp before going into production. When required, apply a coating or a mold compound, being a high viscosity Glob Top or a Dam and Fill compound. Alternatively, use a light blocking tape.

Appendix A Used compounds and used lamps

A.1 Glob Top, epoxy resin based

Poly-Service: Poly-Pox THV Base 500 and Harder 355 in a ratio of 2:1

Cure time: 24 h
Cure temperature: 30 °C

This low viscosity Glob Top is not recommended for blocking light.

A.2 Glob Top, polyurethane based

Purtech: Poly-Urethane EH-E83 and EH-B in a ratio of 4:1

Cure time: 24 h at room temperature, 1 h at 50 °C.
Cure temperature: 50 °C

This high viscosity Glob Top performed better than the epoxy based Glob Top, and when applied under well controlled conditions this type is suitable for blocking light.

A.3 Dam and Fill materials

Dam: Protavic PNE 30252 (resin with high viscosity)
Fill: Protavic PNE 30270 (lower viscosity resin)

Cure time: 1 h
Cure temperature: 120 °C

The Dam and Fill materials can be co-cured.

This Dam and Fill solution gave the best results in our tests with halogen lamp light and direct sunlight. It resulted in a 100 % pass for the halogen lamp light test.

A.4 Light blocking tapes

Tesa: tape 7160. Suitable for operating temperatures up to 100 °C. Thickness: 60 µm.
http://www.tesa.com/industry/electronics/assortment_overview/functional_tapes/light_shading_blocking/download/5172260/4638842/master-pi.pdf

3M: tape 471. Suitable for operating temperatures up to 76 °C. Thickness: 130 µm.
http://solutions.3m.com/wps/portal/3M/en_US/Adhesives/Tapes/Products/~/3M-Vinyl-Tape-471?N=5000130+3294229416+3294328902&rt=rud

A.5 Used halogen lamp

A 42 W halogen lamp (equivalent to a standard tungsten bulb of 55 W) having 630 lm and a colour temperature of 2800 K. Example: Philips EcoClassic WarmWhite 42 W (E27 ES).

A.6 Used infrared lamp

A Philips Infrared R95E 100 W lamp, which has its light irradiance peak at a wavelength of 1100 nm to 1200 nm. See Figure 6 in Appendix B.

Appendix B Irradiance plots of the used lamps

The tungsten-halogen lamp with a colour temperature of 3200 K appears to have its peak at about 800 nm, so mainly reddish and infrared light. The sunlight spectrum peaks at about 500 nm.

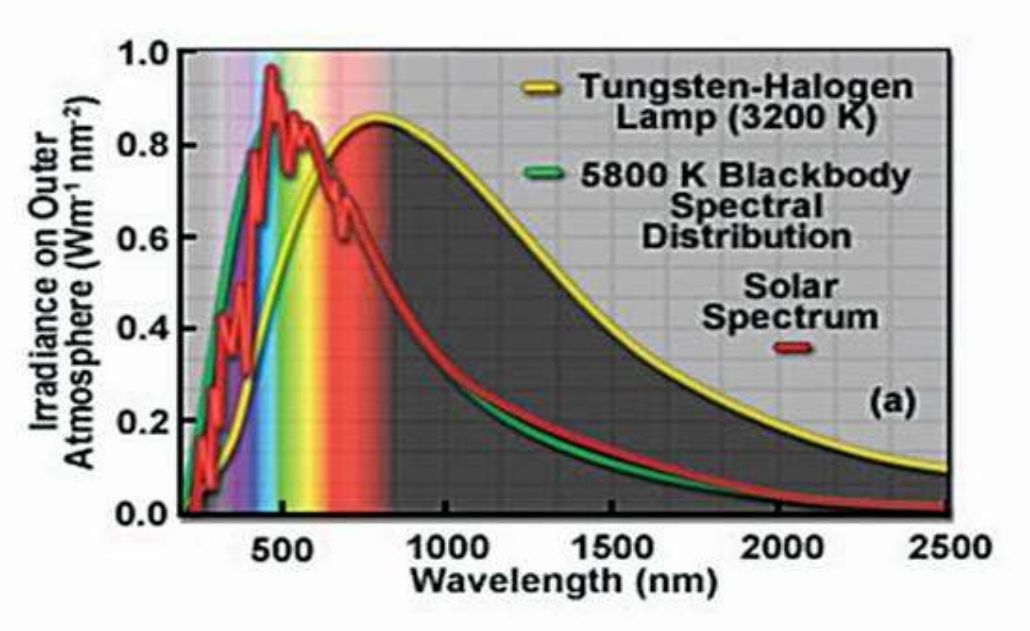

Figure 8: Irradiance plot of a tungsten-halogen lamp and solar light spectrum

The IR R95E infrared lamp peaks at about 1100 nm to 1200 nm, which is deep infrared.

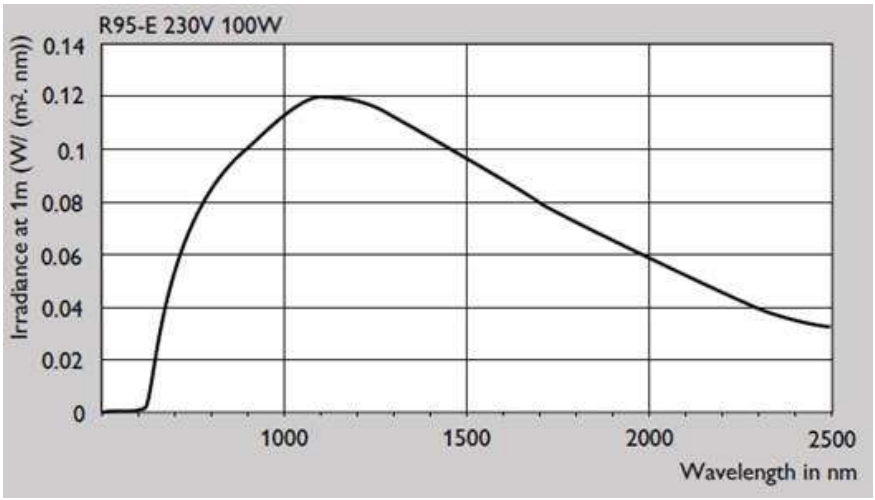

Figure 9: Irradiance plot of the used IR R95E 100 W lamp

Revision history

Revision	Date	Description
1.0	04-Jun-2014	Initial version.
1.1	06-May-2015	Updated section 3.2, adding light blocking tapes.
1.2	22-Feb-2017	Generalising the document for DA1458x
1.3	6-Feb-2018	Corrected the title the file name to DA1458x and clarified the applicable devices
1.4	24-Dec-2021	Updated logo, disclaimer, copyright.

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Status definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
APPROVED or unmarked	The content of this document has been approved for publication.

RoHS Compliance

Dialog Semiconductor complies to European Directive 2001/95/EC and from 2 January 2013 onwards to European Directive 2011/65/EU concerning Restriction of Hazardous Substances (RoHS/RoHS2).
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