Application Note

AN2344/D
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HC908EY16 EMI Radiated Emissions Results

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Introduction

Electromagnetic interference (EMI) is a major concern in the automotive industry as the typical car contains a large number of electronic modules in a relatively small area. If any of these modules emit high levels of unwanted electromagnetic noise there is a possibility that the functionality of other modules may be adversely affected. Therefore it is essential that the radiated emissions from each module are kept within acceptable limits.

The HC908EY16 is a member of the low-cost, high-performance M68HC08 Family of 8-bit microcontroller units (MCUs) and is ideally suited to automotive applications which implement the Local Interconnect Network communications protocol (LIN). As LIN nodes are often located in confined spaces within the car, it is not always possible to implement radiated emissions reduction techniques such as shielding. Therefore it is important that the application board itself exhibits an acceptable level of radiated emissions. As the microcontroller is one of the main contributors to the radiated emissions from a module, it is important that emissions at a device level are as low as possible.

One of the key features of the HC908EY16 is that it allows the user to choose between various clock source options. The first option is to use the external clock generator feature in order to configure the device to work with either a one-pin external clock source such as a canned oscillator, or with an external Pierce oscillator configuration. Alternatively, it is possible to set up the internal clock generation module (ICG) to supply all of the necessary internal clocks, with the bus frequency being configurable in software. Since external clock circuitry can often be one of the biggest contributors to radiated emissions, the availability of the ICG on the HC908EY16 is an extremely attractive feature where EMI is concerned.

SAE J1752/3 Radiated Emissions Testing

The remainder of this document covers a set of EMI radiated emissions tests performed in accordance with the SAE J1752/3 specification J1752/3 “Electromagnetic Compatibility Measurement Procedure for Integrated Circuits – Integrated Circuit Radiated Emissions Measurement Procedure 150 kHz to 1000 MHz, TEM Cell”. A complete description of test equipment, setup, and procedure can be found in the Freescale document “Electromagnetic Compatibility Qualification and Analysis of Microcontrollers (100 kHz – 1 GHz) Test Methods and Procedures.”

The goal of the testing was to document the electromagnetic emissions spectra of the HC908EY16 (mask set 0L31N) at device level. Testing was carried out using two different configurations. Firstly, the external crystal option was tested with an 8MHz crystal being used to generate a bus frequency of 2MHz. The same test PCB was then used to carry out the testing using the Internal Clock Generator (ICG) module to generate a bus frequency of 2MHz. It should be noted that when the ICG configuration was used, the external crystal and related components had been removed from the test PCB. In each case, measurements were taken with the software being executed out of flash memory and with a supply voltage of 5V.

TEM Cell Test Board Information

Test PCB Hardware

The standard board used for TEM Cell testing is specified by the SAE J1752/3 specification. It is a 4-inch square board consisting of 1 ground plane, which serves as a shield and is electrically connected to the body of the TEM, 2 signals layers and a ground plane. Only the IC being evaluated and necessary vias and traces are located on the bottom side of the board to obtain the most accurate measurement of emissions from the device. All support circuitry and cabling is located on the top side of the board. The schematic for the TEM cell PCB for the HC908EY16 is shown in **Figure 1 . TEM Cell PCB Schematic**.

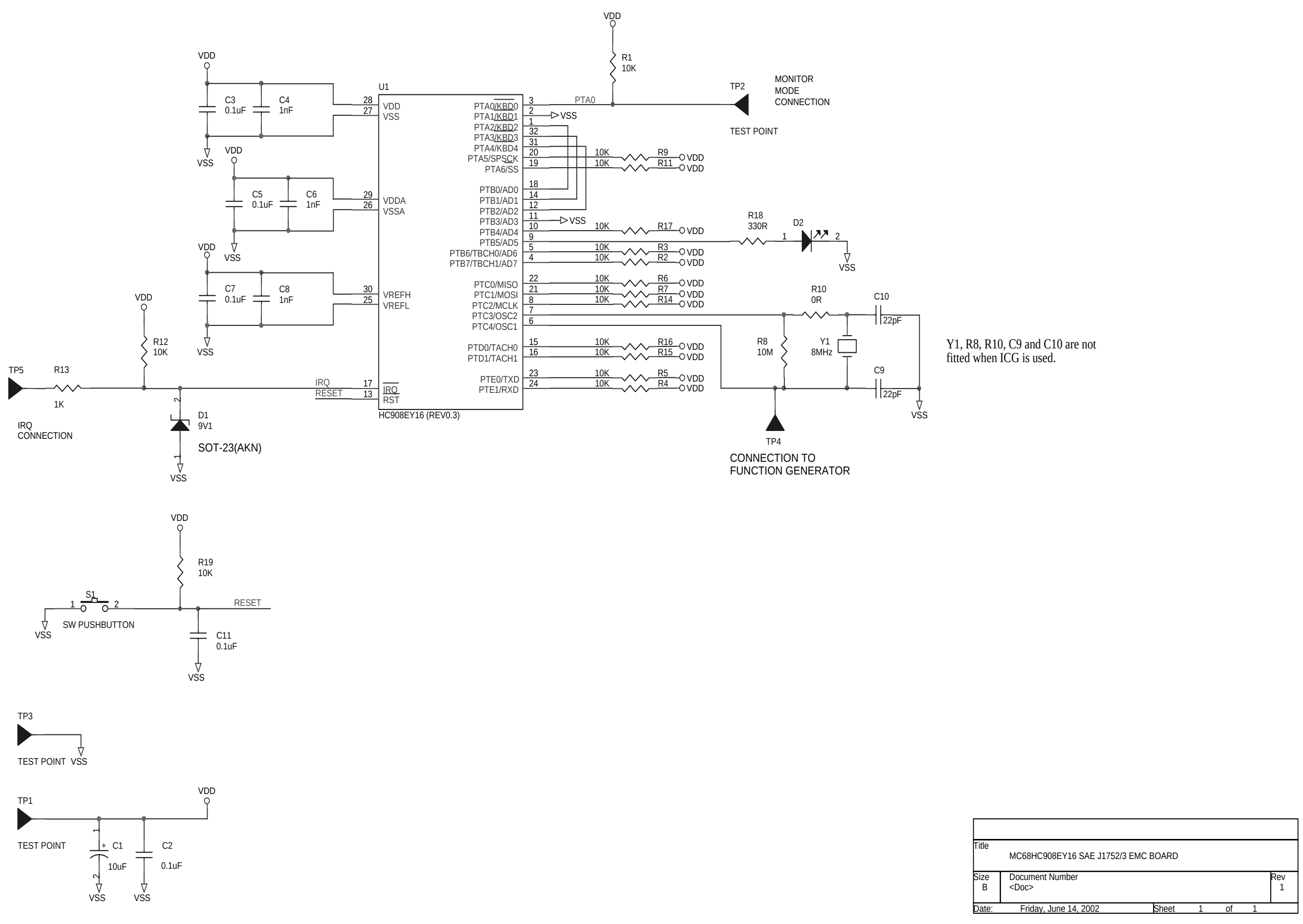

Figure 1. TEM Cell PCB Schematic

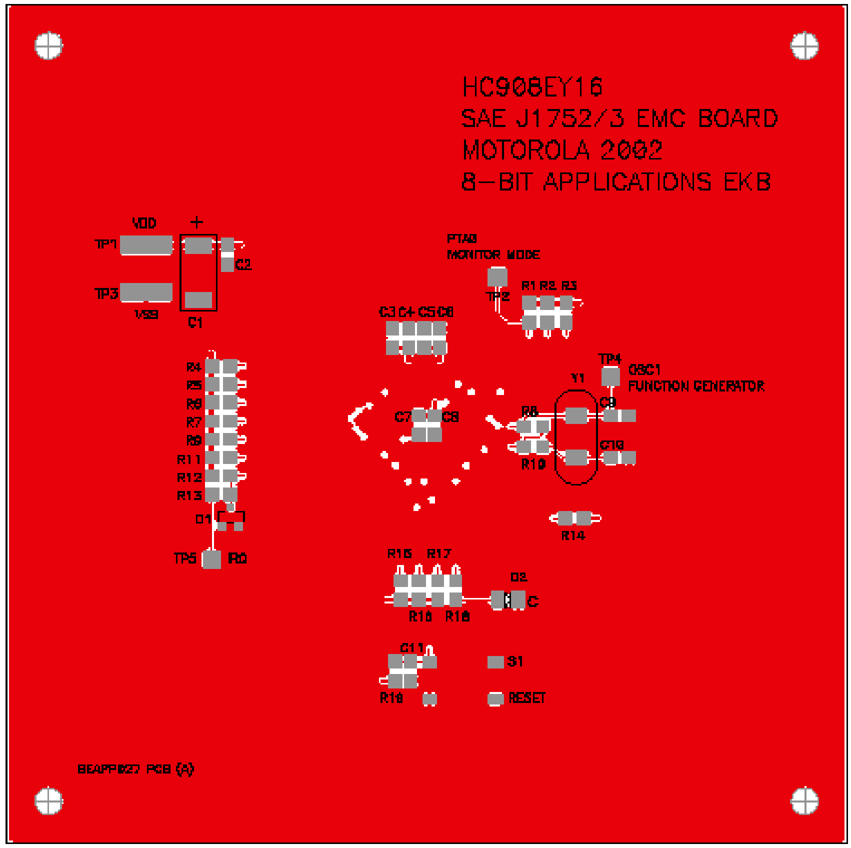

Figure 2. TEM CELL PCB TOP LAYER

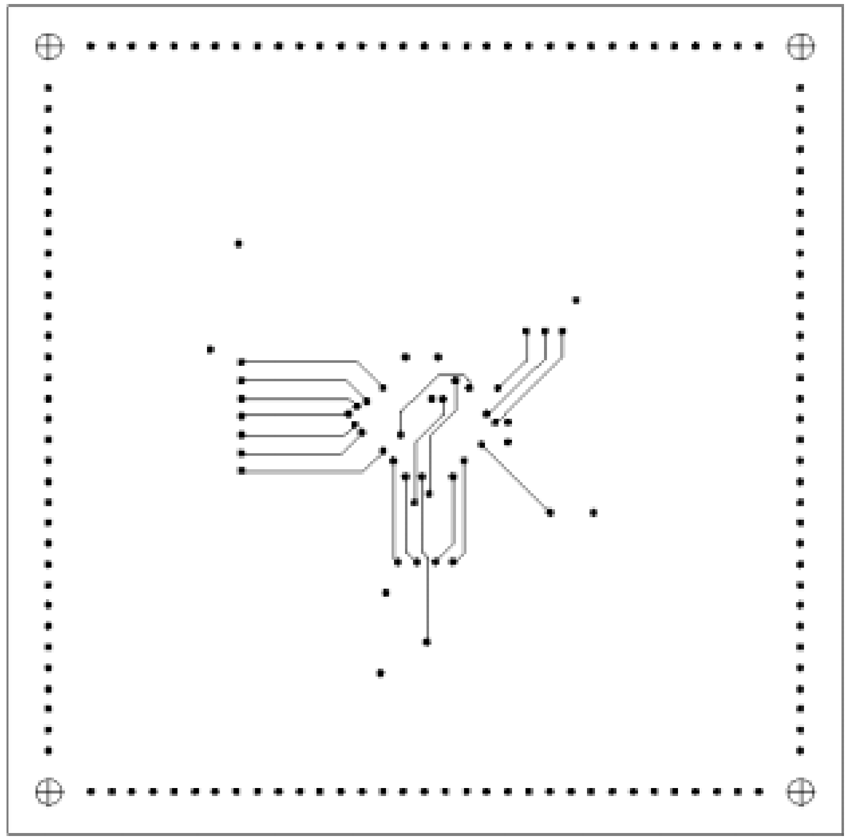

Figure 3. TEM CELL PCB SIGNAL LAYER

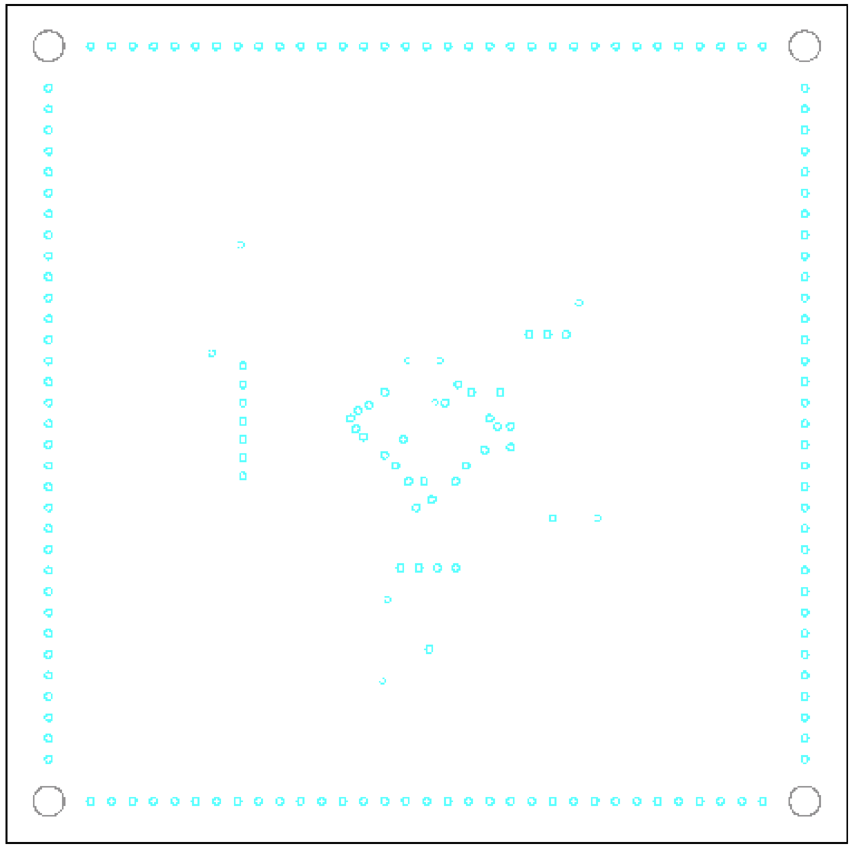

Figure 4. TEM CELL PCB POWER LAYER

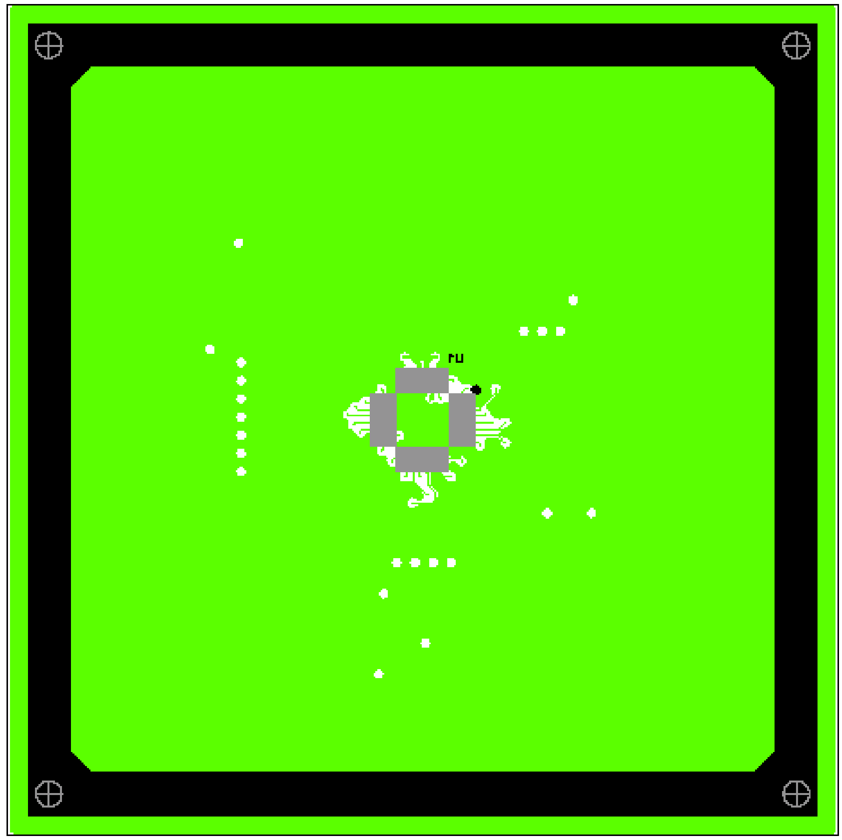

Figure 5. TEM CELL PCB BOTTOM LAYER

Test PCB Software

The flash memory of the microcontroller is programmed with a test routine that exercises two timer channels, the SPI, the ESCI, the ATD and also toggles some port pins. An LED is placed on the output of port pin B5. The software routine toggles this output at a set point during a cycle to verify that the code is still being executed correctly.

As discussed previously, the testing on the microcontroller is performed in two configurations. In the external crystal configuration, an 8.000MHz crystal is connected to the DUT on the TEM Cell board in order to generate an internal bus frequency of 2MHz. In the ICG configuration, the internal bus frequency is set to 2MHz in software. The initialization of the clock source is the only difference between the software routines for the two configurations.

A flowchart for the test software used is shown in Appendix B.

Analysis/Conclusions

The results obtained from the radiated emissions testing are shown in Appendix A. They demonstrate that the radiated emissions from the HC908EY16 microcontroller are very low at a device level. They also confirm that there is a noticeable difference in the emissions spectrum between the external crystal and ICG configurations, with the ICG generally showing a lower emissions spectrum. Therefore, the use of the internal clock generation module is recommended in applications where radiated emissions are regarded as a potential problem. There is an additional advantage in using the ICG configuration in low cost applications as there is no requirement for the external crystal components and therefore there will be a related cost saving.

While the analysis proves that the HC908EY16 exhibits good radiated emissions characteristics, it is important to realise that device level data does not always give an accurate representation of the emissions that will be obtained in a real life application. Board and module level emissions measurements are very dependant on the board layout, the components used and other circuitry. Therefore each application has to be tested in order to fully understand the emissions measurements.

References

1. 1 MC68HC908EY16/D Rev 2.0. This specification is available on the Freescale Semiconductor Products webpage at http://freescale.com.
2. 2 Electromagnetic Compatibility Qualification and Analysis of Microcontrollers (100 kHz – 1 GHz) Test Methods and Procedures.

Further Reading

The following EMC related application notes can be downloaded from

http://e-www.freescale.com

AN1263/D: System Design and Layout Techniques for Noise Reduction in MCU-Based Systems

AN1705/D: Noise Reduction Techniques for Microcontroller Based Systems

AN2321/D: Designing for Board Level Electromagnetic Compatibility

Appendix A: Measured Results

The following pages show the measured results for the two configurations that were tested. The measurement of background emissions that were present in the screened room was performed with the test PCB installed in the TEM cell, but at this point no power was applied to the board.

Measurements were then taken in the North and South orientations with the power applied to the test PCB and the test software being executed in flash memory.

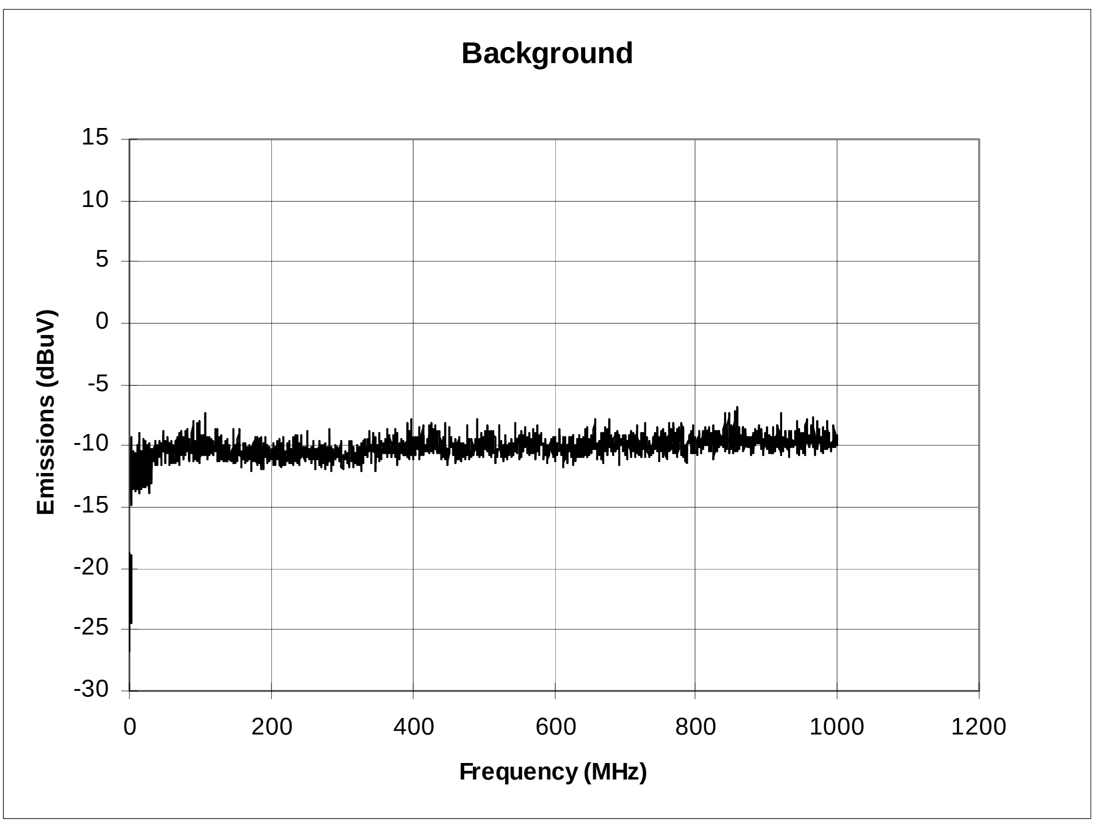

Figure 6. Background Measurement
TEM Cell board in place on TEM Cell, but no power applied to device

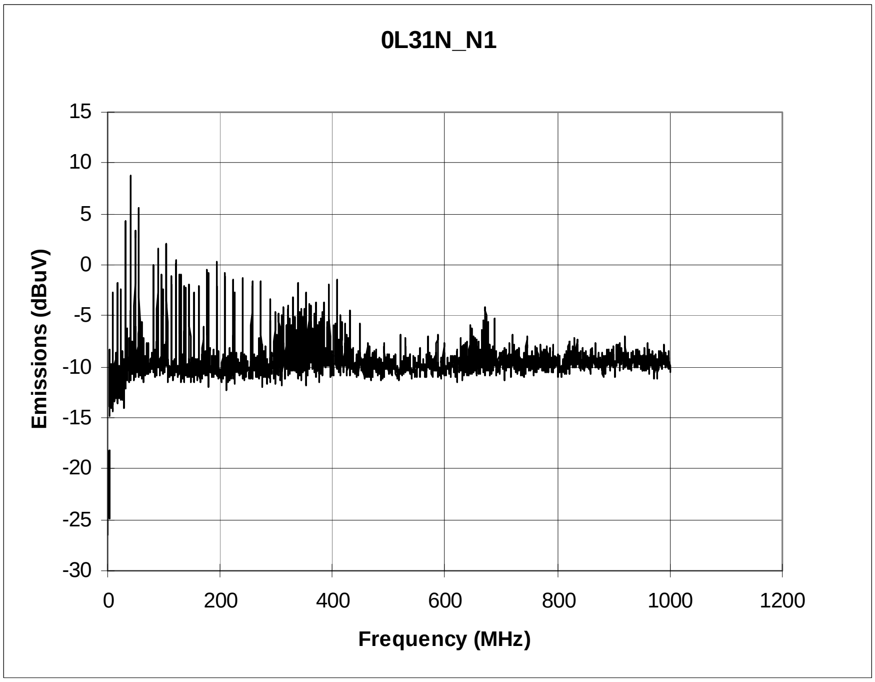

Figure 7. Device in North Orientation (External Crystal)

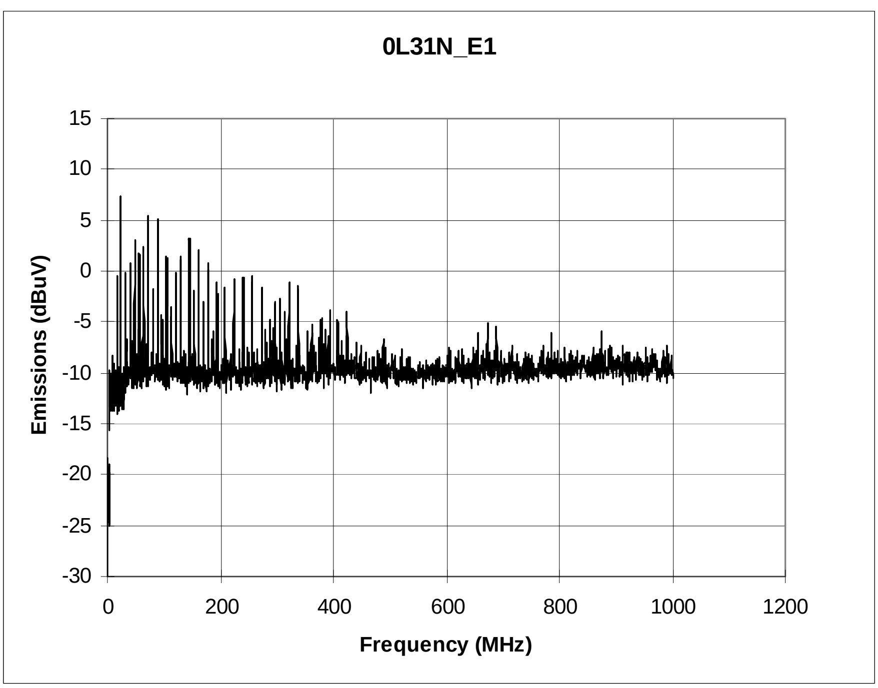

Figure 8. Device in East Orientation (External Crystal)

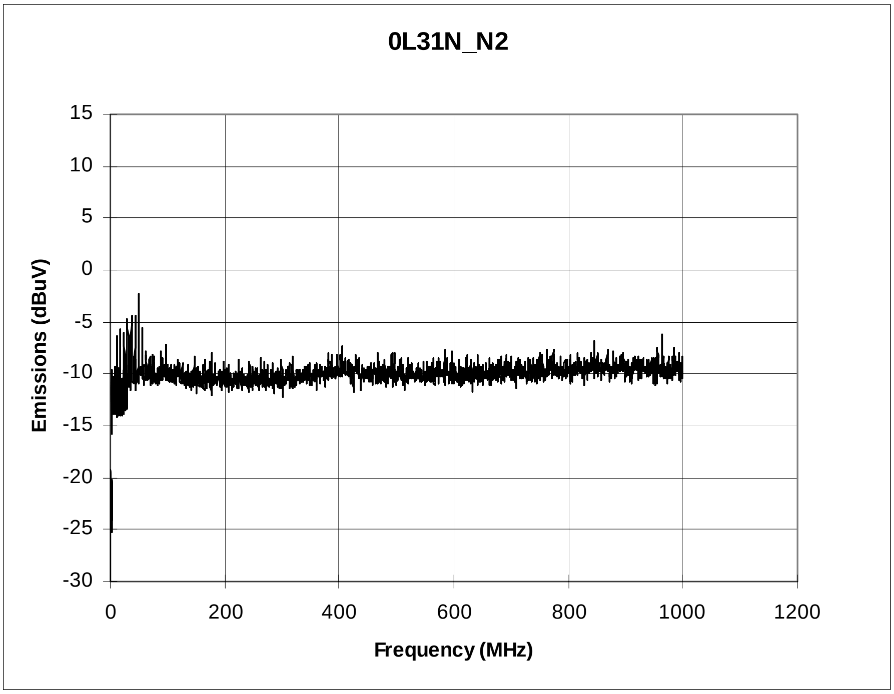

Figure 9. Device in North Orientation (ICG)

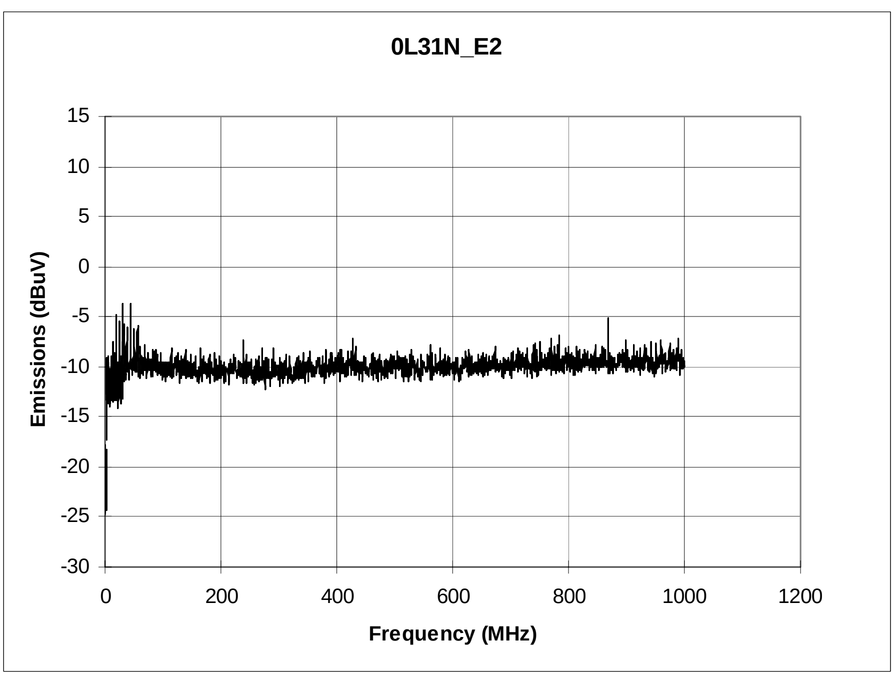

Figure 10. Device in East Orientation (ICG)

Appendix B: DUT Software Flowchart

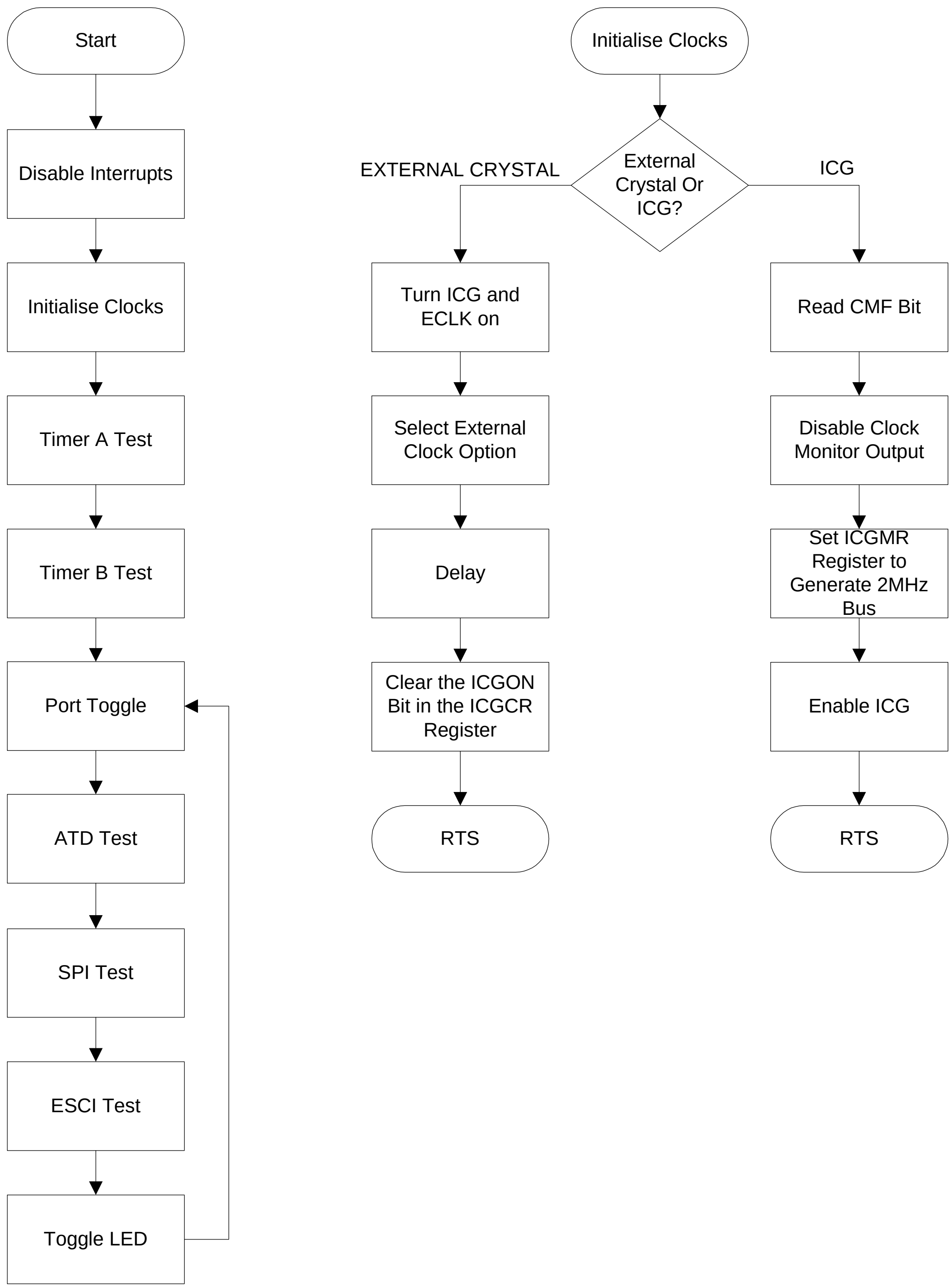

Figure 11. Flowchart, Page 1

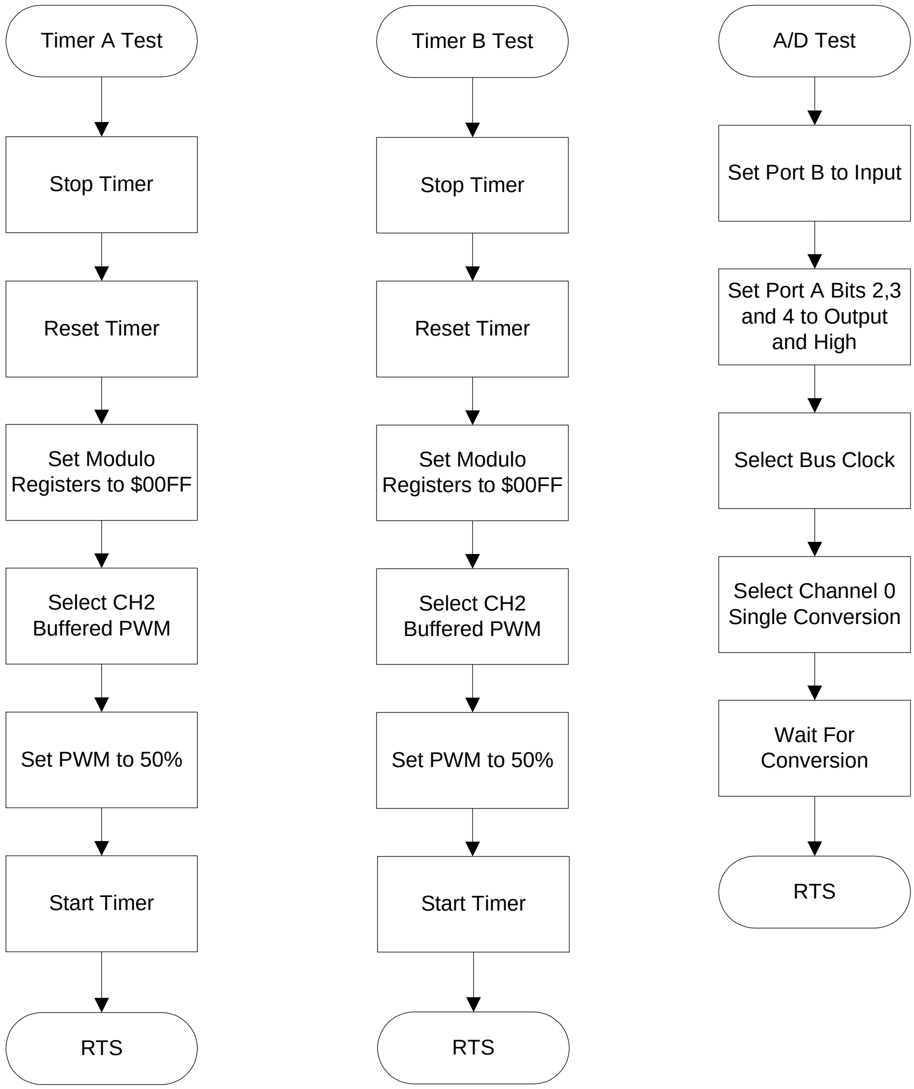

Figure 12. Flowchart, Page 2

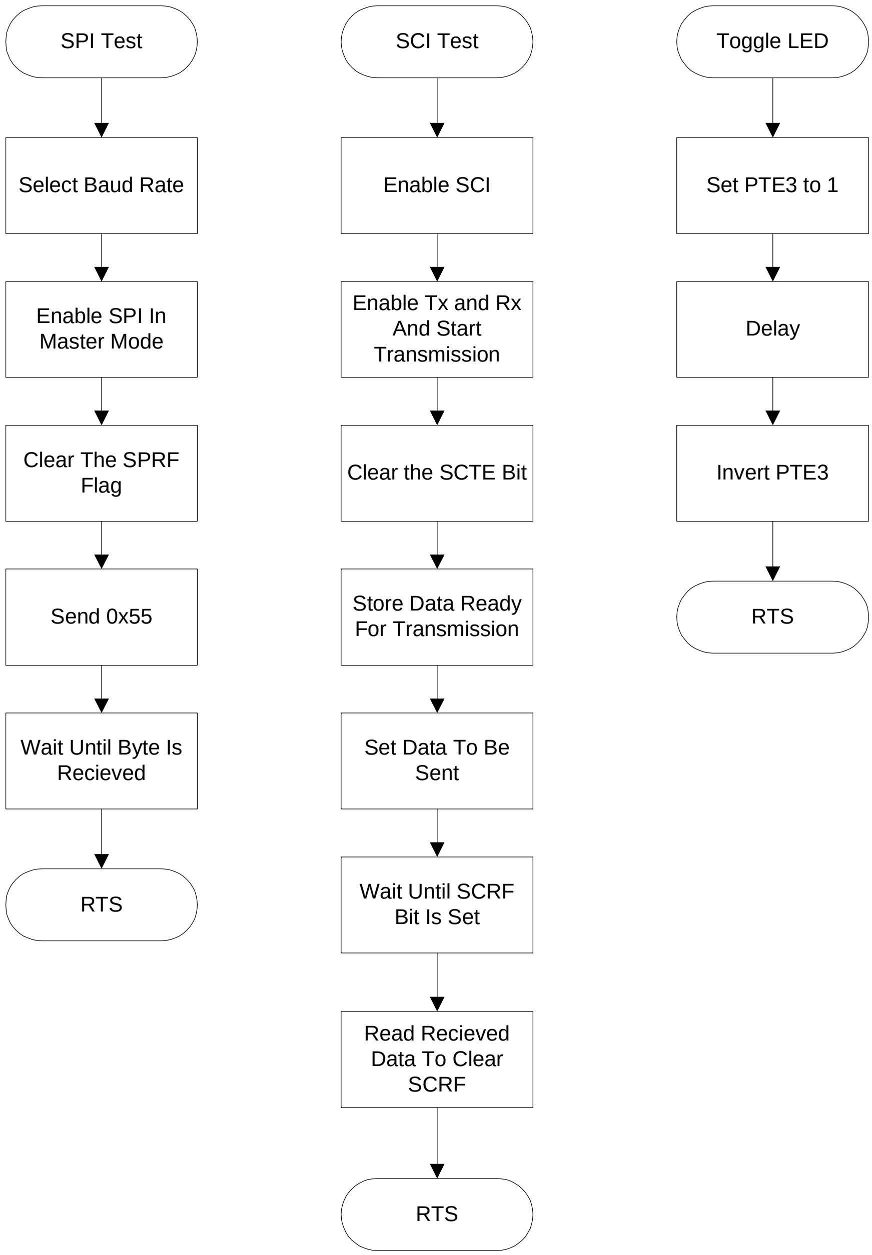

Figure 13. Flowchart, Page 3

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