



1 Introduction

Generally speaking, the resonant circuit of a resonant converter consists of a capacitor, an inductor, and resistance. Two types of resonant converters are generally used: a series resonant circuit and a parallel resonant circuit.

The Induction Cooking evaluation board has been provided with a series resonant circuit. The component L is the cooking element itself.

Contents

1	Introduction	1
2	The resonant converter	5
3	The half bridge driver configuration	7
4	References and related materials	8
5	Revision history	9

List of figures

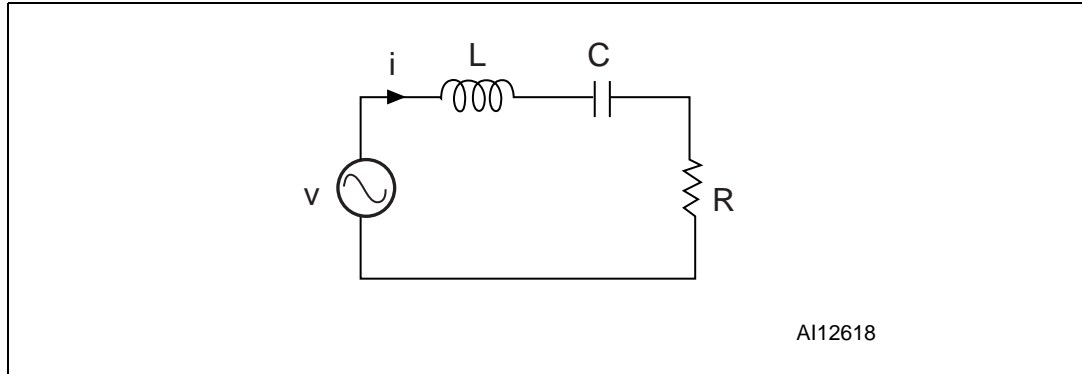
Figure 1.	The series resonant circuit	5
Figure 2.	The resonant curve	6
Figure 3.	The power stage	7

List of tables

Table 1. Document revision history 9

2 The resonant converter

Figure 1. The series resonant circuit



Formula 1

$$X_L = j\omega L = j2\pi fL \text{ } [\Omega]$$

Formula 2

$$X_C = \frac{1}{j\omega C} = \frac{1}{j2\pi fC} \text{ } [\Omega]$$

Formula 3

$$|Z| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \text{ } [\Omega]$$

At the resonance frequency, the inductive reactance X_L of [Formula 1](#) and the capacitive reactance X_C of [Formula 2](#) become the same. The current in the circuit reaches its peak when the switching frequency becomes identical to the resonance frequency. In the case of the Induction Cooking evaluation board, the switching frequency is set by MCU, and the signal sent directly to the IGBT driver.

The resonance frequency can be calculated as shown in the following formula:

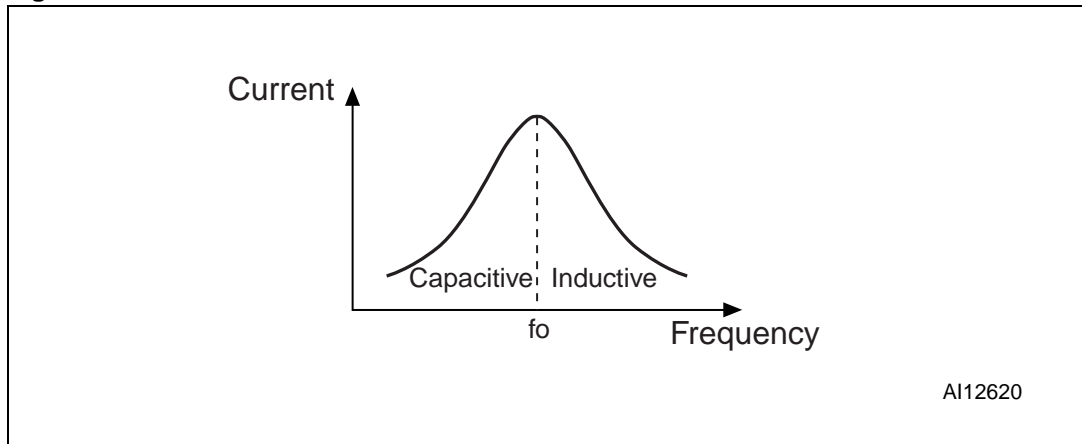
Formula 4

$$2\pi fL = \frac{1}{2\pi fC} \Rightarrow f_0 = \frac{1}{2\pi\sqrt{LC}} \text{ } [\text{Hz}]$$

There are two areas around the resonant frequency: the area where the switching frequency is lower than the resonant frequency and the area where the switching frequency is higher than the resonant frequency. In an Induction Cooking application, the system works always on the right side of the curve, therefore in the inductive area ([Figure 2](#)).

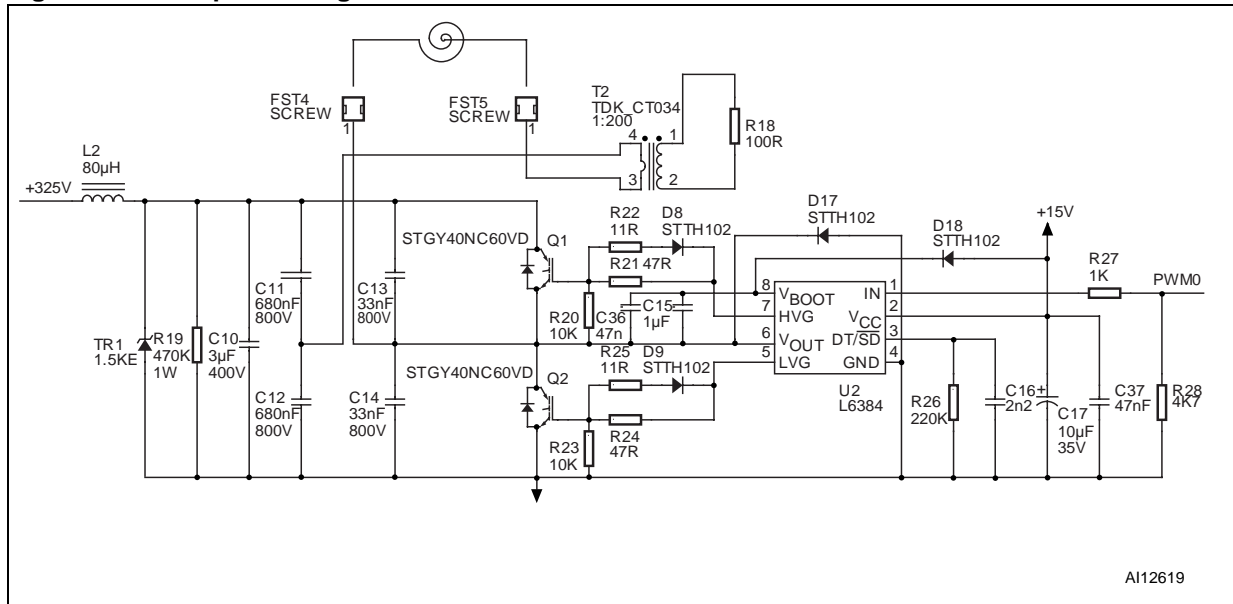
The value of the capacitive reactance becomes smaller according to [Formula 2](#). In this situation, a higher switching frequency is followed by an increase in impedance ([Formula 3](#)), causing the output energy to be lower (as shown in [Figure 2](#)).

Figure 2. The resonant curve



3 The half bridge driver configuration

Figure 3. The power stage



Note: D17 and D18 are not installed.
C16, R26 must be as close as possible to the driver.

The DC link voltage is applied directly to the IGBTs. 220 VAC coming from MAINS are rectified by a diode bridge (not present in the [Figure 3](#)) and leveled by capacitor C10.

Note that this capacitor is too small in capacity to level the voltage properly. In any case, the Induction Cooking board does not require a bigger capacitor to get the voltage more level. In fact, the primary purpose of the system is to generate heat. Moreover, the rugged shape of the DC link voltage improves the system power factor, which is around 0,98. Capacitor C10 is used as a filter, preventing the high frequency current from flowing toward and entering the input circuitry.

The DC link voltage is applied to the load through the IGBT half bridge at high switching frequency. The high frequency harmonics contained in the signal are eliminated by the resonant tank. The circuitry creates a magnetic field around the resonant inductor, affecting the load (pot on the plate).

Capacitors C13 and C14 are placed in parallel to the IGBTs. They act as lossless turn off snubbers keeping the switching losses to a minimum.

The resonant capacitor has been divided in two identical capacitors, C11 = C12). In this way, the amount of current flowing through each capacitor is reduced by half, while the voltage across the capacitor remains the same.

A current transformer T2 has been placed in series with the cooking element (shown in [Figure 3](#) as FST4 and FST5). This does not affect the resonant tank, and provides the MCU with the feedback information needed to control the system.

The gate pulses necessary for the IGBTs are sent and controlled by the half bridge driver U2. The MCU provides the driver with the proper PWM signal, with 50% constant duty-cycle. The operating frequency is in a range between 19 and 60 kHz.

4 References and related materials

For further information strictly related to the basic functionality of each integrated circuit, please refer to the following documentations:

1. ST7LITE datasheet
2. L6384 datasheet
3. STGY40NC60VD datasheet.

5 Revision history

Table 1. Document revision history

Date	Revision	Changes
05-Sep-2006	1	Initial release.

How to size the resonant tank of the Induction Cooking Evaluation Board

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2006 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

