Freescale Semiconductor
Application Note

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Migration from A13 to B5 Wireless Charging Transmitter

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1 Introduction

This application note describes the migration from A13 topology of wireless charging transmitter reference design made by Freescale to the B5 topology of wireless charging transmitter. Both transmitter topologies are suitable for the automotive market. In the B5 transmitter design in comparison to the A13 transmitter design, lower BOM (Bill of Material) can be achieved, but on the other hand the A13 design has better EMC radiation results.

2 A13/B5 comparison

2.1 Coils

A13 design has three litz wire coils, each coil can be connected independently, there is no possibility to charge with two coils connected simultaneously. B5 design has four PCB coils. This transmitter topology allows to connect two coils simultaneously to achieve better charging performance and active area efficiency for the case when the receiver is placed between two coils. This possibility requires additional switch

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for capacitance which is tuning the matching circuit for the case that two coils are connected simultaneously – there needs to be compensated different inductance of the coils.

2.2 Bridge and coil connection topology

Both designs uses full bridge topology. The difference is in the circuit between the bridge and charging coil.

There are two capacitances Cser1 and Cser2 in serial with charging power coil and the filter on the A13 design for better EMC performance. This filter contains two coils L1 and L2, parallel capacitance Cpar and is tuned on the operation frequency of A13 design - 110 kHz. The A13 topology is shown below.

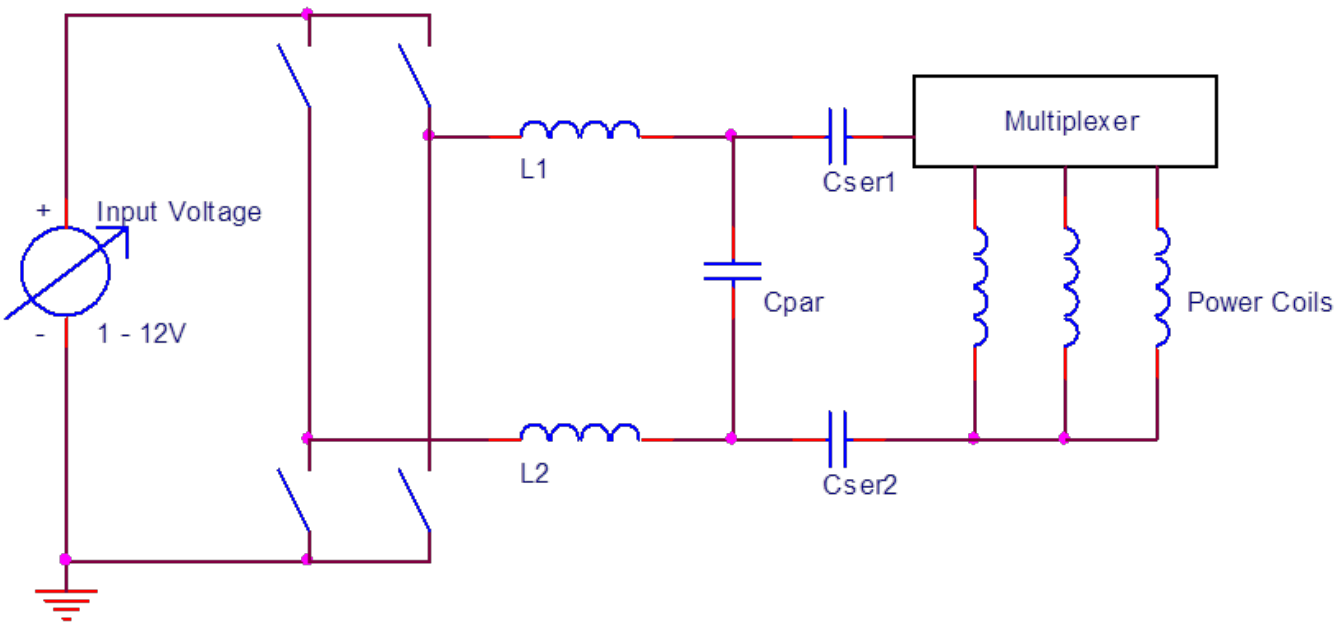

Figure 1. A13 design topology

B5 design has no serial capacitance and filter, there is only matching circuit between the bridge and charging coil. The matching circuit contains one coil Lm and two parallel capacitance Cm1 and Cm2, one of these capacitance is switched on and off for one or two coils connected. The B5 design topology is shown below.

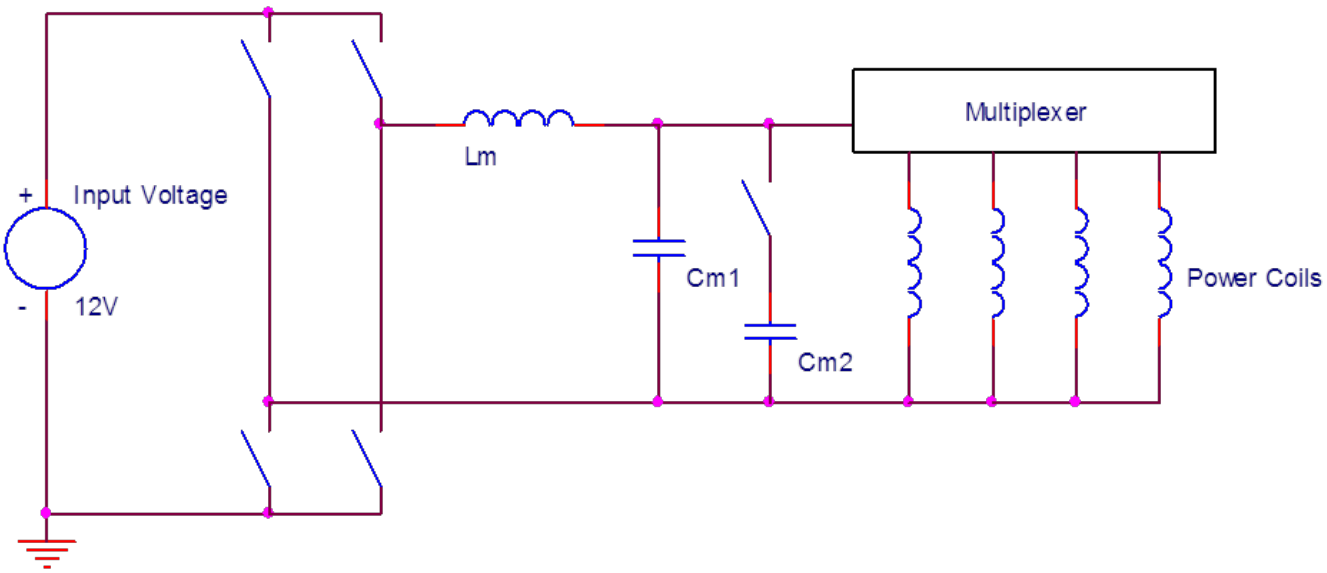

Figure 2. B5 design topology

2.3 Control of transferred energy

A13 topology uses change of the DC rail voltage on the full-bridge inverter for the control of the transferred energy.

B5 topology uses the phase shift between the PWM control signals of the full-bridge inverter for the control of the transferred.

3 HW required changes

3.1 Multiplexer

The multiplexer must be extended from three switches to four switches. Please refer to circuit for switching on the coil on the A13 reference design schematic.

3.2 Tuning capacitor

A switch with capacitor must be added for tuning the resonance circuit when two coils are switched simultaneously.

3.3 DC/DC converter

The amount of transferred power on the A13 topology is driven by changing the voltage in the DC BUS on the full-bridge converter. This requires expensive configurable DC/DC inverter.

B5 topology has the amount of transferred power driven by change of phase between driving PWM signals. The DC BUS on the full-bridge converter remains on the 12V – same like the input voltage from the battery. This allows to use only some voltage stabilizer instead of configurable DC/DC converter.

3.4 Coils

The PCB B5 coils can be designed with addition of touch sensing electrode, NFC antenna and any other feature to one PCB by customer. The shape and ferrite size must be compliant with Qi specification.

4 HW PWM drivers

A13 uses AUIRS2301S PWM drivers, which require PWM driving signal in complementary mode. Each driver needs both sides of the driving signal. It is not possible to do the Phase Shift control of the amount of transferred power with one PWM pair because it requires independent mode, and shifting the phase between each PWM would lead to the shoot through state. It is possible to dedicate another PWM pair to the second driver, but it requires more complicated SW and WCT pins.

Better solution is to use PWM drivers which are driven only with one PWM signal like NCP3420. With this PWM driver one PWM pair can be used in the independent mode.

5 SW required changes

The SW changes relate to the version 3.1 SW for A13 transmitter.

5.1 Number of coils

The B5 design has four coils and allows connection of two neighboring coils simultaneously, this means that from the library point of view there are seven coils.

In the wct_LibStruct.h , the number of coils must be adjusted by macro:

```
#define NUM_COILS_PER_DEVICE
```

In the coilselector.c , the number of coil IDs must be increased

```
BYTE  byCoilIds[NUM_DEVICES][NUM_COILS_PER_DEVICE] = {0, 1, 2, 3, 4, 5, 6};
```

In the wct_lib_cfg.h the mapping of PMW channel must be increased for each coil:

```
#define PWM_CHANNEL_MAPPING{ 3, 3, 3, 3, 3, 3, 3 }
```

In the wct_lib_cfg.h the mapping of ADC channel must be increased for each coil:

```
#define COIL_CURRENT_ADC_CHANNEL_MAPPING{ 0, 0, 0, 0, 0, 0, 0 }
```

5.2 Ports adjustment

The ports for chosen coils need to be adjusted and added in wct_lib_cfg.h in these macros:

```
#define COIL_ENABLE_CONTROL_PORTS
#define COIL_ENABLE_CONTROL_BIT_MASKS
#define COIL_DISCHARGE_CONTROL_PORTS
#define COIL_DISCHARGE_CONTROL_BIT_MASKS
```

5.3 Multiplexer

A multiplexer function is required which will allow to switching two coils simultaneously and switching the additional parallel capacitor.

It is necessary to replace the following line in WCT_CoilControl function with multiplexer function for switching on desired combination of coils:

```
*( ptrCoilEnableControlPort[ byCoilId ] ) |= CoilEnableControlBitMask[ byCoilId ];
```

It is necessary to replace the following line in WCT_CoilControl function with multiplexer function for switching off all coils.

```
*( ptrCoilEnableControlPort[ byCoilId ] ) &= ~CoilEnableControlBitMask[ byCoilId ];
```

5.4 Peripherals modification

Following changes should be done in GCT (Graphical Configuration Tool):

- GPIO – you need to dedicate one more GPIO pin for the multiplexer and one GPIO pin for the additive capacitance.
- PWM – the PWM module for the phase shift control needs to be changed from the complementary mode to the independent.

5.5 Control of power transfer

The basic library delivered for A13 design has no possibility to control the power transfer by changing the phase between two control PWMs in default. Please contact customer support for the delivery of the modified library for phase shift control.

5.6 SW PWM drivers

The SW PWM drivers aren’t prepared in default for phase shift control in the A13 example application.

5.7 NVM parameters

SW required changes

You need to generate new NVM parameters for 7 coils, A13 application SW has NVM parameters only for 3 coils. only for 3 coils. The best way is to use FreeMaster and proceed according to steps below:

- Flash the example application for 3 coils to the board and run FreeMaster.
- In the FreeMaster, navigate to the "Coil Params" tab and write number of the coils (7) to the amount of coils field and press enter on the keyboard as shown below.

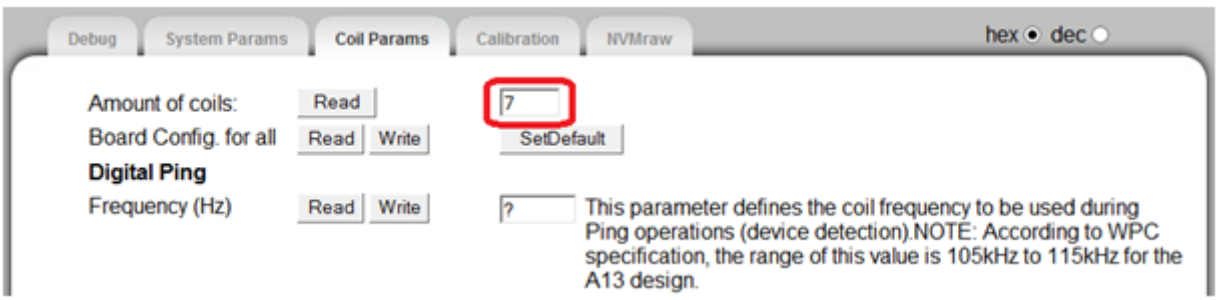

Figure 3. Increase of number of coils

- Navigate to the "NVMraw" tab and click on "Read" button on the line "Board Config. for all" as shown below.

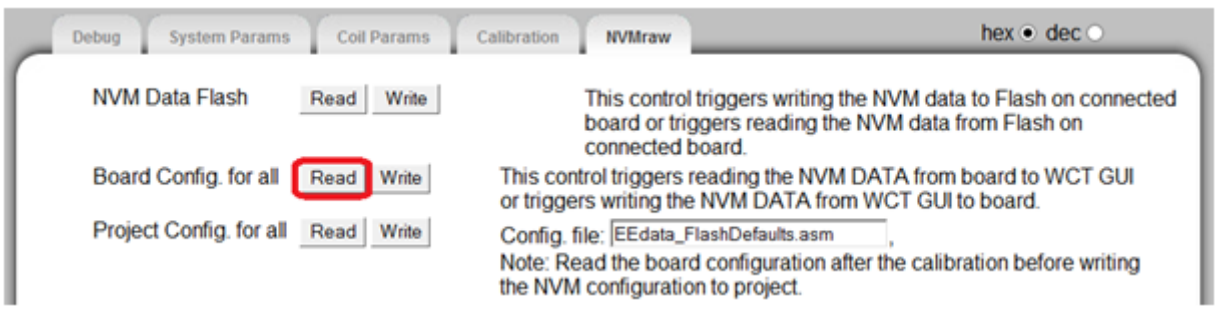

Figure 4. Reading the NVM parameters

- Navigate to the "System Params" tab and click on "Read" button and enable the coils on the "Power Xfer Control Bitfield" line in the "WPT configuration" section. The coils are enabled by checking the desired coils in the checkbox field. Do not press "Write" button!! as shown below.

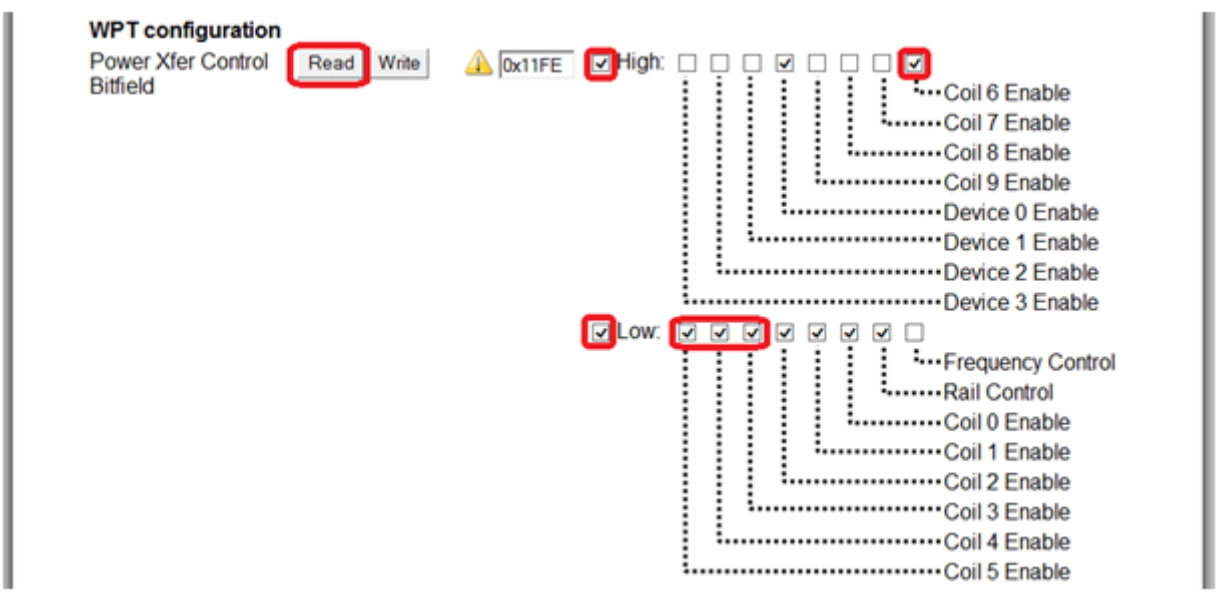

Figure 5. Enabling additional coils

- Navigate to the "NVMraw" tab and click on "Write" button on the line "Project Config. for all" as shown below.

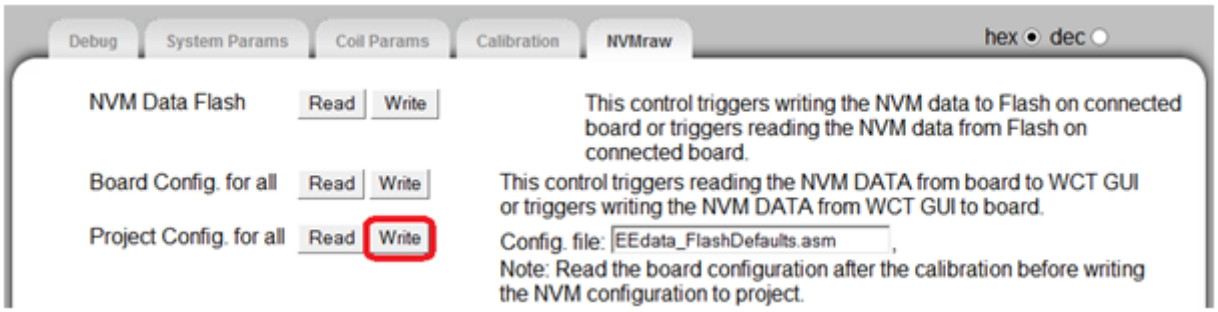

Figure 6. Writing the NVM parameters into the CW project

6 Conclusion

It is possible to control all transmitter types mentioned in the WPC specification with Freescale WCT chips, no matter which HW topology is used. However Freescale Wireless Charger libraries do not support all kinds of power transfer control in default so the customer needs to contact customer support for delivery of library which fits its requirements.

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