

User's Guide

WCT1101 A28 Reference Design System User's Guide

1 Introduction

This document describes how to use 5W low power multi-coil Wireless Charging Transmitter reference board with WPC A28 solution designed by Freescale. The A28 Reference solution is compliant with WPC Qi V1.1 specification. It is low cost reference solution, which can be easy customized through the FreeMASTER GUI tool.



Figure 1 WCT-5WTXMULTI (A28) reference board

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2 System Features

The A28 reference board has the following features:

- Reference design compliant with low power WPC Qi version 1.1 Specification.
- Integrated digital demodulation in chip.
- Supports multiple types Rx modulation signals (AC capacitor, AC resistor and DC resistor).
- Supports Qi power loss FOD feature.
- Supports Qi 1.1 receiver with 5 V DC@1A output power capability.
- Low standby power by analog ping.
- Full bridge topology with freqency modulation power control strategy.
- Multi-coils, can achieve large charging area.
- Supports LED to indicate power transfer status.
- Input voltage/current, coil current and coil temperature sensing for protection.
- FreeMASTER GUI tool to enable customization and calibration.
- Supports the FO detection method before power transfer.

3 Package Checklist

Name	Count
WCT-5WTXMULTI A28 Tx board with Tx coil	1
5V/2.4A DC power adapter	1
Osjtag board and cables for debugging	1

4 System Block Diagram

Multi-coil Tx runs with Rx, as shown in Figure 2, to transfer power from the primary to the secondary side.



Figure 2 Wireless Charging System Overview

Get WPC Qi information from: www.wirelesspowerconsortium.com/developers/

WCT1101 A28 Reference Design System User's Guide, Rev. 2.0, 12/2014



5 Hardware Description

5.1 Reference board block diagram



Figure 3 WCT-5WTXMULTI A28 board block diagram



5.2 Modules description



Extern Touch PAD

Coil switched circuit

Figure 4 5WTXMULTI board modules overview

Controller

Freescale MWCT1101CLH chip is the central controller of the WCT-5WTXMULTI A28 board. It has rich I/O modules but with low power consumption. It processes communication signals, controls power transfer start/stop, controls the coil switched circuit, and controls full bridge PWM inverter for output power control.

These are I/O modules used in this application:

- Two PWM channels for full-bridge DC/AC inverter control. 0
- Three Timers for system timers and communication. 0
- ADC for input voltage, current, coil current and temperature sampling. 0
- GPIOs for pre-drivers control, low power, coils switched, and LED control.
- Two SCI for serial port debugging. 0
- Low cost GPIO touch feature to decrease the standby power. 0
- Inverter

The full bridge PWM control inverter converts input 5 V DC voltage to a higher AC voltage. The PWM frequency follows WPC Qi specification, in 115 KHz–205 KHz range. PWM duty is 50%, and starts duty control (50%-10%) when frequency is 205 KHz. Lower frequency gets larger output power.

Input voltage range: 4.75 V DC – 5.25 V DC Output voltage range: 5 V AC – 20 V AC



Communication

The communication of 2 Kbps signal is demodulated from high frequency coil current AC signal (110 KHz–205 KHz). The RC sensing circuit gets resonant coil current and input to ADC for sampling. Digital demodulation module processes on the input samples and extracts communication packets.

• GPIO Touch sensing for low power mode

The board supports super low power mode by Freescale touch technology. When it is not charging, controller shuts down analog circuit power supply, and start the GPIO touch sensing for every 400mS, when the Receiver is placed on the TX coil surface if will be sensed by the touch feature, and start the wireless charging process.



6 Getting Started

Freescale provides an SW package to modify WCT A28 functions. The user can modify system parameters or configurations to maintain system functionalities. For example, when Tx coil or main power components are changed, it is better to do calibration to get FOD working. This manual describes basic debugging environment on WCT1101. For Multi-coil SW details, see the *WCT1101 A28 Library User's Guide* (WCT1101LIBUG).

6.1 System developing environment

Tx board debugging uses CodeWarrior and the FreeMASTER tool. Set up the debugging connection as shown in Figure 5. The debugger and debugging board is between the PC and Tx board. Connect a debugger (OSJTAG,USBTAP or P&E-Multilink FX) to the JTAG port of a debugging board, and connect the debugging board to a Tx board through a 14-pins cable.

Figure 5 shows the connection and Figure 6 shows a real image.



Figure 5 Debugging connections





Figure 6 Developing environment

For details on the USB TAP debugger, see freescale.com and then search for "USB TAP for Once DSC".

For details on the P&E-Multilink FX debugger, see <u>freescale.com</u> and then search for "U-MULTILINK-FX". It will take you to the "U-MULTILINK-FX: Universal Multilink FX High-Speed Development Interface" page.



6.2 Downloading and debugging firmware with CodeWarrior 10 IDE

6.2.1 Connecting the JTAG debugger

After CW10 is installed, connect the Freescale MCU JTAG debugger, OSJTAG, USB TAP or P&E Multilink to the A28 board.

The cable plug-in direction is shown in Figure 7, OSJTAG board is default used.



Figure 7 Cable plug-in direction



When the debugger is plugged onto the PC, the device can be found in Windows "Device Manager", as shown in the following figures.



OSJTAG



Figure 8 OSJTAG debugger plugged in



USB TAP



P&E Multilink

🖳 Device Manager 🔹 🗖 🔀	😫 Device Manager 📃 🗆 🔀
Eile <u>A</u> ction <u>V</u> iew <u>H</u> elp	Eile Action View Help
Basen 1-01 Basen 1-01	B38910-01 Batteries Computer ControlVault Device Disk drives Disk drives Display adapters MinDriver WinDriver Monitors Monitors Processors Processors Sonart card readers Display adapters Display adapters

Figure 9 USB TAP debugger plugged in

Figure 10 P&E multilink debugger plugged in



6.2.2 Downloading an existing WCT1101 project with CW10

To download an existing A28 project with CW10, perform the following steps (<u>Tested CW tool version is</u> <u>CW10.6</u>):

1. Set the CW10 Workspace.

Open CW10, and set the workspace to multi-coil example project, WCTA28demo.

🥦 Workspace Launc	her 🛛 🔁
Select a workspace	
CodeWarrior Developme Choose a workspace fold	nt Studio stores your projects in a folder called a workspace. Ier to use for this session.
Workspace: D:(User	Browse
Use this as the default	Select Hornspluce Drieston y Select Hornspluce Drieston y Select the workspace directory to use. Cancel Can
	Folder: User Make New Folder OK Cancel

Figure 11 Setting the CW10 workspace (1)



Figure 12 Setting the CW10 workspace (2)



2. Install the WCT service packet.

Choose Help -> Install New Software.



Figure 13 Installing new software



3. Click "Add" and "Archive", and then select

"com.freescale.mcu10_6.WCT_WCT100x_WCT1100x_WCT1200x.win.sp.v1.0.1.zip" (CW MCU v10.6 Wireless Charging MWCT1xxx Service Pack). Download address: http://www.freescale.com/webapp/sps/site/overview.jsp?code=CW_UPDATES_MCU_10_6&fsr ch=1&sr=1&pageNum=1

🥦 Install								
Available S Select a site	oftware	ory			X			
<u>W</u> ork with:	<u>N</u> ame: Location: ht	//			L <u>o</u> cal <u>A</u> rchive	g with the <u>"Avail</u>	able Software S	<u>A</u> dd
Reposit	tory archive	er 🕨 Local Disk (D:)) ► Setup ► CodeW	/arrior 🕨	•	• 4• Search	CodeWarrior	<u>ح</u> م
Diganzi Re	ownloads ecent Places	Name	110.6	*			Date mo 5/28/201	odified
Cibr Di M M Pi Pi Vi	raries locuments fusic ictures odcasts ideos	Com.freesca	le.mcu10_6.WCT_WC	T100x_WCT110	00x_WCT1200x.wi	n.sp.v1.0.1.zip	6/3/2014	4 11:10 AM

Figure 14 Selecting the service pack



4. Select "MCU v10.6 DSC Service Packs", and then click "Next".

(A Install		
Available Software Check the items that you wish to install.		
Work with: jar:file:/D:/Setup/CodeWarrior/com.freescale.mcu10_6.WC	T_WCT100x_WCT1100x_WCT1200x.win.sp.v1.0.1.zip!/	<u>A</u> dd
type filter text		
Name	Version	
▷ 🔽 000 MCU v10.6 DSC Service Packs		
Select All Deselect All 1 item selected Details MCU v10.6 DSC Service Packs. Requires previous installation of DSC Sup	oport	
	_	More
Show only the latest versions of available software	<u>H</u> ide items that are already installed	
Group items by category Show only on the second and the s	What is <u>already installed</u> ?	
Snow only software applicable to target environment Image: Contact all update sites during install to find required software		
?	< <u>B</u> ack <u>N</u> ext > <u>F</u> inish	Cancel

Figure 15 Selecting MCU v10.6 DSC service packs

5. Click "Next".

🥬 Install			
Install Details Review the items to be installed.			
Name	Version	Id	
MCU v10.6 DSC Service Pack for DSC WCT WCT100x WCT1100x WCT1200x	1.0.1	com.freescale.mcu10_6.WCT_WCT100x_WCT1100x_WCT1200x.win.sp.feature.group	
Size: Unknown			
Details			
?		< Back Next > Einish	Cancel





6. Review the license terms. If you agree with the license terms, select "I accept the terms of the license agreement", and then click "Finish".

🥦 Install	- • •
Review Licenses Licenses must be reviewed and accepted before the software can be installed.	
License text (for MCU v10.6 DSC Service Pack for DSC WCT WCT100x WCT1100x WCT1200x 1.0.1):	
IMPORTANT. Read the following Freescale Software License Agreement ("Agreement") completely. By any affirming action by you, you indicate that you accept the terms of this Agreement and you also acknowledge that you have the authority, on behalf of your company, to bind your company to such terms. You may then download or install the file.	-
I accept the terms of the license agreement ○ I do not accept the terms of the license agreement	
(?) < <u>Back</u> <u>Next</u> >	Cancel

Figure 17 Installation finished



7. Import a project.

Right-click in the "CodeWarrior Projects" window and choose "Import" to import an existing project, as shown in the following figures. If the "CodeWarrior Projects" window is not displayed, open it through Window -> Show View -> CodeWarrior Projects.

😫 C/C++ - CodeWarrior Development Studio	
File Edit Search Project Run MQX Tools Processo	r Expert
🗂 🕶 🔚 🔞 🔨 - 🛛 💋 - 👬 🕴 (Active)	
😼 CodeWarrior Projects 🛛 🗖 🗖	
📳 📮 🕒 🤹 🔎 File Name	
File Name 🔺 Build	
New	
C 🔁 Import	
🗾 Export	

Figure 18 Importing a project (1)



Figure 19 Importing a project (2)



Select the project directory, as shown in Figure .

Browse For Folder	×
Select root directory of the projects to import	
⊳ iii sw ⊳ iii sw v2	
WCT_5W_MultiCoils_V2.0	
⊳ M28 ⊳ WCTLib	
🚺 Bug fix	
Datasheet	-
Eolder: WCT_5W_MultiCoils_V2.0	
Make New Folder OK Can	i cel

Figure 20 Importing a project (3)

Select the project found by CW10.

12 Import	
Import Projects Select a directory to search for existing Eclipse projects.	
Select root directory: F:\WirelessCharging\A28\SW V2\5W_MultiCoil Select archive file:	B <u>r</u> owse
Projects:	
	Select All
4	
Copy projects into workspace Working sets	
Add projec <u>t</u> to working sets Working sets:	S <u>e</u> lect
(?) < <u>B</u> ack <u>Next</u> > Finish	Cancel

Figure 21 Importing a project (5)



8. Build a project.

You can select build configurations -> Debug or Release build, by clicking the project name in the project window shown in Figure . Debug build includes more debug information.



Figure 22 Building a project (1)

Right-click the project name "WCTA28demo: SDM_Debug", and then select "Build Project", "Clean Project", or "Close Project". You can also perform building from "Project".





Figure 23 Building a project (2)

9. Download the project.

After the project is built, the MCU binary files are generated to a folder, with the same name as the build configuration name, "SDM_Debug".

Download the project from the "Debug" drop-down list, or from "Run -> Debug".

In "Debug Configurations", select a download configuration according to your build configurations and debugger type, OSJTAG, USB TAP, or PnE Multilink.

eate, manage, and run configurations	
ebug or run an application to a target.	
/ De filter text ▲ CodeWarrior	Name: WCTA28demo_SDM_Debug_OSJTAG Imain Imain Imain Imain
WCTA28demo_FLASH_SDM_PnE Cyclone MAX WCTA28demo_SDM_Debug_FSL USB TAP IE WCTA28demo_SDM_Debug_OSITAG @ WCTA28demo_SDM_Debug_PnE U-MultiLink WCTA28demo_SDM_Release_FSL USB TAP @ WCTA28demo_SDM_Release_OSITAG @ WCTA28demo_SDM_Release_PnE U-MultiLink Launch Group	Choose a predefined debug session type or custom type for maximum flexibility Download Connect Attach Custom Custom Custom
	Project: WCTA28demo Browse Ø Application: SDM_Debug/WCTA28demo.elf Search Project Browse Variables Normality Normality
	Found in required, before nameling Tarnet settings
	Connection: WCTA28demo_FLASH_SDM_OSJTAG Center Edit Edit Edit Edit Edit Edit
ter matched 9 of 9 items	
er by Project:	
	Apply

Figure 24 Downloading the project



Go	Pause Stop Step	Development Studio EMicro Run Window Help & Ø • * * *	Watching	windov	v for Variables, Regist	ers, Memory, and B	reakpoints
The Debug S?	, ·			181: Variables	22 9 Breaknoints IIII Registers 1 Memor	v 🐋 Monales 🖉 🚓 🖂	
E WCTA28demo.30M.Pebug. & Ø DC, WCTA28demo.4f (5	05/TAG (CodeWarnior) usgended) ended: Signal 'Halt' received. Description: Us <u>174 0.000000</u> SW V2.SW, MultiCoit_Release\WCT_SW, Mul m	er halted thread.) tiCoils_V2.0_RCS\WCT_SW_Multif	Coils_V2.0_RC5\A28\example\V Source code	Name		Locati	Disassembly
	m			•			
Image: State	interrupt vectors "interrupt vec upt vectors begin it(void) Description ISR HM RESET // Reserved for C LLEGALOP // Ilegal Instru- NG RESET // Reserved for C LLEGALOP // Ilegal Instru- NG // SW Interrupt 3 VERFLOW // Handware Stack ISALGOME // Higalinged Dat ISALGOME // EndC Ereacpoi RBUF // EOnCE Freacpoi RBUF // EOnCE Freacpoi RBUF // EOnCE Freacpoi RBUF // EOnCE Reacpoint X_REG // EOnCE Reacpoint US ERR // Bus Error Inte	tors.text" RX eset Overlay OP Reset Overlay ction Overflow a Access nter Interrupt therinterrupt Register Full rrupt	Pri VBA+ • 0x980 6 • 0x987 1 • 3 0x94 2 • 3 0x986 4 • 1-3 0x966 3 • 1-3 0x966 • • 1-3 0x966 • • 1-3 0x966 • • 1-3 0x106 • • 1-3 0x114 10 • 1-3 0x14 10 •	174 ▶ 000000: 000000: 0000001: 175 00000002: 0000003: 176 0000005: 0000005: 177 0000006: 0000006: 00000005: 178 00000005: 179 0000008: 0000008: 0000008: 0000005: 179	by 28 30P Init Martloxx ISR MM RESET add B,A A,X1(R0)+ add B,A A,X1(R0)+ add B,A A,X1(R0)+ add B,A A,X1(R0)+ 35R Martloxx_ISR ILEGALOP add B,A A,X1(R0)+ 35R Martloxx_ISR SWI3 mpv (1,Y1,A A,X1(R0)+ 35R Martloxx_ISR SWI3 mpv (1,Y1,A A,X1(R0)+ 35R Martloxx_ISR (R0)+ 35R MartloXX_ISR	Enter location here // Reserved for Reser Overlay // Reserved for COP Reset Over // Illegal Instruction // SW Interrupt 3 // Hardware Stack Overflow // Misaligned Data Access III	2 A Poly (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c
Commander 😫 Project Creation Import project Import acample project Import MCU rescutable file New MQX-Lite project New MQX-Lite project	 ▶ Build/Debug ▶ Settings ♥ Doubl (Al) ♥ Project settings ♥ Clean (Al) ♥ Build settings ♥ Debug ♥ Debug settings 	 ▼ Miscellaneous 3 Welcome screen > Quick access 3 Flash programmer 					8. ∠ = D

Figure 25 Project Downloaded

6.2.3 Downloading an existing WCT1101 bin file (.s) with CW10

To flash an ".s" file, perform the following steps:

1. From the Flash Programmer drop-down list, select "Flash File to Target".



Figure 26 Bin file download



2. Click "New" to create a new connection.

Connection	e a connection before	using the Flash Prog	rammer.	
Connection:		•	Edit	New
Flash Configu	ation File			\smile
				Browse
Unprotect	ash memory before e	rase		
File to Flash				
File:				Browse
Offset: 0x 0				
Offset: 0x 0	et Task			

Figure 27 Bin file download

3. Enter a connection name and click "New" to create a target.

🥦 New Connectio	n			
Hardware or Simulator Connection ③ "Connection type" is undefined.				
Parent profile:	B46685-11			•
Name: 🧲	WCT_5WTXMULTI	>		
Description:				
Template:	None		- Ap	oply Defaults
Target: Connection type:		Edit		New
	Nevts	Finis	h	Cancel
	INEXT >			Cancel

Figure 28 Bin file download



4. Enter a target name, and then select "WCT1101" from the "Target type" drop-down list.

🏴 New Connec	tion	-		x
Hardware or S	Simulator Target			
Configuration	for a hardware-based or simulated target.			
Parent profile:	B46685-11			•
Name: 🔇	WCT1101			
Description:				
Template:	None	-	Apply De	faults
remplates			Coppil or	liduits
T	MWCT1101			
Target type:	MWCT100	^	Edit	
	MWCT1000			
Initialization	MWCT1003			
Execute r	MWCT1101			
Run d	MWCT1200			
Initialize f	▷ eppc.MPC5658x			
	▷ eppc.MPC56xxA	.		
? <	Back Next > Finish		Cano	el :

Figure 29 Bin file download



5. Select "Execute reset" and "Initialize target", set the initialization file path to the CW10 installation folder, and select "MWCT1101.tcl" for the WCT1101 chip.

🥦 New Connec	tion
Hardware or	Simulator Target
Configuration	for a hardware-based or simulated target.
Parent profile:	B46685-11
Name:	WCT1101
Description:	
Template:	None Apply Defaults
Target type:	MWCT1101 T Edit
Execute r	Menory eset but of reset target: F/WirelessCharging\A28\SW V2\5W MultiCoil R
? <	Back Next > Finish Cancel

Figure 30 Bin file download



6. Set the memory configuration file path. For the WCT1101 chip, it is "MWCT1101.mem", located under the CW10 installation folder. Then click "Finish".

🥦 New Connec	tion	
Hardware or	Simulator Target	
Configuration	for a hardware-based or simulated target.	
Parent profile:	B46685-11	•
Name:	WCT1101	
Description:		
Template:	None	Apply Defaults
Target type:	MWCT1101 -	Edit
Initialization	Memory	
Memory	configuration F:\WirelessCharging\A28\SW	V2\5W_Mu
? <	Back Next > Einish	Cancel

Figure 31 Bin file download



7. Select "P&E DSC Multilink\Multilink Universal\Cyclone Pro\OSJTAG" or "USB TAP" for the connection type. Then click "Finish".

🥬 New Connecti	on	
Hardware or Si Connection cor	imulator Connection rfiguration for a hardware-based or simulated target.	
Parent profile:	B46685-11	
Name:	WCT1101	
Description:		
Template:	None App	ly Default
Target:	UCT_SWTXMULTI + Edit	New
Connection type	P&E DSC Multilink\Multilink Universal\Cyclone Pro\OSJTAG	
Interface:	USB Multilink, USB Multilink FX, Embedded OSBDM/OSJTAG - USB Compatible Hardware USB1 : Embedded DSC OSBDM/OSJTAG Device (SER01) 127.0.0.1 Spgcify Network Card IP 127.0.0.1 Advanced Programming Op	tions
- Target Com	munication Speed	
De <u>b</u> ug Shif	r reset and before communicating to target for0 milliseconds (decimal)	
Enable logg	ing	
•		
(?)	< Back Next > Finish C	ancel

Figure 32 Bin file download

8. Set the Bin file path (The location is

\...\WCT_5W_MultiCoils_V2.0_RC5\A28\WCTA28demo.elf.S). Before downloading, you can save the configuration to the workspace for next-time downloading. Click "Erase and Program". NOTE: To download an ".elf" file, please do "Erase Whole Devices" before "Erase and Program". Otherwise it may fail.



🥦 Flash File To Target
Erase and program flash devices.
Simplified user interface for Flash Programmer
Connection
Connection:
Flash Configuration File
MWCT1101.xml
Unprotect flash memory before erase
File to Flash
File: F:\WirelessCharging\A28\SW V2\5W_MultiCoil_Release\WCT_5W_M
Offset: 0x 0 File size is 0x15100 bytes
Save as Target Task
Task Name: Flash 5WTXMULT
Erase Whole Device Erase and Program Close

Figure 33 Bin file download

9. The flashing progress is displayed in the CW10 console window. After flashing is completed, reset the board to make WCT1101 running.



Figure 34 Bin file download



6.2.4 Setting up FreeMASTER connection to target board

 Set symbol file for your project (<u>Tested Freemaster tool version is V1.4.2.3</u>): Select symbol file in FreeMASTER Project -> Options -> MAP Files in Freemaster tool, as shown in Figure.

Options		×
Comm MAP Files	Pack Dir HTML Pages Demo Mode	
Default symbol file:	\cw10\SDM_Debug\WCTA28demo.elf	
File format:	Binary ELF with DWARF1 or DWARF2 dbg format.	Del
List of all valid	.\cw10\SDM_Debug\WCTA28demo.elf	New.
symbol files:		Del
		View
	Note: The file selected in the list will be used as default symbol file when the project is opened	
	On Load Let the user select starting symbol file	
	✓ Synchronize variables each time the symbol file loads	
	 ✓ List errors (variables using undefined symbols) ✓ Always ○ Except after project load 	
	OK Cancel Apply	Help

Figure 35 Selecting symbol file

- 2. Perform settings for using the SCI/OSJTAG debugger.
 - By default, SCI is used for Freemaster connection in A28 demo, and the baud rate is 19200. Before connecting Freemaster, confirm that the baud rate of the computer com port is 19200. It can be found in Computer -> Manage -> System Tools -> Device Manager -> Ports. Right-click "OSBDM/OSJTAG" and choose "Properties". Then the baud rate can be changed as shown in Figure .



OSBDM/OSJTAG - CDC Serial Port (http:/	/www.pemicro.com/osb
General Port Settings Driver Details	
<u>B</u> its per second:	9600 -
<u>D</u> ata bits:	/5 110 134
<u>P</u> arity:	300 600
Stop bits:	1200 1800 2400
Flow control:	4800 7200
	9600 - 14400 - 19200
	38400 57600
	128000
	OK Cancel

Figure 36 Computer band rate setting

2) Select "FreeMASTER BDM JTAG/OnCE" in Project -> Options -> Comm in Freemaster tool, as shown in Figure .

Options			100,000	<u> </u>	×
Comm	MAP Files Pa	ck Dir HTML Pages	Demo Mode		
•	Direct RS232:	Port: COM12	OSBDM/OSJ Timeouts	TAG - CDC	Serial Port (http
	Plug-in Module: Connect string:	addr=localhost;core=	56F&xxx		▼ Configure
	Save settings to	project file 🗌 Sa	ive settings to re	gistry, use it	t as default.
	nunication state Open port at sta Do not open por Store port state Store state to pr	on startup and on proje rtup t at startup on exit, apply it on start oject file, apply upon it:	ect load up s load		Advanced
		ОК	Cancel	Apply	Help

Figure 37 Options dialog box

- 3) Click the "Start/Stop" button to make the Freemaster connection work.
- 3. Perform settings for using the USB TAP/ P&E Multilink FX debugger.

As SCI is used for Freemaster connection in current A28 demo by default, if other debuggers are used, some changes are needed. Perform the following steps to enable the USB TAP/P&E Multilink FX debugger connection:



- Import WCTA28demo in CW10. Disable macro "FMSTR_USE_SCI" and enable "FMSTR_USE_JTAG". They are defined in WCTA28demo -> Sources -> Application -> freemaster_cfg.h as follows: #define FMSTR_USE_SCI 0 /* To select SCI communication interface */
 - #define FMSTR_USE_JTAG 1 /* 56F8xxx: use JTAG interface */
- 2) Rebuild the demo, and download it according to the used debugger type USB TAP/P&E Multilink FX.
- 3) For the USB TAP debugger, keep the CW10 connected, and select "JTAG/OnCE" in Freemaster Project -> Options -> Comm in Freemaster tool as shown in Figure .

Options		
Comm MAP Files Pack Dir HTML Pages Demo Mode Communication		
○ Direct RS232: Port: COM8 ▼ Speed: 19200 ▼		
Plug-in Module: FreeMASTER CodeWarrior-CCS JTAG/OnCE Communicatio Connect string: addr=localhost;core=56F&xxx Configure		
Save settings to project file		
Communication state on startup and on project load C Open port at startup Do not open port at startup C Store port state on exit, apply it on startup		
Store state to project file, apply upon its load		
OK Cancel Apply Help		

Figure 38 Options dialog box

Click the "Start/Stop" button to make the Freemaster connection work.

4) For P&E Multilink FX debugger, disconnect the CW10, select "JTAG/OnCE" in Freemaster Project -> Options -> Comm in the Freemaster tool as shown in Figure .



ptions)					
Comm	MAP Files Pack Dir	HTML Pages	Demo Mode		
Cor	munication				
C	Direct RS232: Port:	COM8 –			
	Speed	: 19200 💌	Timeouts		
•	Plug-in Module: Freel	MASTER BDM	JTAG/EOnCE Co	ommunicatio	on Plug-in (5 💌
	Connect string: drv=0);ptype=3;pnum	=1;devid=;devloo	k=0j ▼	Configure
	, Save settings to projec	t file 🔲 Sa	ave settings to re	egistry, use i	t as default.
Cor	munication state on sta	rtup and on proj	ect load		
0	Open port at startup				
•	Do not open port at sta	artup			
0	Store port state on exit	, apply it on star	tup		
	Store state to project fi	le, apply upon it	s load		Advanced
		ок	Cancel	Apply	Help

Figure 39 Options dialog box

Click the "Start/Stop" button to make the Freemaster connection work.



6.2.5 Using FreeMASTER GUI for calibration

Freescale provides the FreeMASTER GUI tool for calibration and parameters tuning. Freemaster configuration file WCTA28demo.pmp is saved under \A28\example\WCTxxx\WCTA28demo. See the *WCT1101 A28 Reference Design Calibration User's Guide* (WCT1101CALUG) for calibration. See the *WCT1101 A28 Run-Time Debug User's Guide* (WCT1101RTDUG) for Multi-coil parameters tuning. For the FreeMASTER tool, see freescale.com/Freemaster.

WCTA28demo.pmp - FreeMASTER					
Eile Edit View Explorer Project Tools	Help				
: 🖆 🖬 🌐 🖂 🗠 😫 🖉 💷	1 ※ 魚魚の気管 🏢 🛧 🖡	🖆 餐 : Tahoma	- 8 - B / U 9 9 = =		
			· · · ·	semiconductor	
🚰 New Project		Contraction Contract		her e dec	
Power Loss log	Debug System Params	Coll Params Calibrati	on NVMraw	nex @ dec 0	
Percent Power Used		-	_	1	E
Power Loss	Amount of coils:	Read 3			
	Board Config. for all	Read Write Se	tDefault		
FAULT	Digital Ping				
FSL DEBUG	Frequency (Hz)	Pond Write V 0x24	Res This parameter defines the coil	frequency to be used during	
State	rioquonoy (inz)	Neau White VILLE	Ping operations (device detecti	on).NOTE: This value varies	
- 😂 eOpstate			from the WPC v1.0 specificatio	n of 175KHz due to the	
Freq			frequency limit of this design. Vi	alue 0 to 20000.	
New Scope	Duty Cycle (%)	Read Write V 0x32	This parameter defines the coil	duty cycle to be used during	
DPL	Dulas Duration (ma)	-	Ping operations (device detecti	on). Value 10 to 50.	
New Scope	Pulse Duration (ms)	Read Write V 0x45	should be applied while waiting	for device detection. Value 0 to	
DDM			65535.	for device detection. Value 0 to	
Protection	Ping Interval (ms)	Read Write V 0x19	This parameter defines the amo	ount of time between attempts to	
🛛 🖓 ОТР		•	Ping the secondary for device d	letection. Value 0 to 65535.	
ta Rx	Analog Ping				
RSFOD	Frequency (Hz)	Read Write V 0x2A	B98 This parameter defines the coil	frequency to be used during	
			Analog Ping operations (preser	nce detection). Value 0 to	
🕀 New Scope			4294967295.		
🖓 Input Volltage	Min Coil Current	Read Write V 0x05	This parameter defines the thre	shold below which an Analog	
- Ke Input Current	(ADC counts)		Ping has detected a fault in the circuit. If the ADC count is not a	resonant tank or coll drive	
			shut down with a coil fault. Value	e 0 to 65535.	
	Coil Current	Read Write V 0x0F	This parameter defines the thre	shold above which an Analog	
	Threshold (%		Ping may have detected a chan	ged in device presence. Value 0	
	change)		to 65535.		-
	control page				
	Variable Watch				▲ # ×
	Name	Value	Unit	Pe	eriod
	RunTimeParams[0].byEptReasonCode RunTimeParams[0].bySignalStrength	0	DEC 100 DEC 100		
	RunTimeParams[0].byPercentPowerUsed	ō	DEC 100		
	RunTimeParams[0].iReportedError RunTimeParams[0].wCoilCurrent	0	DEC 200		
	RunTimeParams[0].wInputCurrent	0	DEC 200		
			long long		

Figure 40 FreeMASTER GUI tool

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6.2.6 Enabling the RS FOD function

RS-FOD (Resonance Shift FOD) is one optional solution to detect FO in standby mode, when Rx is not on the surface of Tx. This can ensure that the charging never starts power transfer if FO is present. It does not belong to Qi 1.1, so the feature is disabled in the demo image. However, you can enable it by the following steps if the feature is required.

The steps of enabling this function are as follows:

1. Right-click the project, and choose "Properties".



Figure 41 Choosing the properties of project



2. Choose C/C++ Build -> Setting -> DSC Linker -> Input, as shown in the following figure.



Figure 42 Finding the additional libraries option

3. Double click "…/…/wct_mp1_SDM_Debug.lib" in "Additional Libraries", and change to "wct_a28_RSFOD_SDM_Debug.lib". Then click "OK" and exit.

🥦 Edit file path	
File:	
"\${ProjDirPath}\\\\WCTLikQwct_a28_RSFOD_SDM_De	ebug.lib
☑ Relative To: ProjDirPath ▼	Variables
	Workspace
	File system
ОК	Cancel

Figure 43 Modifying the relevant library

4. Set the macro RESONANCE_SHIFT_FOD to TRUE in wct_LibStruct.h. Rebuild the project to make the RS FOD function work.



6.2.7 Enabling or disabling board functions

Freescale provides full-featured wireless charging functions on the reference board. If you do not need a function, you can disable it by definitions in the header file or by parameters in the FreeMASTER GUI.

The following header files are used to enable or disable functions, and to configure low-level driver. A28\lib\A28\ wct_hal_cfg.h

A28\example\WCTxxxx\WCTA28demo\cw10\Sources\application_cfg.h, peripheral_cfg.h

In application_cfg.h, you can configure the following functions:

- Low power mode by analog ping enable/disable #define LOW_POWER_MODE_SUPPORTED TRUE // FALSE for calibration or debug on FreeMASTER GUI. #define LOW_POWER_MODE_BY_ANALOG_PING TRUE // FALSE for calibration or debug on FreeMASTER GUI.
- Freemaster support enable/disable #define FREEMASTER_SUPPORTED TRUE // FALSE if disable Freemaster connection.

Note: ** Touch sensor should be disabled when low power mode by analog ping is enabled.



6.3 Test

6.3.1 Basic charging test

When software work is prepared, power on the A28 demo board with standard 5V adapter to make it work.

Put the standerd QI receiver on the charging pad, and make sure the coil is aligned and the load is in the allowed range—5W. Then the Tx will charge the Rx normally.



Figure 44 Working system

The defined LED display mode for defferent Tx working states is shown in below table:

LED			LED Operational States						
Configure					Charge				
Option	Description	LED #	Standby	Charging	Complete	Power Limit	FOD Fault	TX Fault	RX Fault
Default	Default Choice	LED1	Off	Blink slow	Off	Blink fast	On	On	On
		LED2	Blink slow	On	On	Blink fast	Off	Off	Off
Option-1	Choice-1	LED1	Off	Blink slow	On	Off	Off	Off	Off
		LED2	Off	Off	Off	Blink fast	Blink fast	Blink fast	Blink fast
Option-2	Choice-2	LED1	Off	On	Off	Blink fast	Off	Off	Off
		LED2	Off	Off	Off	Blink fast	On	Blink slow	Blink slow
Option-3	Choice-3	LED1	Off	Blink slow	On	Blink fast	Blink fast	Blink fast	Blink fast
		LED2	-	-	-		-	-	-



6.3.2 Signals on the board

Main signals on A28 board are shown in the figure below.



Figure 45 Test points on 5WTXMLTI A28

- TP1: Vcc, controller input voltage 3.3V
- TP13: Coil current sensing
- GC10,GE2,GF3: GPIO touch pad
- TP18: Input current sensing
- TP20&21: PWM1&2, PWM signals to pre-driver
- TP33: LC-Resonant voltage on the coil
- TP6,TP16,TP17: Touch sensing signal to an external electrode
- TP22: VCC-SW 9~10V for coil switched drive circuits.



6.3.3 Test environment

Set up the A28 test environment as shown in Figure by using the DC power supply and electronic load for input source and output load. Get system efficiency by measuring input and output power.



Figure 46 Test environment

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6.3.4 Measurements

These are the examples for measuring signals on the board.

1. Measure the signals when Tx board works under ping and stand by states, when Tx wakes up for charging, and from charging to power stop.



Figure 47 Signals from Ping to Sleep

The AC signal frequency changes to adjust the output power when the load changes.

Ch1: Rx communication signal	Ch2: TP20 PWM	l

Ch3: TP21 PWM2

Ch4: Coil current





Figure 48 PWM frequency on 0.5 W power output



Figure 49 PWM frequency when 5W power output

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2. System response measurement for load dump and load step test.

Ch1: Rx communication signal

Ch2: TP9 PWM1

Ch3: TP10 coil voltage Ch4: Coil current ek Stop 2.00 V 5.00 V 1.25MS/s 5M points 2.00 V 400ms 2 1 22 Jan 2013 09:29:15 Std Dev Value Mean Min Max 125.3kHz Low resolution Frequency

Figure 50 System response on load dump



Figure 51 System response on load step

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7 References

- Freescale wireless charging solution page: <u>freescale.com/wirelesscharging</u>
- Freescale Codewarrior 10 IDE page: <u>freescale.com/codewarrior</u>
- Freescale Freemaster tool page: <u>freescale.com/Freemaster</u>
- WPC page: <u>www.wirelesspowerconsortium.com</u>
- WCT1101 Documents:
 - WCT1101 A28 Reference Design System User's Guide (WCT1101SYSUG), this document
 - WCT1101 Library User's Guide (WCT1101LIBUG)
 - o WCT1101 A28 Run-Time Debug User's Guide (WCT1101RTDUG)
 - WCT1101 A28 Reference Design Calibration User's Guide (WCT1101CALUG)
 - o WCT1101 A28 V2.0 Release Notes (WCT1101RN)



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