瑞萨电容触摸技术

低功耗应用培训

实验环节

描述

本文档从基本的触摸应用工程创建、使用QE for Cap touch监控触摸数据和调试运行参数开始,循序渐进的增加并调 试以下功能.

- ✓ 12个按键矩阵功能(自容式)
- ✓ RX140 MEC多电极连接功能
- ✓ 低功耗功能(RX140 Auto Judgement功能)
- ✓ 接近传感功能(改变MEC灵敏度)
- ✓ 低功耗数据的测试

实验目标	实验材料
 基本的 RX140 触摸应用工程创建 使用 QE for Cap touch 监控触摸数据 使用 QE for Cap touch 调试运行参数 RX140 MEC 多电极连接功能 低功耗功能(RX140 Auto Judgement 功能) 接近传感功能的实现方式 低功耗数据的测试方法 	 RX140低功耗触摸评估板套件 评估板 x 1 Ez-cube2仿真器 x 1 亚克力板: 1mm厚度 x1, 2mm厚度 x1 塑料柱、塑料螺丝若干 电池盒 x 1 1.5V AAA电池 x 2 Renesas e² studio & QE for Cap Touch e² Studio: v 2023-04 QE for Cap Touch: v 3.2.0. 编译器: Renesas CCRX v3.05.00 仿真器: Ez-CUBE2 备注:
 技能水平 C语言和嵌入式编程基础 瑞萨触摸应用开发环境,包括: e2 studio 集成开发环境 Smart Configurator 驱动代码生成工具 QE for Cap Touch 触摸应用开发工具 	时间 • 90 mins

实验环节

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1 实验前的准备

概述

在本实验环节中,将介绍实验前的准备,包括培训提供的配套资料,软件开发环境的安装、硬件安装以及 RX140 低功耗触摸评估板的功能说明。

实验前的准备:

配套资料说明:

Pre-installations 文件夹

|-----Renesas e2 studio 2023-04 安装指南.pdf

Presentation 文件夹

|------ 瑞萨电容触摸技术-低功耗应用培训 (基于 RX140 MEC+AJ 新功能).pdf

Lab 文件夹

|-----Checkpoints 文件夹

|-----Lab session 1 文件夹 |-----Lab session 2 文件夹 |-----Lab session 3 文件夹 |-----Lab session 4 文件夹

软件安装

Renesas e2 studio 2023-04.

详见《Renesas e2 studio 2023-04 安装指南.PDF》

硬件安装

下图为实验环节用的 RX140 低功耗触摸评估板套件。



瑞萨电容触摸技术-低功耗应用培训-实验环节

Renesas

RX140 低功耗触摸评估板的组装:

将 1mm 厚度亚克力板,通过塑料柱、塑料螺丝固定在 PCB 板上。 2mm 厚度亚克力板备用,用于体验不同的覆盖物厚度对灵敏度的影响。 电池盒以及电池用于低功耗测试时的电源供电。







RX140 低功耗触摸评估板的简要说明

功能总览:





以下为各功能电路的简要说明。

MCU 部分(包含触摸功能必需的 Tscap 滤波电容(C5)、阻尼电阻(从 R14 到 R25)):



触摸电极电路:



电源电路及低功耗测试端子:



LED 驱动电路:



仿真接口电路:



RENESAS

瑞萨电容触摸技术-低功耗应用培训-实验环节

EZ-CUBE2 仿真器:

使用 EZ-CUBE2 前, 将跳线开关设定到"3.3V 供电输出"和"调试 RX". 注意线缆在连接 EZ-CUBE2 本体时的接口方向,不要插反。



END OF SECTION

Renesas

2 Lab Session 1: 基于 RX140 创建一个基本的含有 12 个自容按键的触摸应用工程

概述

在本实验环节中, 将基于 RX140 创建一个基本的含有 12 个自容按键的触摸应用工程,以此了解使用 QE For Cap Touch 进行触摸应用开发的软件步骤和流程,主要包括以下方面:

- **2.1** 新建工程
- 2.2 使用 Smart configurator 添加必要的驱动程序
- 2.3 创建触摸接口(interface)或者配置(Configuration)
- 2.4 自动调整过程(Auto Tuning Process)
- 2.5 增加应用程序
- 2.6 运行程序
- 2.7 使用指示触摸按键状态的 LED 监控触摸行为
- 2.8 使用全局变量 button_status 监控触摸行为
- 2.9 使用 QE for Cap Touch 监控触摸底层数据以及触摸行为
- 2.10 调试触摸运行参数

如果对 Lab session 1 的内容非常熟悉或者有一定困难,可跳过步骤 2.1 到步骤 2.5,

在 e2 studio 中 import 导入培训配套资料 Checkpoints 文件夹中的工程 Lab session 1,

直接进行步骤 2.6 到步骤 2.10 的实验。

实验步骤

2.1	新建工程
2.1.1	 启动"e2 studio 2023 04".
	新建工作空间 Workspace: workspace Captouch Training
	单击"Launch"
	🕲 e² studio Launcher – 🗆 X
	Select a directory as workspace
	e ² studio uses the workspace directory to store its preferences and development artifacts.
	Workspace: C\Users\a5048269\e2_studio\workspace Captouch Training V Browse
	Use this as the default and do not ask again Launch Cancel



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New Renesas CC-RX Executable Project 选择编码的手设置 ② Use Smart Configurator ③ Use Peripheral Code Generator ^④ 智能配置器是一种将代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时钟配置视图、中断配置视图和引脚配置视则 当不同类型的驱动程序和中间件模块之间存在分设模块、中断或 (智能配置器仅适用于受支持的器件) Application Code Software Components	户界面,支持导入、配置和生成不同类型的驱动程序和 图。 引脚等硬件资源中突时,用户将收到通知。
New Renesas CC-RX Executable Project 选择编码助手设置 びse Peripheral Code Generator 智能配置器是一种将代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时转配置视图、中断配置视图和引脚配置视 当不同类型的驱动程序和中间件模块之间存在外设模块、中断或 (智能配置器仅适用于受支持的器件) Application Code Software Components Middleware & Drivers	户界面,支持导入,配置和生成不同类型的驱动程序和图。 引脚等硬件资源中突时,用户将收到通知。
New Renesas CC-RX Executable Project 选择编码助手设置 び Use Smart Configurator Use Peripheral Code Generator 智能配置器是一种将代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时钟配置视图,中断配置视图和引脚配置视 当不同类型的驱动程序和中间件模块之间存在外设模块。中断或 (智能配置器仅适用于受支持的器件) Application Code Software Components Drivers Device Drivers	产界面,支持导入,配置和生成不同类型的驱动程序和图. 引脚等硬件资源冲突时,用户将收到通知.
New Renesas CC-RX Executable Project 选择编码助手设置 ビUse Smart Configurator Use Peripheral Code Generator 智能配置器是一种特代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时钟配置视图、中断配置视图和引脚配置视 当不同类型的影动程序和中间件模块之间存在外设模块、中断或 (智能配置器仅适用于变支持的器件)	产界面,支持导入,配置和生成不同类型的驱动程序和 图. 引脚等硬件资源中突时,用户将收到通知.
New Renesas CC-RX Executable Project 远輝編码助手设置	产界面,支持导入,配置和生成不同类型的驱动程序和 图。 引脚等硬件资源中突时,用户将收到通知。
New Renesas CC-RX Executable Project 远緯編码助手设置	产界面,支持导入,配置和生成不同类型的驱动程序和 図. 引脚等硬件资源中突时,用户将收到通知.
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New Renesas CC-RX Executable Project 选择编码助手设置 ② Use Peripheral Code Generator 智能配置器是一种将代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时转配置视图、中断配置视图和引脚配置视 当不同类型的感动程序和中间件模块之间存在外设模块、中断成 (智能配置器仅适用于受支持的器件)	PR面、支持导入、配置和生成不同类型的驱动程序和 图. 引脚等硬件资源中突时,用户将收到通机.
New Renesas CC-RX Executable Project 选择编码助手设置 ② Use Peripheral Code Generator ① 智能配置器是一种将代码生成器与 FIT 配置器功能合二为一的用 中间件模块。 智能配置器包含统一时转配置视图、中断配置视图和引脚配置视 当不同类型的驱动程序和中间件模块之间存在外设模块、中断或 (智能配置器仅适用于受支持的器件)	PR面、支持导入、配置和生成不同类型的驱动程序和 图。 引脚等硬件资源中突时,用户将收到通机.



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	New Renesas CC-RX Executable Project		New Renesas CC-RX Executable Project	
	Settings The Contents of Files to be Generated		Summary of project "Lab_session_1"	
	忽希望创建哪种类型的初始化程序?		工具総名称: Renesas CC-RX 工具総名称: va.05.00	
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2.1.9	打开"Smart configu	itor"		
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2.1.10			"++-" ~ • "⊥- // -	
	新建工程后, 默认米纳	的"Smart Configurator	r"的"Overview"标签贝	
	workspace Captouch Training - Lab session	on 1/Lab session 1.scfa - e² studio		
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			0	
		Overview Get an overview of the features provided b	by Smart Configurator.	
		Videos	Application Code	
		Introduction to Smart Configurator	Software Components	
		What's New	RTOS	
		Check out <u>what's new</u> in the latest release.	e. Device Drivers	
		Product Documentation	MCU Hardware	
		Application Notes		
		Tool news		
		Selected board/device: R5F51406BxFL (ROM size: 256KB	KB, RAM size: 64KB, Pin count: 48)	
	1	Generated location (PROJECT_LOC\): src\smc_gen	Edit	
	1	Component ^	Version Configuration	
		Board Support Packages. (r_bsp)	7.40 <u>r_bsp(used)</u>	
	1			
	1			
		Overview Board Clocks System Components Pins Inter	errupts	



2.2	使用Smart Configurator添加必要的外设驱动程序
2.2.1	Clock设定 切换到" Smart configurator "的" Clocks "标签页,时钟配置的默认设定如下图 保持默认设定
2.2.2	<complex-block></complex-block>
	将"Software interrupt Unit1(SWINT1)"的设定从默认"Unused"改为"Used" ^{* Tab_session_1.scfg × Software component configuration ************************************}
	Generals Code Generals Report Configure Other Statup Statup Other Statup Configure Other Statup Other Statup Other Statup Other Statup



2.2.5	"r_ctsu_qe"设定
	将"Data transfer of INTCTSUWR and INTCTSURD"从默认的"Interrupt Handler"改为"DTC"
	将"TSCAP"以及使用的12个触摸通道设定为"Used"
	TS5、TS6、TS7,TS8,TS9,TS10,TS13,TS14,TS15,TS20,TS22,TS24
	Software component configuration
	Components in Ld Ap. D (2) (2) Configure ()
	Type Thore Static V W Consumptions V ⊗ Randup # Persenter check V ⊗ Generic # Data basisfier of INCTSURD BTC Diable # Set and check in the state of INCTSURD BTC
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	Overview Board Clocks System Components Pres Interrupts
	1. "CTSUWR"和"CTSURD"为CTSU底层中断,用于传输CTSU的运行参数,
NOTE	传输的方式可以选择" Interrupt Handler ",也可以选择为" DTC"。
NOTE	需要注意的是,CTSU在低功耗模式下工作时,必须选择为"DTC"。
	2. "Tscap"为必选项。
2.2.6	法加纳特担义的观动程序
	New Component - X Software Component Selection
	Select component from those available in list
	Category All
	Function All
	Components Short Name Type Versi
	Ports Code Generator 2.4.1 PWM Mode Timer Code Generator 1.12.0
	If SCI/SCIF Asynchronous Mode Code Generator 1.12.0 If SCI/SCIF Clock Synchronous Mode Code Generator 1.12.0
	# Single Scan Mode S12AD Code Generator 2.5.0 # Smart Card Interface Mode Code Generator 1.12.0
	# SPI Clock Synchronous Mode (3-wir Code Generator 1.12.0
	Touch QE API rm_touch_ge Firmware Inte 2.10
	Watchdog Timer Code Generator 1.11.0
	☑ Show only latest version ☑ Idie items that have duplicated functionality
	Description
	Dependency: r_cbsg version(s) 0.10 Dependency: r_cbsg version(s) 2.10 This module allows for touch detection of buttons, sliders, and wheels using CTSU sensor
	Download the latest FIT drivers and middleware
	Configure general settings
	Omega Kext > Finish Cancel



Software car	nonent confi-	ration		1				
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2.2.11	"PORT"设定	
	选择"PORTA"和"PORTE"	
		_
	Software component configuration	
	Components 🔤 🖆 🎼 🕀 🏝 🔹 Configure	5
	type filter text	
	✓	
	W of the raw W Bevent link controller By refer raw PORTE	
	© r_lpc_rx Handling of all unused pins Keep as current ↓	
	✓ ≧ Middleware ✓ ≧ Middleware	
	💣 rm_touch_ge	
	Overview Board Clocks System Components Pins Interrupts	
2.2.12	"PORT"设定	
	将"PORTE (PE1, PE2, PE3, PE4)"全部设定为	'OUT"
	19 Tab sesion (Lady X - 0	© tab session Lodg × □
	Software component configuration Generate Report	Software component configuration
	Port selection PORTA PORTE	Components in all $\beta_{2} \oplus 0$ is - Configure
	Versetie Versetie	ype filter toot ✓ 🍐 Startup ✓ 🔓 formic
	Comp Composition Composition	
	V territik controller V territik V territik controller V territik V territik	Controller C
	Chruzed GPIO Uni BOot PA1-up CMDS output ↓ Codput 1 CMDS output 1 Codput 1 PA4	
	∨ (b) Low power consumption ○ Unused GPD ○ In ●Ot Pull-up CMDS output ∨ ○ Output 1 Sr / pc,rx PA6	Composition Ollinuxed GPI0 O in ⊛ Out Pull-up CM05 subput ✓ Output 1 % (lpc,x) PE4
		¥r_jpt_rx OUnosed GPO O In ®Out □Pull-up Output 1 vo Modeware vo capacitier touch
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	C Survive Baard Clocks System Components Res Internants	a second se
		Overview (bioaru) Colocol (system <u>Componenti</u>) Ansi mentapa
		于亚动坦宁甸塔埃姆州太的LED
NOTE		
	PE1用于驱动用户LED	
2.2.13		
	只击 Generate Code 生成驱动程序代码	
2.2.14		ckina"
2.2.11	勾近 Always save and generate without a	sking
	点击Proceed继续	
	Cata Caractina	× fi
	i Code Generating	^
	Configuration must be saved before generating code.	
	Proceed with save and generate?	
	generate.	
	Always save and generate without asking?	
	Proceed	Cancel
		¥









Description:	Lab_session_1	Setup Configuration	X Import / Re-edit
Setting Setup Touch I/F Se There are some problems v	Sutton00 Button01 Button03 Button04 Bs Sutton03 Button04 Bs Sutton06 Button07 Bs Sutton09 Button10 B sutton09 Button10 Bs	tor/02 Setup Touch Interface X Button(self) Name Button00 Touch Sensor Resistance(ohm) TS01 560 OK Can 150 200 220 240 250 550 550 550 550 550 550 55	Touch I/F * Capacitance Type Self Capacitance Self Capacitance * Button Slider (horizontal) Slider (vertical) Wheel Key pad 3D Gesture (Al) Touch pad Shield Pin TC Pin Capacitance Sensor Diagnosis Pin Remove Touch I/F Remove Touch I/F *
阻尼电阻的值,勇 设定的范围为 10	更根据硬件电路 obm 到 1000c	中实际使用的阻尼电阻值正确设定	È.
		ohm,默认值为 560ohm	
正确设定完成后, " 点击"Create"完成	'Button"将由红的	ohm,默认值为 560ohm 色变为绿色	











4.8 自动调整过程(Auto Tuning Process)开始,依次显示如下四步,这时不需要用户操作 第一步:开始自动调整过程,引导用户按提示操作,按照要求"触摸按键"或者"不要触	乍。 中 堪按键''
Automatic Tuning Processing	×
1/17:QE is beginning the tuning process. During the tuning process, please do not touch the sensors on the targe board until instructed by the QE Tuning Program.	et
Cancel Hel	lp .
第二步:QE 正在测量所有触摸按键的寄生电容。	
Automatic Tuning Processing	×
2/17:QE is measuring the parasitic capacitance for all touch sensors. During this measurement process, please do not touch the sensors on target board.	the
Cancel He	lp
第三步: QE 正在调整触摸按键的偏置电流值。	×
3/17:QE is adjusting offset values for each sensor.(config01) During the adjustment process, please do not touch the sensors on the target board.	
Cancel He	lp
第四步:QE 开始进行灵敏度测量。	
Automatic Tuning Processing	×
4/17:QE is now starting sensitivity measurement for each of the touch sensors when not touched.(config01) During this step, please do not touch the sensors on the target board.	
Cancel He	elp
E 对话框左上角,显示了当前的步骤,以及总计步骤,例如 1/17:显示当前步骤为	1, 总计步骤为 17

第	5步:灵敏度调整
白	
+n-	
хн т	
仕〉	又有按下熙操按键时,自谷式按键的灵敏度测重的基准值为15360。
100	Lab_session_1.scfg 🛛 🖸 ctsu_fn_int() at tuning_ctsu2.c.792 0x4b0 X
C I	ant find a source file at "C\project.IDE\e2studio\e2studio.202110\workspace_RAM_program_RX140\RX140_tuning\src\/tuning_ctsu2.c" ocate the file or edit the source lookup path to include its location.
	view Disassembly
l	idit Source Lookup Path
6	onfigure when this editor is shown Preferences
L	
ł	Carl Automatic Tuning Processing X
ł	5/17: QE will now measure touch sensitivity for (Button00, TS05 @ config01). In this step please use normal touch pressure on the sensor for once. Press any key on the PC
L	keyboard to accept the sensitivity measurement.
L	
L	Cancel Help
L	
I.	
按照	照提示,使用手指以正常压力按住" Button00/TS05 "的触摸按键,
按此	照提示,使用手指以正常压力按住" Button00/TS05 "的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化,
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按 此 保	照提示,使用手指以正常压力按住"Button00/TS05"的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化, 寻期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ③ Automatic Tuning Processing × 5/17: QE will now measure touch sensitivity for (Button00, TS05 @ config01). n this step please use normal touch pressure on the sensor for once. Press any key on the PC sevboard to accept the sensitivity measurement.
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按 此 保	照提示,使用手指以正常压力按住"Button00/TS05"的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化, 寻期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ③ Automatic Tuning Processing
按 此 保	 照提示,使用手指以正常压力按住"Button00/TS05"的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化, 寺期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ▲utomatic Tuning Processing × 5/17: QE will now measure touch sensitivity for (Button00, TS05 @ config01). n this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config01: 22668
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	網提示,使用手指以正常压力按住"Button00/TS05"的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化, 時期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ▲utomatic Tuning Processing × 5/17: QE will now measure touch sensitivity for (Button00, TS05 @ config01). n this step please use normal touch pressure on the sensor for once. Press any key on the PC explored to accept the sensitivity measurement. Button00, TS05 @ config01: 22668 Line Help
按此保 在	網提示,使用手指以正常压力按住"Button00/TS05"的触摸按键, 时黄色进度条将根据手指按压触摸按键的力度而变化, 寻期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ③ Automatic Tuning Processing × 5/17: QE will now measure touch sensitivity for (Button00, TS05 @ config01). In this step please use normal touch pressure on the sensor for once. Press any key on the PC exploard to accept the sensitivity measurement. Button00, TS05 @ config01: 22668 ——————————————————————————————————
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Project Explo	rer 🐚 CapTouch V	Workflow (QE)	× 🔊	8 🗖 🗖 🕼 Lab_session_1.scfg	C ctsu tu			
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1.1	
-	
1	在"Cap Touch Workflow"的"3.Coding"中,点击"Show Sample"
5	弹出样例程序的预览对话框
	Show Sample Code X
	Output Parameter Files Sample code of main() function.
	Output Parameter Files FILE : qe_sample_main.c OSperify an output folder • OATE : 2022;03:09
	Use an external trigger Use an external trigger VoteTrils IS A TYPICAL EXAMPLE.
	□ Use API compatilibity mode = indude 'qe_touch_config.h'
	S.Coding
	#define TOUCH_SCAN_INTERVAL_EXAMPLE (20) /* milliseconds */ void R_CTSU PinSetint(void);
	Show Sample
	4.Monitoring start Monitoring (Emulator) start Monitor (Emulator) start Monitor (Emulator)
	Copy to the Clipboard Output to a File Show the Application Note
	Show Views OK Help
,	点击对话框中的"Output a File"
	生成今右触境样例应用程序的文件"ae touch sample c"
-	土成百有脑荚件的应用程序的文件 qe_touch_sample.c
	Copy to the Clipboard Output to a File Show the Application Note
	QE for Capacitive Touch
	2023/05/12 03:14:33
	Succeeded to output the sample code tile. C:/Users/a5048269/e2_studio/workspace Captouch Training/Lab_session_1/qe_gen/qe_touch_sample.c
1	在" Cap Touch Workflow "的" 3.Coding" 步骤生成的全部文件,如下所示
	Image: Project Explorer × ∑ CapTouch Workflow (QE) E S Y S □ Y Estab session 1
	> 🐇 Binaries
	> j∋µ includes
	➤ Mu includes ✓ ఊ qe_gen > @ qe_touch_config.c > D as two h and a h
	<pre>> bit includes > bit qe_gen > bit qe_touch_config.c > bit qe_touch_config.h > bit qe_touch_define.h</pre>
	> jiji includes ✓ @ qe_gen > @ qe_touch_config.c > jiji qe_touch_config.h > jiji qe_touch_define.h > jiji qe_touch_sample.c
	> Includes ✓ ఊ qe_gen > ⓒ qe_touch_config.c > ⓑ qe_touch_config.h > ⓑ qe_touch_define.h > ⓒ qe touch_sample.c ✓ ఊ src > smc_gen
	<pre>> includes > inc</pre>
	<pre>> In Includes > Image: A set of the se</pre>
	<pre>> bit includes > bit includes > bit qe_touch_config.c > bit qe_touch_config.h > bit qe_touch_define.h > bit qe_touch_define.h > bit qe_touch_sample.c > bit src > bit src > bit src > bit hardwareDebug > bit Lab_session_1.c > bit HardwareDebug > bit rash > bit</pre>
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Image: Section and the sectio	Image: Section (Section (Electrony) Set (Section) Section (Section) Section) Section (Section) Section) Section (Section) Section (Section) Section) Section (Section) Section) Section (Section) Section (Section) Section) Section) Section (Section) Section) Section (Section) Section) Section) Section) Section) Section (Se	⁻ "ge touch sar	nple.c"中⊽	ミン,如下!	所示:	
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************************************	Image: Sector Pall Set R SCL Pall Set R SCL Pall Set SCL2 Image: Sector Pall Set R SCL Pall Set R SCL Pall Set SCL2 Image: Sector Pall Set R SCL Pall Set R SCL Pall Set Scl2 Image: Sector Pall Set R SCL Pall Set R SCL Pall Set Scl2 Image: Sector Pall Set R SCL Pall Set R SCL Pall Set Scl2 Image: Sector Pall Set R Scl Pall Set R	应 Lab session 1.scfg	i *ge tou	ch sample.c >	<	
isi uint64; button_status; isi uint64; button_stat	initial initialinitial initial initial initial initial initial initia	48	#define QE_SCI	 PIN_SET R_S	SCI_PinSet_SCI1	2
52 55 55 55 55 55 55 55 55 55 55 55 55 5	Particle * Button_status; Particle * Bitton_status; Particle * Status; P	50 51	#endif			
54 ●##f (TOUCH_CFG_MUM_SLIDERS); #endiff ************************************	************************************	52	uint64_t butto	on_status;		
************************************	****(*1000L_CFG_MMF_MEELS):************************************	54 ⊖ 55	#if (TOUCH_CFG uint16_t slide	i_NUM_SLIDERS er_position[1	S != 0) TOUCH_CFG_NUM_S	IDERS];
************************************	Biggeneration Wariables Notestation Second	56 57 ⊖	<pre>#endif #if (TOUCH_CFG wint16 to wheel</pre>	i_NUM_WHEELS	!= 0)	
*Add Watch Expression "添加完成后,显示在"Expression "窗口 *Add Watch Expression "添加完成后,显示在"Expression "窗口 ***********************************	Add Watch Expression "添加完成后,显示在"Expression"窗口 Variables ® Breakpoints @ Project Explorer @ Expressions X ● Eventpoints D Registers Part := button status Add new expression Type Value Address Constants Texpression "窗口,在全局变量"button_status"上单击右键, Constants C	59 9	#endif	_position[IC	UUCH_CFG_NUM_WH	::::];
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		后,全局变量"but	ton status"前面图标变为 😪 ,如1	图所
	,			
(x)= Variables 🗣 Breakpe	points 陷 Project Explorer 👫 Expressio	ons 🗙 🥌 Eventpoints 🔀 Periph	erals 📄 10 Registers 🛛 🖓 🗖 👘	
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		button_status _		_
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	Fina	Cuitr		
	Show Details As	,		
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-	iγ' Watch	LIC 开始录制 Real-time Re	fresh Interval	
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		Noise [NT]: Average [NT]: Minimum: Maximum: Noise [T]: Average [T]: Signal: CNP.	
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Button09	Button10 Button11		
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CapTouch Multi Status Chart (QE) ×	5 10 10 10 10 10 10 10 10 10 10 10 10 10	<u>⊴ 8 ⊂ □</u> 16383	
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0		6	









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2.5.0	在"CapTouch Status Chart (QE) View"中, 可以实时显示单个 TS 通道的详细数据,例如:
	实时测量值 Count Value,波形图中的 <mark>红色曲线</mark> 。
	基准参考值 Reference Value , 也叫 Baseline,波形图中的 <mark>蓝色曲线</mark> 。为实时测量值 Count Value 的长 期平均值。
	阈值 Threshold,波形图中的 绿色曲线。 改变阈值,可调整触摸按键的灵敏度。
	差分值 Difference 为实时测量值 Count Value 与基准参考值 Reference Value 的差值
	另外,用户可以在"CapTouch Status Chart (QE) View"中,通过"Start Data Collection"按钮,测量SNR 数据。
	Touch I/F: Button00 @ config01 □ Sync a selection
	I/F Type: Button(self), Channel(s): TS05
	Count Value: 18092 Reference Value: 15394 Threshold: 1128 Difference: 2698
	Start Data Collection
	Noise [N1]: Average [N1]: Minimum: Maximum: Maximum: Noise [T1: Signal: SNR:
	18148
	16752
	16055
	15358
	通过"Start Data Collection"按钮 测量 SNR 数据的方法。可参考如下各个 MCU 系列的文档·
NOTE	KA FSP : Using QE and FSP to Develop Capacitive Touch Applications
	RX FIT : Using QE and FIT to Develop Capacitive Touch Applications Rev.2.00
	RL78 SIS : Using QE and SIS to Develop Capacitive Touch Applications Rev.2.10

2.9.9	在"CapTouch Parame	eters (QE) View	w"中, 可以显示和修	波, 触摸	按键的	的运行参数。	
	相同分组(configuration)	n)内的各个按键	建, 共享相同的运行	参数。			
	单击选中各个参数后, ⁻	下方窗口会显示	该参数的意义。				
	修改各个参数的数值后挂	安下回车键,然	后可以通过单击右上	上方的按钮	證 ,	写入目标板,实时生效。	
	右上方各个功能按钮的环	力能,详见下面	右侧图片。				
	点击 可 按钮后,可显示	√隐藏高级运行	参数 CTSUSO、C	rsusnun	и, с	TSUSDPA,通常不需要修改。	0
	🔀 CapTouch Parameters (QE)	×			Icon	Tooltip	
	Touch I/F: Button00 @ confid	101 ¥ □ Svi	nc a selection		Ę,	Enable Monitoring	
	I/F Type: Button(self), Channel	(s): TS05				_	
	Item	Value					
	Drift Correction Interval	255					
	Long Touch Cancel Cycle Positive Noise Filter Cycle	3				Display in Advanced Mede	
	Negative Noise Filter Cycle	3			90	Display in Advanced Mode	
	Moving Average Filter Depth	4					
	Touch Threshold	1128					
	Hysteresis	56			齫	Read Value from the Target Board	
	CTSUSNUM	7			齫	Write Value to the Target Board	
	CTSUSDPA	SUCLK divided by 8					
					1.	Enable Auto Writing	
	Set a value of touch threshold. Touch Threshold is a paramete	er used for determining	g whether the button / key pa	d	m(v	Lindere France Withing	
	button switches from touch OF The button / key pad button is	F to ON.	N when the count value excee	•ds			
	the value specified in [Touch T	hreshold].			Ď	Output Parameter File	
	Input a value between 1 and 6 Input a value larger than [Hyst	5535. eresis].			None		
	This setting item will be applie	d for each button.				Web	
					(*)		
2.10	调试触摸运行参数						
2.10.1	在"CapTouch Parame	eters (QE) Viev	w"中,可以对触摸道	运行参数进	÷行调	整, 包括:	
	Drift Correction Inter	rval 漂移校正间	同隔				
	Long Touch Cancel C	ycle 长按键取;	肖周期				
	Positive Noise Filter	- Cvcle 按键 On	判断的噪声滤波周期	相			
	Moving Average Filte	er Deptn 杨动·	平均滤波涂度				
	Touch Threshold 触搏	模固值					
	Hysteresis 迟滞						
NOTE	在使用以上相关参数进行	亍灵敏度调整时	,只能进行微调。暑	寄生电容值	i从根	本上决定了灵敏度的高低。	
	在"CapTouch Parame	eters (QE) View	w"中,点击 🔠 扮	安钮,使能	自动	写入参数功能。	
2.10.2	该功能打开后,修改参数	<u>教</u> ,按下回车键	,新参数即可立即4	E效。			

2) CapTouch Parameters (QE) × 2) CapTouch Workflow (QE) 日 見 同 語 語 認 合 8	🔀 CapTouch Parameters (QE) × 这 CapTouch Workflow (QE)
Touch I/F: Button00 @ config01	Touch I/F: [Button00 @ config01 ♥]Sync a selecti
Item Value	
Drift Correction Interval 255	Drift Correction Interval
Long Touch Cancel Cycle 0	Long Touch Cancel Cycle 0
Negative Noise Filter Cycle 3	Positive Noise Filter Cycle 3 Negative Noise Filter Cycle 3
Moving Average Filter Depth 4	Moving Average Filter Depth 4
Hysteresis 187	Hysteresis 187
L	
Set a drift correction interval. Drift Correction is a function to make the reference value follow the surrounding environment. Input a value between 0 and 65535.	Set a drift correction interval. Drift Correction is a function to make the reference value follow surrounding environment. Input a value between 0 and 65535.
The value is 1 or more: The reference value will be corrected every cycle specified in the [Drift Correction Interval] item. The value is 0: No correction.	 The value is 1 or more: The reference value will be corrected cycle specified in the [Drift Correction Interval] item. The value is 0: No correction.
This setting item will be applied for each method.	This setting item will be applied for each method.
	OE is executing a topic function
漂移校正间隔 Drift Correction Interval"用 [:] 艮据应用的实际需要,调整设定值。 王本实验例中,将"Drift Correction Interval Reference Value"的 <mark>蓝色曲线</mark> ,将以设定值注	于应对环境、器件老化等电容环境变化非常缓慢的 "的设定值从默认 255 ,改为 100 后,代表基准参 为 100 的时间间隔进行更新,此时加快了对环境实
漂移校正间隔 Drift Correction Interval"用 思据应用的实际需要,调整设定值。 E本实验例中,将"Drift Correction Interval Reference Value"的蓝色曲线,将以设定值为 速度。	于应对环境、器件老化等电容环境变化非常缓慢的 "的设定值从默认 255,改为 100 后,代表基准参 为 100 的时间间隔进行更新,此时加快了对环境变
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漂移校正间隔 Drift Correction Interval"用 跟据应用的实际需要,调整设定值。 E本实验例中,将"Drift Correction Interval Reference Value"的蓝色曲线,将以设定值分 速度。	于应对环境、器件老化等电容环境变化非常缓慢的 "的设定值从默认 255, 改为 100 后, 代表基准参 为 100 的时间间隔进行更新, 此时加快了对环境变
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漂移校正间隔 Drift Correction Interval"用 限据应用的实际需要,调整设定值。 E本实验例中,将"Drift Correction Interval Reference Value"的蓝色曲线,将以设定值的 基度。	Toco对环境、器件老化等电容环境变化非常缓慢的 "的设定值从默认 255, 改为 100 后, 代表基准参 b 100 的时间间隔进行更新, 此时加快了对环境变 "
漂移校正间隔 Drift Correction Interval"用 限据应用的实际需要,调整设定值。 E本实验例中,将"Drift Correction Interval Reference Value"的蓝色曲线,将以设定值的 速度。 \$\[CapTouch Sta \ Q Lab_session_1.c [ctsu_rd_int(] resetprg.c Touch lyff: Button00 @ config01 Sync a selection [\f Type: Button(self), Channel(s): TSO5	于 应 对 环 境、器件 老 化 等电容环境 变 化 非常缓慢的 " 的 设 定 值 从 默 认 255,改为 100 后,代表基准参 为 100 的时间间隔进行更新,此时加快了对环境致 " **********************************

ि C/C++ _ Smart Configura	ator 🎄 Debug 🔊 CapTouch Monitor (QE)	CapTouch Parameters (QE) 🗙 💭 CapTouch Workflow (QE
CapTouch Parameters (QE)	× S CapTouch Workflow (QE)	
-		Generate a parameter file to reflect the settings in the source
A Generate a parameter file	to reflect the settings in the source code.	
	J.	Touch I/Fr Rutton00 @ config01
Touch I/F: Button00 @ confi	g01 V Sync a selection	VE Turse Rotter (cold) Channel (c): TCOE
I/F Type: Button(self), Channe	l(s): TS05	I/F Type: Button(self), Channel(s): TSUS
		Item Value
Item	Value	Drift Correction Interval 255
Long Touch Cancel Cycle	0	Long Touch Cancel Cycle 0 Positive Noise Filter Cycle 3
Positive Noise Filter Cycle	3	Negative Noise Filter Cycle 3
Negative Noise Filter Cycle	3	Moving Average Filter Depth 4
Moving Average Filter Depth	1 4	Touch Threshold 2000 ≑
Touch Threshold	3740	Hysteresis 187
Hysteresis	187	
Set a value of touch threshold	. ^	Set a value of touch threshold.
Touch Threshold is a paramet	ter used for determining whether the	button / key pad button switches from touch OFF to ON.
The button / key pad button switc	s judged to be touch ON when the count	The button / key pad button is judged to be touch ON when t
value exceeds the value specifi	fied in [Touch Threshold].	value exceeds the value specified in [Touch Threshold].
Input a value between 1 and 6	55535.	Input a value between 1 and 65535.
Input a value larger than [Hys	teresisj.	······································
This setting item will be applie	ed for each button.	This setting item will be applied for each button.
	~	
		QE is executing atoring functio
代表"阈值 Thresh 原来按下按键后,注 现在只需要超过 20	old"的 绿色曲线 立即发生3 则量值需要超过 3740 ,才 000.即可判定为按键按下	€化,从 3740 修改为 2000。 能判定为按键按下,
代表"阈值 Thresh 原来按下按键后, 注 现在只需要超过 20 10.在按压力度不?	old"的 绿色曲线 立即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(变化,从 3740 修改为 2000。 能判定为按键按下, 。 直 Threshold",由 3740 缩小 2000,从而提高 ^一
代表"阈值 Thresh 原来按下按键后, 注 现在只需要超过 20 阝么在按压力度不多 笔。	old"的 绿色曲线 立即发生雪 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(图化,从 3740 修改为 2000。 能判定为按键按下, 。 直 Threshold",由 3740 缩小 2000,从而提高了
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大表"阈值 Thresh 原来按下按键后, 於 现在只需要超过 20 多么在按压力度不多 と。 ¹ CapTouch Sta × @ Lab.e Touch l/F: Button00 @ config U/F Type: Button(self), Channel(self),	old"的绿色曲线立即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(^{11 v} Sync a selection ^{13;} ISO5 ference Value: 15462 Threshold: 2000 erage [NT]: Minimum: erage [T]: Signal:	E化,从 3740 修改为 2000。 能判定为按键按下, a a Threshold",由 3740 缩小 2000,从而提高了 "2 CapTouch Parameters (QE) × 20 CapTouch Workflow (QE) CapTouch Varameters (QE) × 20 CapTouch Workflow (QE) CapTouch Vir: Button(00 @ config01)) Sync a select Vir Type: Button(self), Channe(s): TSO5 Herm SNR: Value Difference: 63 Herm SNR: Value Positive Noise Filter Cycle 3
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代表 " 阈值 Thresh 原来按下按键后, 於 现在只需要超过 20 多么在按压力度不多 と CapTouch Sta × @ Lab.s Touch l/F: Button00 @ config l/F Type: Button(self), Channel(Count Value: 15525 Ref Start Data Collection Noise [NT]: Avv Noise [T]: Avv Noise [T]: Avv	old"的绿色曲线立即发生到 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(ession_1.c	E化, 从 3740 修改为 2000。 能判定为按键按下, 。 a Threshold", 由 3740 缩小 2000, 从而提高了 *2 CapTouch Parameters (QE) 》 CapTouch Workflow (QE CapTouch Vorkflow (QE) CapTouch Parameters (QE) 》 CapTouch Workflow (QE) CapTouch Vorkflow (QE) CapTouch Parameters (QE) 》 CapTouch Workflow (QE) CapTouch Vorkflow (QE) CapTou
式表"阈值 Thresh 表来按下按键后, デ 现在只需要超过 20 多么在按压力度不 す。	old"的绿色曲线立即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(eession_1.c	E化,从 3740 修改为 2000。 能判定为按键按下, a Threshold ",由 3740 缩小 2000,从而提高了 ^{**} 2 ^{*********************************}
式表 "阈值 Thresh 示接下按键后, 流 现在只需要超过 20 及在按压力度不 す。 ² CapTouch Sta × @ Lab.e Touch I/F: Button00 @ configG I/F Type: Button(self), Channel(s Count Value: 15525 Ref Start Data Collection Noise [NT]: Avv Noise [T]: Avv Noise [T]: Avv	old"的 绿色曲线 立即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈 ¹¹	E化,从 3740 修改为 2000。 能判定为按键按下, 。 a Threshold",由 3740 缩小 2000,从而提高了 "2 C CapTouch Parameters (QE) 公 CapTouch Workflow (QE CapTouch Verameters (QE) 公 CapTouch Verameters (QE) (QE) (QE) (QE) (QE) (QE) (QE) (QE)
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代表 "阈值 Threshe 京来按下按键后, 注 辺在只需要超过 20 邓在只需要超过 20 邓在只需要超过 20 邓在只需要超过 20 邓在京志、× ≧ Lab e 丁ouch I/F: Button00 @ config [/F Type: Button(self), Channel(s Count Value: 15525 Ref Start Data Collection Noise [NT]: Avv Noise [NT]: Avv Noise [T]: Avv 19215 18265 17315 16365 15415	old"的绿色曲线立即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变"阈(ession_1.c	E化, 从 3740 修改为 2000。 能判定为按键按下, 。 a Threshold", 由 3740 缩小 2000, 从而提高T **_ ** ** ** ** ** ** ** ** ** ** ** **
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、表"阈值 Thresh 東来按下按键后, 於 和在只需要超过 20 多本按下按键后, 於 和在只需要超过 20 多人在按压力度不多 。	old "的绿色曲线 ^立 即发生3 则量值需要超过 3740 ,才 000,即可判定为按键按下 变的情况下,通过改变 "阈(ession_1.c	医化, 从 3740 修改为 2000。 能判定为按键按下,
、表 "阈值 Threshe 家来按下按键后, 於 现在只需要超过 20 多、在按压力度不多 。 ② CapTouch Sta × @ Lab.e Touch I/F: Button00 @ config I/F Type: Buttonselfi, Channel(s Count Value: 15525 Ref Start Data Collection Noise [NT]: Ave Noise [T]: Ave Noise [T]: Ave Noise [T]: Ave Start Data Collection Start Data Collection Noise [T]: Ave Noise [T	old "的绿色曲线 立即发生了 则量值需要超过 3740,才 2000,即可判定为按键按下 变的情况下,通过改变 "阈 ession_1.c @ctsu_rd_int(@resetprg.c 11 v © Sync a selection 0): TS05 ference Value: 15462 Threshold: 2000 erage [NT]: Minimum: signal: france (T): Signal: erage (T): Signal:	医化,从 3740 修改为 2000。 能判定为按键按下, Threshold",由 3740 缩小 2000,从而提高T CapTouch Parameters (QE)



CapTouch Parameters (QE)	× 🔀 CapTouch Workflo	ow (QE)	CapTouch Parameters (QE)	× 🔀 CapTouch Workflow (QE)
		1 19 19 19 19 8		
Touch I/F: Button00 @ confir		a selection	Touch I/F: Button00 @ conf	q01 V Sync a selection
I/F Type: Button(self), Channel	el(s): TS05		I/F Type: Button(self), Channe	el(s): TS05
Item	Value		Item	Value
Drift Correction Interval	255		Drift Correction Interval	255
Long Touch Cancel Cycle	0		Long Touch Cancel Cycle	2
Positive Noise Filter Cycle	3		Positive Noise Filter Cycle	3
Moving Autors Filter Cycle	5		Moving Average Elter Dent	h 4
Touch Thread -1-	2740		Touch Threshold	3740
Hysteresis	187		Hysteresis	187
i iysteresis	107		- Hysteresis	
Set a long touch cancel cycle.	on that forcibly judges as t	touch OFF when	Set a long touch cancel cycle Long Touch Cancel is a function	on that forcibly judges as touch OFF
the touch ON period of the bu	utton / key pad button exc	ceeds a certain	the touch ON period of the b	utton / key pad button exceeds a ce
cycle.	Lorgan		cycle.	4 65525
Input 0 or value between 2 an	id 65535.		Input 0 or value between 2 a	גללט מו
- Input a value larger than [Po	ositive Noise Filter Cycle].		- Input a value larger than [F	ositive Noise Filter Cycle].
- The value is 2 or more: It is	judged as touch OFF, if th	ne period of	- The value is 2 or more: It is	judged as touch OFF, if the period
touch ON exceeds the cycle sp . The value is 1. Prohibition (b	pecified in [Long Touch Ca because [Positive Noice Ei	ancel Cycle].	touch ON exceeds the cycle s	pecified in [Long Touch Cancel Cycle because [Positive Noise Filter Cycle]
prohibited to set to 0).	because (Positive Noise Fil	iter Cyclej is	prohibited to set to 0).	occause (nostave moise niter Cycle)
- The value is 0: No judgemen	nt.		- The value is 0: No judgeme	ent.
This setting item will be applie	ed for each method		This setting item will be appli	ed for each method
mis setting item will be applie	ta for each method.		This setting item will be appli	ca lo, each mealoù.
		V		
。 按键一直按下,B	_{QE} is executing atoring f 时间招讨设定信	function	↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	Off,如下客所示:
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ː 按键一直按下,即 ≌ ^{CapTouch Sta…} × @ Lab_s	2E is executing a …toring f 时间超过设定值 session_1.c	iunction. 正 致 100 的时 at(这 resetprg.c	状态强制由 On 改为	QE is executing atoring function. Off,如下图所示:
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C 按键一直按下,即 CapTouch Sta × @ Lab_s Touch I/F: Button00 @ config0 I/F Type: Button(self), Channel(s	2E is executing atoring f 时间超过设定值 session_1.c	iunction. 正		QE is executing atoring function. Off,如下图所示:
C 按键一直按下,日 CapTouch Sta × @ Lab_s Touch I/F: Button00 @ config0 I/F Type: Button(self), Channel(s Count Value: 15493, Ref	2E is executing atoring f 时间超过设定值 session_1.c	iunction. 正 致 100 的时 ut(底 resetprg.c lection Threshold: 3740	t状态强制由 On 改为 □ □ ℃ CapTouch Parameters (Q) □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □	QE is executing atoring function. Off,如下图所示: () × (2) CapTouch Workflow (QE) (3) 网 甜 甜 醬 (1) (1) (2) Sync a selection
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C 古安键一直按下,日 CapTouch Sta × @ Lab_s Touch I/F: Button00 @ config0 I/F Type: Button(self), Channel(s Count Value: 15493 Ref Start Data Collection Noise [NT]: Ave Noise [T]: Ave	QE is executing atoring f 时间超过设定值 session_1.c E ctsu_rd_in 01	iunction. 正 立力 100 的时 t(译 resetprg.c lection Threshold: 3740 Minimum: Signal:	Wt 态 强 制 由 On 改 为	QE is executing atoring function. Off,如下图所示: () × ② CapTouch Workflow (OE) 同面 翻 翻 翻 fig01 v □ Sync a selection rel(s): TSO5 Value 255
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CapTouch Sta X @ Lab_s CapTouch Sta X @ Lab_s Touch I/F: Button00 @ config0 I/F Type: Button(self), Channel(s Count Value: 15403 Ref Start Data Collection Noise [NT]: Ave Noise [T]: Ave 26060	QE is executing atoring f 寸问超过设定信 session_1.c	iunction. 通为 100 的 武力 100 的 100 的 武力 100 的 100 的 武力 100 的 100 的 武力 100 的 100 的 100 的 武力 100 的 100 0 000 00	Wt 杰 强制由 On 改为 CapTouch Parameters (Q) CapTouch V/F: Button00 @ coo (VF Type: Button(self), Chan Item Drift Correction Interval Long Touch Cancel Cycle Positive Noise Filter Cycle	QE is executing atoring function. Off,如下图所示: ② × ② CapTouch Workflow (QE) ③ ៣ 部 部 節 fig01 v □ Sync a selection nel(s): TSO5 Value 255 100 3
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C 按键一直按下, B CapTouch Sta × @ Lab = Touch I/F: Button00 @ config0 I/F Type: Button(self), Channel(s Count Value: 15493 Ref Start Data Collection Noise [NT]: Ave Noise [T]: Ave 26060 23397	QE is executing atoring f 时间超过设定值 session_1.c E ctsu_rd_in 01 V Sync a sel s): TSO5 ference Value: 22320 erage [NT]: erage [T]:	iunction. 百方 100 的时 tt(区 resetprg.c lection Threshold: 3740 Minimum:	また また また また に また に また に また に また に また	QE is executing atoring function. Off,如下图所示: ③ × ② CapTouch Workflow (QE) □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □
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:C : 古安键—直按下, B CapTouch Sta × ⓒ Lab.e Touch I/F: Button00 @ configū I/F Type: Button(self), Channel(s Count Value: 15493 Ref Start Data Collection Noise [NT]: Ave Noise [T]: Ave 2606(0 23397 20734 18071	QE is executing atoring f 时间超过设定值 session_1.c E ctsu_rd_in 01 Sync a sel s): TSOS ference Value: 22320) erage [NT]: erage [T]:	function. 下	またのでは、 またのの との に 、 、 、 、 、 、 、 、 、 、 、 、 、 、 、 、 、 、	DE is executing atoring function. Off,如下图所示: ② × ② CapTouch Workflow (QE) ③ ◎ 圖 圖 圖 圖 fig01
☐ 古安键—直按下, 日 ② CapTouch Sta × @ Lab se Touch //F: Button00 @ config0 //F Type: Button(self), Channel(s Count Value: 15493 Ref Start Data Collection Noise [NT]: Ave Noise [NT]: Ave 26060 23397 20734 18071	QE is executing atoring f 时间超过设定值 session_1.c E ctsu_rd_in D1 Sync a sel s): TSO5 ference Value: 22320 erage [NT]: erage [T]:	iunction.	またの調子の「日本のの」のの「日本の」では、 またのでは、 またので、 またのので、 またので、 またのので、 またので、 またので、 またのので、 またのので、 またのので、 またのので、 またのので、 またのので、 またのので、	QE is executing atoring function. Off,如下图所示: ② CapTouch Workflow (QE) ③ 简 简 ③ 简 简 简 简 简 简 简 简 简 简 简 简 简 简 简 简
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Negative Noise Filter Cycle Moving Average Filter Depth	3		Negative Noise Filter Cycle Moving Average Filter Depth	4
Touch Threshold	3740	<u> </u>	Touch Threshold	3740
Hysteresis	187	$ \longrightarrow $	Hysteresis	187
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Inished download	Hardware breakpoint set at address 0xfffc0a06	QE is executing atoring function. QE is executing atoring function. Digle fact代表 "阈值 Threshold"的绿色曲线下方, 在设定值为 3000 的历 又有 Threshold", 按键状态也不改变。 CapTouch Sta X Lab_session_1.c Cctsu_rd_int(Cresetprg.c *2	QE is executing a . (QE is executing a .	toring function 即便起〕 。 即意 認 認 意 。 可意 認 認 意

END OF SECTION

3 Lab Session 2: 在 Lab 1 的基础上增加 MEC 功能

概述

在本实验环节中,将在 Lab session 1 的基础上,增加 MEC 多电极连接功能,12 个按键电极将在内部连接在一起, 作为一个 MEC 电极工作,此时不识别 12 个按键电极中的哪个按键电极被按下。

- 3.1 修改触摸接口(interface)或者配置(Configuration)
- 3.2 自动调整过程 (Auto Tuning Process)
- 3.3 使用 QE for Cap Touch 监控 MEC 电极的触摸底层数据以及触摸行为
- 3.4 调试 MEC 电极的运行参数

如果对 Lab session 2 的内容非常熟悉或者有一定困难,可跳过步骤 3.1 到步骤 3.2,

在 e2 studio 中 import 导入培训配套资料 Checkpoints 文件夹中的工程 Lab session 2,

直接进行步骤 3.3 到步骤 3.4 的实验。

实验步骤

3.1	修改触摸接口(interface)或者配置(Configuration)
3.1.1	在"Lab session 1" 的 e2 studio 丁程中。
	注
	选择"Renesas view 瑞萨视图" → Renesas QE → Capiouch workflow
	session 1/1 ab session 1 star - ef studio
	session_//tab_session_in.etg + e station 瑞萨视图(V) Run Window Help
	C/C++ >
	8 Code Generator > X
	Debug
	Partner OS > pent configuration
	Pin Configurator >
	Renesas QE >> 💭 CapTouch Gesture Monitor (QE)
	Smart Configurator > 💭 CapTouch Board Monitor (QE)
	Solution Toolkit > S CapTouch Pad Monitor (QE)
	Tracing > S CapTouch Multi Status Chart (QE)
	▲ 講萨软件安装程序 Solution Parameters (QE)
	CapTouch Status Chart (QE)
	CapTouch Tuning Result (QE)
	∼ 👝 DMA 😂 CapTouch Workflow (QE)
	😵 r_dtc_ri 🚧 Measuring Current Consumption (QE)
	✓ Event link controller
	Capacitive Jouch
	v the l/O parts
	✓ Onfig PORT
	✓ ➢ Low power consumption
	0. r loc or



workspace Captouch Training - e ² studio File Edit Source Refactor Navigate Search Project 瑞萨視型(V) III 和 - 名 - i 知 : 本 - 日 - i 配 =	Run Window Help			
Project Explorer (2) CapTouch Workflow (QE) × (3) 8 "	∰ Lab_session_1.scfg 🗧	CapTouch Tuning Result (QE)	CapTouch Status Chart (QE) X 🗟 Lab_session_1.c	.etprg.c 🗖 🛙
OPreparat Tuning Coding Monitoring	Create Configuration o	f Touch Interfaces		
1.Preparation -	File Name of Touch I/F:	Lab_session_1	Setup Configuration	Import / Re
 Select a Project 	Description:			
				Touch I/F
Lab_session_1 V				Capacitance Type
				Self Capacitance
 Prepare a Configuration 		Button00 Button01 Bu	utton02	Button
Lab session 1 tifrfa		TS05 TS06	TS07	Slider (horizon
Lub_absath_functy				Slider (vertice
Modify Configuration		Button03 Button04 Bu	utton05	Wheel
	ľ	TS10 TS09	TS08	Key pad
2.Tuning Touch Sensors		Button06 Button07 Bu	utton08	3D Gesture (A
Start luning	4	TS15 TS14	TS13	Touch pad
Start Tuning		Button09 Button10 Bu	utton11	Shield Pin
Enable advanced tuning		TS20 TS22	TS24	TC Pin
				Capacitance Se
				Current Sense
Display Tuning Result	Setting			Diagnosis Pi
	occurry			

可以通过"Add Configuration",以及勾选 Config01 下方的 Available,为 Button 分组 (Configuration),下图中,Button00 到 Button11 的 12 个 Button 都在 Config01 组中。

勾选 Config01 下方的"Multiple Electrode Connection"右侧的 Enable,将 config01 配置为 MEC 电极。

单击 OK,关闭"Setup Configuration"对话框,回到"Create Configuration of Touch Interfaces"页面.

单击 Create,在对话框中选择 Yes 覆盖之前的设定,完成触摸接口(interface)或者配置(Configuration)的设定。

ndu comgututori	comgaration
	config01
Button00(self)	✓ Available
Button01(self)	✓ Available
Button02(self)	✓ Available
Button03(self)	✓ Available
Button04(self)	✓ Available
Button05(self)	✓ Available
Button06(self)	✓ Available
Button07(self)	✓ Available
Button08(self)	✓ Available
Button09(self)	✓ Available
Button10(self)	✓ Available
Button11(self)	✓ Available
Auto Sensing by Hardware	Enable
Multiple Electrode Connection	🗹 Enable
ОК	Cancel Help



3.2.3	按照提示,使用手指以正常压力按住 12 个按键中的任意一个按键,
	此时黄色进度条将根据手指按压触摸按键的力度而变化,
	Automatic Tuning Processing
	5/6: QE will now measure touch sensitivity for (Mec00, TS05 @ config01). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement.
	Mec00, TS05 @ config01: 16846
	Cancel Help
NOTE	
NOTE	通过 MEC 多电极连接功能,12 个按键电极已经在内部连接在一起,作为一个 MEC 电极上作,此时无论 哪个按键被按下,都可以进行 MEC 电极的灵敏度测量。
3.2.4	完成自动调整过程(Auto Tuning Process)后,自动弹出结果,显示了 MEC 电极的阈值 Threshold。
	与击" Continue the Tuning Process "自动调整过程的结果对话框关闭。
	小田 Continue the Fulling Process, 白山洞道正空住的北京大街山に大河。
	自动调查过程(Auto Fulling Frocess)无规。
	Automatic Tuning Processing X
	The automatic tuning process is now complete. If overflow or warning/errors are indicated,
	those sensors can be retried. If there are continued overflows or warning/errors, please consult the Reposes application potes for Capacitive Touch for guidance
	Select the target Method Kind Name Touch Sensor Threshold Overflow Warning / Error
	Retry Continue the Tuning Process
	Cancel Help



3.2.5	在"Cap Touch Workflow"的"2.Tuning Touch Sensors"中,点击"Display Tuning Result"
	Project Explorer Captouch Workflow (QE) ×
	自动调整过程(Auto Tuning Process)的结果,如下图所示: 包括 Method, Kind, Name, Touch Sensor, Parasitic Capacitance, Sensor Driver Pulse Frequency, Threshold, Scan Time,以及 Overflow 等重要信息。 (受环境影响,重新进行自动调整过程时,寄生电容值会有细微差异,传感器驱动脉冲频率也有可能因寄生 电容值的变化发生变化;阈值 Threshold 也会因按压力度的变化发生变化,阈值也可以在配置文件中直接 修改)
	Method Kind Name Touch Sensor Parasitic Capacitance[pF] Sensor Drive Pulse Frequency[MHz] Threshold Scan Time[ms] Overflow config01 Button(self) Mec00 TS05 72.66 0.5 1177 0.576 None
NOTE	这里要特别注意 MEC00 的寄生电容值 72.66pF,由于超过了 50pF,因此只能使用 0.5MHz 的传感器驱 动脉冲频率,因此阈值只有 1177,灵敏度大幅度降低。
3.2.6	输出参数文件 在"Cap Touch Workflow"的"2.Tuning Touch Sensors"中, 点击"Output Parameter Files"
	以下三个参数文件将被覆盖 Qe_touch_define.h Qe_touch_config.h QE_touch_config.c



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3.4	调试 MEC 电极的运行参数
3.4.1	MEC 电极的运行参数,以及调试 MEC 电极的运行参数方法与 2.10 小节介绍的完全相同
	包括:
	Drift Correction Interval 漂移校正间隔
	Long Touch Cancel Cycle 长按键取消周期
	Positive Noise Filter Cycle 按键 On 判断的噪声滤波周期
	Negative Noise Filter Cycle 按键 Off 判断的噪声滤波周期
	Moving Average Filter Depth 移动平均滤波深度
	Touch Threshold 触摸阈值
	Hysteresis 迟滞

END OF SECTION

Renesas

4 Lab Session 3: 在 Lab 2 的基础上通过改变 MEC 电极的灵敏度增加接近传感功能

概述

在本实验环节中,将在 Lab session 2 的基础上,通过调整 MEC 电极的运行参数,提高灵敏度,增加接近传感功能。

- 4.1 修改 MEC 电极的阈值
- 4.2 使用 QE for Cap Touch 监控 MEC 电极的触摸底层数据以及触摸行为
- 4.3 调试 MEC 电极的运行参数

如果对 Lab session 3 的内容非常熟悉或者有一定困难,可跳过步骤 4.1 到步骤 4.2, 在 e2 studio 中 import 导入培训配套资料 Checkpoints 文件夹中的工程 Lab session 3,

直接进行步骤 4.2 到 4.3 的实验。

实验步骤









END OF SECTION

Renesas

5 Lab Session 4: 在 Lab 3 的基础上增加低功耗(Auto Judgement)功能

概述

在本实验环节中,将在 Lab session 3 的基础上,增加低功耗功能(Auto Judgement)功能.

修改触摸接口(interface)或者配置(Configuration),将按键分组(Configuration),将用于接近传感功能的 MEC 电极设定为 Config1,将 12 个按键设定为 Config2。

上电复位后,系统进入低功耗工作模式,此时接近传感电极工作,以100ms的控制周期进行测量。

当用于接近传感功能的 MEC 电极,通过 AJ 自动判断功能,判断为没有触发时,系统始终保持在低功耗模式下工作。 当用于接近传感功能的 MEC 电极,通过 AJ 自动判断功能,判断为触发时,退出低功耗模式,系统在 Normal 模式 下对 Config1 的 MEC 电极进行 baseline 调整,然后对 Config2 的 12 个按键进行测量和判断。

- 5.1 修改触摸接口(interface) 或者配置 (Configuration)
- 5.2 使用 Smart configurator 添加必要的驱动程序
- 5.3 自动调整过程 (Auto Tuning Process)
- 5.4 增加低功耗 (Auto Judgement) 功能应用程序
- 5.5 使用 QE for Cap Touch 监控触摸底层数据以及触摸行为
- 5.6 调试低功耗 (Auto Judgement) 功能运行参数

如果对 Lab session 4 的内容非常熟悉或者有一定困难,可跳过步骤 5.1 到步骤 5.4, 在 e2 studio 中 import 导入培训配套资料 Checkpoints 文件夹中的工程 Lab session 4, 直接进行步骤 5.5 到 5.6 的实验

实验步骤



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5.3	自动调整过程 (Auto Tuning Process) 开始自动调整过程(Auto Tuning Process) 在"Cap Touch Workflow"的"2.Tuning Touch Sensors"中, 单击"Start Tuning" . 『Workspace Laptouch Training - Lab_Session_1/Lab_Session_1/Scig - et studio File Edit Source Refactor Navigate Search Project NetWindow Help Project Explorer © CapTouch Workflow (2E) × ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ●	
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5.3.2	自动调整过程(Auto Tuning Process)开始,依次显示如下四步,这时不需要用户操作。
	,弗—步:QE止任测重所有肥焊按键的奇生电谷。
	第三步:QE 正在调整触摸按键的偏置电流值
	第四步:QE开始进行灵敏度测量
NOTE	
NOTE	以上自动调整过程(Auto Tuning Process)开始时的四个步骤的图片可参考
5.3.3	
	如下图所示,为 MEC 电极,"Mec00,TS05"进行灵敏度测量。
	使用手指或者手掌靠近 MEC 电极, 在期望的接近传感距离停住, 例如距离 MEC 电极 1.5cm 处, 查看进
	度条的变化,按下PC键盘的任意键,接受灵敏度测量。
	C Automatic Tuning Processing X
	6/20: QE will now measure touch sensitivity for (Mec00, TS05 @ config01).
	In this step please use normal touch pressure on the sensor for once. Press any key on the PC
	keyboard to accept the sensitivity measurement.
	Mec00, TS05 @ config01: 15412
	Cancel Help
	Cancel Help
	Cancel Help
	Cancel Help United States of the Help Development of
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示。使用手指\\\\'III';常压力按住 Button00/TS05 的触道按键
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键,
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化,
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 ③ Automatic Tuning Processing × 8/20: OE will now measure touch sensitivity for (Button00, TS05 @, config02)
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 《 Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement.
	Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC键盘的任意键,接受该触摸按键的灵敏度测量。 《Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00_TS05 @ config02: 15394
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 《Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394
	Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394
	Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394
	Cancel Help 如下图所示,为 Button00 到 Button11 的 12 个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住 Button00/TS05 的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394 Lucent Help
	Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394
	Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394 Image: Cancel
	Image: Cancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing Image: Automatic Tuning Proc
NOTE	Lancel Help 如下图所示,为Button00到Button11的12个按键,进行灵敏度测量。 按照提示,使用手指以正常压力按住Button00/TS05的触摸按键, 此时黄色进度条将根据手指按压触摸按键的力度而变化, 保持期望的按压力度,同时按下 PC 键盘的任意键,接受该触摸按键的灵敏度测量。 Image: Automatic Tuning Processing X 8/20: QE will now measure touch sensitivity for (Button00, TS05 @ config02). In this step please use normal touch pressure on the sensor for once. Press any key on the PC keyboard to accept the sensitivity measurement. Button00, TS05 @ config02: 15394 Image: Teacher T


Automatic Tun	ing Processi	na	_						_
The automati	c tuning	nroco	e ie now	<i>i</i> complete	If overflo	w or wa	rning/errore	aro indic	atod
those sensors	c tuning s can be i	retried	. If there	are continu	ied overfl	lows or v	warning/errors	s. please	a con
the Renesas a	pplicatio	on note	es for Ca	pacitive To	uch for g	uidance.	manning, en or	o, preuse	con
Select the target	Method	Kind	Name	Touch Sensor	Threshold	Overflow	Warning / Error		
	config01	Button	Mec00	TS05	309				
	config02	Button	Button00	TS05	3980				
	config02	Button	Button01	TS06	3939				
	config02	Button	Button02	TS07	7886				
	config02	Button	Button03	TS10	6788				
	config02	Button	Button04	TS09	7405				
	config02	Button	Button05	TS08	7627				
	config02	Button	Button06	TS15	7474				
	config02	Button	Button07	TS14	7510				
	config02	Button	Button08	TS13	7244				
	config02	Button	Button09	TS20	6763				
	config02	Button	Button10	TS22	8083				
	config02	Button	Button11	TS24	5964				



5.3.5	在"Cap Touc	h Wo	rkflow	'的" 2.T	uning	Tou	ch Sensors'	'中, 点	ē击"Disp	olay T	uning	Result"	
	Project Evoluter (2) CanTouch Work	flow (OF) X	Q : - 0	····	E dsub			.,		,			
	Preparatio Tuning	Coding	Monitoring	Can't find a source fi Locate the file or ed	le at "C:\projec t the source loc								
	2.Tuning Touch Sensors Start Tuning		-	Locate File Edit Source Lookup	Path								
	Start	Tuning Enable ad	dvanced tuning	Configure when this	editor is shown								
	Display Tu	ining Result											
	Output Parameter Files Output Parameter Files	The ameter Files	tuning result can be viewe	i in the dedicated view.									
		□ Specify an ou □ Use an extern □ Use diagnost	utput folder nal trigger tic code										
		Use API com	patilibity mode		_								
	自动调整过程(Auto	Tuning	g Proce	ess)的	结果,	如下图所示:						
	包括 Method	, Kin	d, Nai	ne, To	ouch S	Senso	r, Parasitio	c Capa च===	citance	, Ser	isor D	river Pul	se
	requency, (受环境影响,	Thres 重新讲	前回 位, 特行自动	Scan T 调整讨利	me, 得时,	い及 い 寄牛申	Dvernow 寺 B容值会有细	■安に 微差异	i忌。 · 传感器	驱动	脉冲频	率也有可能	能因寄牛
	电容值的变化; 修改)	发生变	化; 阈	直 Thre	shold	也会	因按压力度的	·变化发	建变化,	阈值	也可以	在配置文	件中直接
	Tuning Gesture												
	Touch I/F Configuration	n: Lab_sessio	n_1										
	Method Kind	Name Mec00	Touch Sensor	Parasitic Cap	acitance[pF]	Sensor Dri	ive Pulse Frequency[MHz]	Threshold	Scan Time[ms]	Overflow	^		
	config02 Button(self) config02 Button(self)	Button00 Button01	TS05 TS06	11.917		2.0		3980 3939	0.576	None None			
	config02 Button(self)	Button02	TS07	9.347		4.0		7886	0.576	None			
	config02 Button(self)	Button04	TS09	9.125		4.0		7405	0.576	None			
	config02 Button(self)	Button05	TS08	8.16		4.0		7627	0.576	None			
	config02 Button(self)	Button07	TS14	7.993		4.0		7510	0.576	None			
	config02 Button(self)	Button08	TS13	7.625		4.0		7244	0.576	None			
	config02 Button(self)	Button09 Button10	TS20 TS22	6.431		4.0		6763 8083	0.576	None	_		
5.3.6	输出参数文件												
	在"Cap Touc	h Wo	rkflow	'的 "2.T	uning	Tou	ch Sensors'	'中, 勾	〕选"Use	an ex	cterna	l trigger	"
	点击 "Output	Parar	meter I	lles"									
	🍐 Project Exp 🖏 CapTe	ouch ×	- 🗆 🎯 Lab_	session_1.scfg	CapTouc	n Tuning Resu	It (QE) × 🖪 Lab_session_1	I.c 💽 ctsu	rd_int() at tuning_cts	u2.c:698 0x3	01	000	
		Co Mon	ittor Tuning	Gesture I/F Configuration	: Lab_session_	1							
	2.Tuning Touch	Sensors ·	- Meth	od Kind	Name 1	ouch Sensor	Parasitic Capacitance[pF]	Sensor Drive P	ulse Frequency[MHz] Threshold	Scan Time[n	ns] Overflow ^	
	 Start Tuning 		confi	g01 Button(self) g02 Button(self)	Mec00 1 Button00 1	S05	72.819 11.917	0.5		309 3980	0.576	None None	
	Start Tunir	ng	confi	g02 Button(self) g02 Button(self)	Button01 1 Button02 1	S06 S07	9.347	4.0		7886	0.576	None	
	Enable adva	nced tunin	Ig confi	g02 Button(self) g02 Button(self)	Button03 T Button04 T	S10 S09	9.312 9.125	4.0		6788 7405	0.576	None	
			confi	g02 Button(self)	Button05 1	S08	8.16	4.0		7627	0.576	None	
			confi	g02 Button(self) g02 Button(self)	Button07 T	S14	7.993	4.0		7510	0.576	None	
	Display Tuning	Result	confi	g02 Button(self) g02 Button(self)	Button08 1 Button09 1	\$13 \$20	7.625 6.431	4.0		7244 6763	0.576	None None	
	Output Param	eter Files	confi	g02 Button(self)	Button10 T	\$22	6.007	4.0		8083	0.576	None ¥	
	Output Paramet	ter Files											
	Charify an outr	ut foldor											
	Use an external	trigger											
	Use diagnostic o	code											
	Use API compat	unbity mod	ie in the second se										
	以下三个参数	文件将	被覆盖										
	Qe_touch_de	efine.ł	h										
	Qe_touch_co	onfig.l	h										
	QE_touch_co	onfig.o	c										
				-	?c		ESAS						

NOTE	"Low-Power Timer"将作为 CTSU 的 external trigger 使用
5.4	增加低功耗(Auto Judgement)功能应用程序
5.4.1	将培训配套资料 Checkpoints 文件夹中的工程"Lab session 4"中的 qe_gen 文件的 "qe_touch_sample.c"拷贝并覆盖"Project Explorer"的 Lab_session_1 工程中 qe_gen 文件的 "qe_touch_sample.c".
5.4.2	应用程序代码说明使用 init_peripheral_function 初始化需要使用的外设使用 R_CTSU_Open()初始化 config01(MEC 电极)使用 RM_TOUCH_Open()初始化 config02(12 个自容式按键)/* Initialize peripheral functions */init_peripheral_function();/* Open Touch middleware */err = R_CTSU_Open (g_qe_ctsu_instance_config01.p_ctrl,g_qe_ctsu_instance_config01.p_cfg);ctsu_ctrl = (ctsu_instance_ctrl_t *)g_qe_ctsu_instance_config01.p_ctrl;err = RM_TOUCH_Open (g_qe_touch_instance_config02.p_ctrl,g_qe_touch_instance_config02.p_cfg);
5.4.3	<pre>应用程序代码说明 以下代码完成 config01(MEC 电极)和 config02(12 个自容式按键电极)的初始化编置电流调整. /* Initial Offset Tuning */ { (void)R_LPT_SetCMT(<i>LPT_CH1</i>, (uint32_t)WAKEUP_LPT_PERIOD_NORMAL); /* Method1 offset tuning */ do { err = R_CTSU_ScanStart (g_qe_ctsu_instance_config01.p_ctrl); if (<i>FSP_SUCCESS</i> != err) { while (true) {} } (void)R_LPT_Control(<i>LPT_CMD_START</i>); while (0 == g_qe_touch_flag) {} g_qe_touch_flag = 0; err = R_CTSU_OffsetTuning (g_qe_ctsu_instance_config01.p_ctrl); while(err != <i>FSP_SUCCESS</i>); /* Method2 offset tuning */ do { err = RM_TOUCH_ScanStart (g_qe_touch_instance_config02.p_ctrl); if (<i>FSP_SUCCESS</i> != err) { while (true) {} } (void)R_LPT_Control(<i>LPT_CMD_START</i>); while (0 == g_q_touch_flag) {} g_qe_touch_flag = 0; err = RM_TOUCH_Destate(g_qe_touch_instance_config02.p_ctrl); if (<i>FSP_SUCCESS</i> != err) { while (true) {} j_UCOUCH_DEstate(g_qe_touch_instance_config02.p_ctrl); if (<i>PSP_SUCCESS</i> != err); { while (true) {} } (void)R_LPT_Control(<i>LPT_CMD_START</i>); while (0 == g_q_touch_flag) {} g_qe_touch_flag = 0; err = RM_TOUCH_DEstate(g_qe_touch_instance_config02.p_ctrl, 8button_status02, NULL, NULL); } </pre>

5.4.4	应用程序代码说明
	以下代码完成 config01(MEC 电极) <mark>在 Normal 模式下</mark> 的 baseline 调整。
	<pre>/* base line setting @method1 */ for (uint32_t i = 0U; i < WAKEUP_TIME_BASELINE; i++) {</pre>
	<pre>err = R_CTSU_ScanStart (g_qe_ctsu_instance_config01.p_ctrl); if (FSP_SUCCESS != err) {</pre>
	<pre>while (true) {} }</pre>
	<pre>(void)R_LPT_Control(LPT_CMD_START); R_BSP_SoftwareDelay(WAKEUP_WAIT_MEASUREEND, BSP_DELAY_MILLISECS); (void)R_LPT_Control(LPT_CMD_STOP); (void)R_LPT_Control(LPT_CMD_COUNT_RESET);</pre>
	<pre>ctsu_ctri->state = CISU_STATE_SCANNED; err = R_CTSU_AutoJudgementDataGet (g_qe_ctsu_instance_config01.p_ctrl, &button_status01); if (FSP SUCCESS == err)</pre>
	<pre>{</pre>
	&monitor_id_address, &monitor_size_address);
	<pre>qe_monitor_autojudge (g_qe_ctsu_instance_config01.p_ctrl); }</pre>
5.4.5	
	以下代码完成进入低功耗模式的操作,在低功耗模式里完成 config01(MEC 电极)的测量和自动判断, 当 config01(MEC 电极)有按键 On 判断是时,退出低功耗,并通过 R_CTSU_AutoJudgementDataGet() 取得结果。
	/* Standby mode */
	<pre>/* for [CONFIG01] configuration */ (void)R_LPT_SetCMT(LPT_CH1, (uint32_t)WAKEUP_LPT_PERIOD_STANDBY); err = R_CTSU_ScanStart (g_qe_ctsu_instance_config01.p_ctrl); (* Enton coftware standby mode */</pre>
	<pre>inter software standby mode '' ipc_err = R_LPC_LowPowerModeActivate(&activate_standby_callback); if (LPC_SUCCESS != lpc_err) </pre>
	<pre> while (true) {} </pre>
	<pre>} while (0 == g_qe_touch_flag) {}</pre>
	<pre>g_qe_toucn_flag = 0; err = R_CTSU_AutoJudgementDataGet (g_qe_ctsu_instance_config01.p_ctrl,</pre>
	<pre>if (FSP_SUCCESS == err)</pre>
	<pre>{ RM_TOUCH_MonitorAddressGet (g_qe_touch_instance_config02.p_ctrl,</pre>
	<pre>&monitor_size_address); qe_monitor_autojudge (g_qe_ctsu_instance_config01.p_ctrl); }</pre>
	}
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5.5	使用 QE for Cap Touch 监控触摸底层数据以及触摸行为
5.5.1	按照"2.6 运行程序"小节介绍的方法,在仿真状态下全速运行程序。 在"Cap Touch Workflow"的"4.monitoring"中,点击"Start Monitoring(Emulator)"下方的"Show Views"
5.5.2	<text><section-header><list-item><list-item><list-item><list-item></list-item></list-item></list-item></list-item></section-header></text>
NOTE	在 e2 studio 左下角的状态栏,显示了当前工程的运行状态,包括以下几种。 在低功耗时显示: 待机 → 在正常运行时显示: 运行 → 在程序暂时显示: 暂停 →





1. 低功耗工作模式下 MEC 电极的运行参数

• MEC 电极的阈值 Threshold (为 Normal 模式下工作时的 50%)

举例来说,在"qe_touch_config.c"中可以看到 MEC 电极的阈值 Threshold 为 309.



但是在 QE 监控窗口看到的阈值 Threshold 为 309 的 50%,为 154.

为 Normal 模式下工作时的 50%的原因如下:

CTUS2 为三频率测量, 三频率测量是丢弃一个异常值, 最终两个频率的值求和, 因此自动调整过程 (Auto tuning process) 输出一个频率测量 x2 的结果, 并反映在 Log 日志中。使用低功耗 (Auto Judgement) 功能时的监测只显示一个频率的结果, 因此结果是日志中显示的阈值的一半。这是因为即使在测量三个频率时, 自动判断版本也不会组合这些值, 而是对每个频率单独执行触摸判断【这个机制以后可能会修改】。

低功耗模式下 MEC 电极阈值 Threshold,建议使用"CapTouch Parameters (QE) View"在程序运行状态下通过"Touch Threshold"修改并调试,然后在"qe touch_config.c"中直接修改。

调试时,先通过手指接近 MEC 电极,使系统自动判断有按键动作,退出低功耗模式返回 Normal 模式,然后 "CapTouch Parameters (QE) View"中修改"Touch Threshold",手指再次接近 MEC 电极观测灵敏度变化,由于 MEC 电极在 Normal 模式下运行的时间非常短,因此需要反复调试以达到满意的效果。

L/E Turper Putton(solf), Channel	(c), TCO5						
i/i Type: button(seil), channel	(5). 1305						
Count Value: 6984 Re	eference Value: 7181	Threshold: 15	4 Difference:	-197	Touch I/F: Mec00 @ config	01 ∨ Synca	t.
Start Data Collection					I/F Type: Button(self), Chann	el(s): TS05	
Noise [NT]: Av	verage [NT]:	Minimum:	Maximum:		Item	Value	1
Noise [T]: Av	verage [T]:	Signal:	SNR:		Drift Correction Interval	7	
					Moving Average Filter Dept	th 2	
					Touch Threshold	154	
					Hysteresis	7	
						7	
028					CTSUSDPA	SUCLK divided by 32	
530						, i	
7650							
052							
7267							
507							
	1 MIM					^	
' WIVV		M M M M.		/			

5.6.3	 将低功耗工作模式下 MEC 电极的阈值 Threshold,调整为 300 的示例操作,如下图所示:
	🕼 Lab. session 🔯 qe_touch_con 🖏 CapTouch Sta X 🔯 resetprg.c. 🔯 Lab. session_1.c. 🔯 r_bsp_common.c. 📮 🗖 🖏 CapTouch Parameter X 🕲 CapTouch Workflow, 📮 🗖
	Up bd bi
	Count value: 7000 Interchoic: 300 Unterchoic: 65 Start Data Collection Value: Value: Value: Noise (NT): Average (NT): Maximum: Maximum: Noise (NT): Average (NT): Start Data Collection
	Moving Average Title Depth 2 Touch Threshold 300 Hysteresis 7 CTSUGO 159
	T/195 CTSUSNUM 7 CTSUSDPA SUCLK divided by 32
	7362
	7229
	7096
	whether the button / key pad button switches from touch OFF to N. The button / key pad button is judged to be touch ON when the court value exceeds the value specified in [Touch Threshold].
	Console X = 2 ‰ R, B3 @ @ @ r ⊂ → r → = Input a value between 1 and 65535.
NOTE	低功耗工作模式下的 MEC 电极除了在低功耗模式下运行外,在 Normal 模式下的也会短暂运行,因为需
	要在Normal 模式下进行 baseline 调整,因此在 baseline 调整期间可以通过 QE 的监控窗口调试和修改 阈值 Threshold。在 Normal 模式下的短暂运行的时间,也可以调整。
5.6.4	2. 低功耗工作模式下的 Auto Judgement 自动判断功能的相关参数
	以下三个参数,由于无法在低功耗模式下仿真调试,因此只能直接在"qe_touch_config.c"中直接修改。
	Tlot,Non-touch judgment continuous count,与 Button 的"Negative Noise Filter Cycle"意义相同
	Ajmmat, Moving average, 与 Button 的"Moving Average Filter Depth"意义相同
	下面的参数,由于工作在 Normal 模式下,因此可以 QE 监控窗口进行调试和修改。
	AJbmat, Baseline average count, 与 Button 的"Drift Correction Interval"意义相同, 也可以在 "qe_touch_config.c"中直接修改, 如下图:
	Image: Construction in the imag
	74 { 75
	<pre>80 81 const ctsu_cfg_t g_qe_ctsu_cfg_conf1g01 = 82 { 83</pre>
	85 .txysel - CTSU_TXYSEL VCC, 86 .txysel2 - CTSU_TXYSEL_NODE, 87 .atume12 - CTSU_TXYSEL_VADE, 88 .atume12 - CTSU_TXYSEL_VADE, 89 .nd - CTSU_NODE_SELF_MULTI_SCAM, 90 .nope1 = CTSU_NODE_SELF_MULTI_SCAM,
	91 .tsod = 1, 92 .mec_ts = 5, 93 .tlot = 2, 95 .tlot = 2,
	90 .jL = 1, 97 .afmat = 2, 98 .afmat = 7, 99 .mtucfen = 0, 100 .ajfer = 1, 101 .autojudge monitor_num = 0,
	102 .p_ctsu_auto_buttons = g_qe_ctsu_auto_button_cfg_config01, 103 .ctsuchac0 = 0x80, /* cho ² -cho ² enable mask */ 104 .ctsuchac1 = 0x87, /* cho ² -chi ² enable mask */ 105 .ctsuchac2 = 0x80, /* cho ² -chi ² -cha ² -chi ² enable mask */ 106 .ctsuchac3 = 0x81, /* chi ² -chi ² -chi ² -chi ² enable mask */ 107 .ctsuchac3 = 0x81, /* chi ² -chi
	108 .ctsuchtrc9 0x00, /* ch0-ch7 mutual tx mask */ 109 .ctsuchtrc1 0x00, /* ch8-ch15 mutual tx mask */ 110 .ctsuchtrc2 0x00, /* ch8-ch15 mutual tx mask */ 111 .ctsuchtrc3 0x00, /* ch2-ch31 mutual tx mask */ 112 .ctsuchtrc4 0x00, /* ch3-ch31 mutual tx mask */
	113 .num_rx = 1, 114 .num_tx = 0, 115 .p_elements = g_q_ctsu_element_cfg_config01, 116
	119 .tuning_mutual_target_value = 10240, 120 #endif 121 .num_moving_average = 4, 122 .num_noving_average = 4, 123 .tuning_enable = true, 124 .p_cellback = & ege_cts_uato_cellback,
	125 1:
	RENESAS

5.6.5	
	修改如下宏定义:
	<pre>/* Baseline number = 256[Times] at AJBMAT = 7 */</pre>
	<pre>#define WAKEUP_TIME_AJBMAT (256)</pre>
	<pre>#define WAKEUP_TIME_BASELINE (WAKEUP_TIME_AJBMAT * 2)</pre>
	WAKEUP_TIME_AJBMAT 的设定值为 Ajbmat 的设定值的 2+1 次方,
	例如 Ajbmat 的设定值为 7 时 WAKEUP_TIME_AJBMAT 的设定值为 2 ⁷⁺¹ =256
	Baseline 调整的应用程序代码详见 5.4.4 小节。
NOTE	如果 baseline 调整的时间设定过长,会影响按键的响应时间,影响用户体验
5.6.6	下图为将 Ajbmat 设定为 3 时的调整示例,如下图:
	在"qe_touch_config.c"中,将 Ajbmat 设定为 3,
	在"qe_touch_sample.c"中,将 WAKEUP_TIME_AJBMAT 设定为 16
	可以看到, baseline 调整的时间非常短。
	此时, MEC 电极的测量值有可能来不及跌落阈值之下, 此时即便回到低功耗模式之中, 由于按键判定依然
	为 OII 状态,所以去立即逐山似幼稚侯氏固封 Normal 侯氏。因此,安日连反定 Ajbinat 的道。
	□ □ </th
	I/F Type: Button(self), Channel(s): TS01
	Count Value: 9506 Reference Value: 8435 Threshold: 500 Difference: 1071 Start Data Collection
	Noise [NT]: Average [NT]: Minimum: Maximum:
	Noise [T]: Average [T]: Signal: SNR:
	10001
	9608
	WAREUP_TIME_BASELINE
	8826
	▼ Normal mode WAKEUP TIME SLEEP超时控制
	8435 测试时无按键,超时时间为3S

5.6.7

3.其他低功耗工作相关的参数 低功耗控制周期 • 低功耗模式下的 MEC 电极的 Sensor 驱动脉冲频率 无按键按下时的等待时间 低功耗控制周期 低功耗控制周期的设定越长,功耗越低,响应时间也越长,即灵敏度很低。 要根据产品应用, 合理的设定低功耗控制周期。 Process CPU Operation Mode Software standby mode Snooze mode Software standby mode стѕи Suspend Start Suspend Operation Status 100ms 在"qe touch sample.c"中,通过修改以下两个宏定义,修改控制周期,当前设定值为 100000,即 100ms. 修改低功耗控制周期后,可通过电流表查看电流波形以及功耗数据。 /* LPT cycle = 100000[microseconds] (100 microseconds) */ #define WAKEUP LPT PERIOD (100000) /* LPT compare = 100000[microseconds] (100 microseconds) */ #define WAKEUP LPT PERIOD STANDBY (100000) 低功耗模式下的 MEC 电极的 Sensor 驱动脉冲频率 在低功耗模式下,仅 MEC 电极在工作,修改 MEC 电极的 Sensor 驱动脉冲频率,会影响功耗数据。 低功耗模式下的 MEC 电极的 Sensor 驱动脉冲频率设定越大,功耗越大。 Sensor 驱动脉冲频率可设定的最小值为 0.5MHz。

在本例中, MEC 电极的 Sensor 驱动脉冲频率从 0.5MHz 改为 1MHz 后,功耗数据会有 5uA 左右的提高。

无按键按下时的等待时间

在"qe_touch_sample.c"中,通过修改以下宏定义,修改在 Normal 模式下,无按键按键返回低功耗模式 的等待时间。

#define WAKEUP_TIME_SLEEP (3000U) /* 3sec*/

END OF SECTION

6 Lab Session 5: 在 Lab 4 的基础上使用 DMM7510 测试低功耗数据

概述

在本实验环节中,将介绍使用 Keithley DMM7510 数字多功能表,在 Lab session 4 的基础上测试低功耗数据.

- DMM7510 需要设定在数字化电流的测量模式,量程 10mA,采样率 100000 点/秒,采样数 100000.
- 启动测量,查看结果
 - 以图形的形式,查看系统在低功耗模式下(Software Standby mode 和 Snooze mode)的电流波形
 查看平均电流/功耗数据
- 6.1 硬件准备
- 6.2 Keithley DMM7510 设定
- 6.3 启动测量
- 6.4 修改低功耗控制周期

实验步骤

6.1	硬件准备
6.1.1	将评价板的 SS1 跳线断开,如下图所示
6.1.2	按照下图将 Keithley DMM7510 的电流测量表笔连接到 J2,使用装有两节电池的电池盒给评价板供电。

6.2	Keithley DMM751	0 设定			
6.2.1	将 Keithley DMM751 Function: Digitize C Range: 10mA Sample Rate: 10000 Sample Count: 1000	l0 按下图设定: Current 0 00			
	Primary Function Second Measurement Settings Function Range Aperture (s) Auto Aperture Display Digits Image Rel Rel Value Filter Type Count Window (%) Math	dary Function Digitize Current 10mA Colored Generation Colored Colore	Trigger Trigger Mode Acquisition Sample Rate Sample Count Start at HH:MM Timestamp Format Limit 1 Auto Clear Upper Limit Lower Limit Audible Limit 2 Auto Clear	Immediate	
6.3	启动测量				
6.3.1	启动测量后,得到测量	结果			
	以数据的形式,查看功	耗数据 亚均功 <u>耗为</u> 、 11 A			
	TUUUUUU 个测试数据的- KickStart - <新建项目> 《微应用程序 Suite Apps Data Logger 1.946 DMM Characterizer	半口3山和志力: 11uA ● ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○		<u>.</u>	





END OF SECTION

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