

PL7413

(Single Phase, Power/Energy Metering IC)

ZCC + Auto Learn Demo Board Multi-Device

Auto Calibration Application Note

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Prolific Technology Inc.

7F, No. 48, Sec. 3, Nan Kang Rd. Nan Kang, Taipei 115, Taiwan, R.O.C. Telephone: +886-2-2654-6363 Fax: +886-2-2654-6161 E-mail: <u>sales@prolific.com.tw</u> Website: <u>http://www.prolific.com.tw</u>



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1. HW Setup environment and SPI communication

1.1 Setup Environment

1.1.1 PL7413 demo board + Auto Learn+ ZCC Board

Use Demo_Board Function: AC_Plug_1 Phase connect CON9(or CON8)AC_Plug_1 Neutral connect CON5/ Loading: AC_Socket Phase connect CON6(or CON7); AC_Socket Neutral connect CON4;J4 Short

Use Auto Learn Function: AC_Plug_1 Phase connect CON9(or CON8)AC_Plug_1 Neutral connect CON5/; J4 Short

Use ZCC Function: AC_Plug_1 Phase connect CON9(or CON8) AC_Plug_1 Neutral connect CON5/ AC_Plug_2 Phase connect CON10(or CON12) AC_Plug_1 Neutral connect CON3; J4 OPEN





There are three function in this board can be applied:

- (1).Use Demo board function of PL7413
- (2).Use auto learn function of PL7413
- (3) Use ZCC function of PL7413+ PL7223 Demo board



This document is focus on using PL7413 demo board and auto learn function of PL7413.

1.1.2 Use Demo board function + Auto learn function of PL7413

If you use the PL7413's auto learn DSP codes, it will auto counting zero-crossings to help the relay switch at the zero crossing. It also has the AFE of meter functions. About auto learn ZCC, please reference Section 5.5.

Prolific Calibration AP software control



Figure 1.2 : PL7413_ZCC+AL_DB demo board with auto learn ZCC

1.1.3 Use ZCC function of PL7413+PL7223 Demo board

If your calibration target is PL7223 demo board, because PL7233 DSP codes size has limit, so needs PL7413 to help count PL7223's zero crossing.



PL7223 Demo Board

Figure 1.3 : PL7413_ZCC+AL_DB board + PL223 Demo board +



1.1.4 Calibration Overview

- 1. Use the calibration board to supply 3.3V to VCC33 of PL7413,as below picture. (Use CON3 short for calibration board).
- 2. CON4 of SPI connect to SPI pin of PL7413 from calibration board.



Figure 1.4 : Calibration Overview

1.1.5 Calibration Board Bottom Board Setting

Below bitmap to show bottom board the interface connect via SPI, First Please set Calibration Jump as follows :



Figure 1.5 : Calibration Bottom Board



Calibration board Top Board setting

Below bitmap to show Top board the interface connect via SPI, First Please set Calibration Dip Switch as follows



Figure 1.6 : Calibration Top Board

1.1.6 New calibration board Top Board Serial Number setting

Below bitmap to show Top board can via Dip switch to change the Serial Number, This is for Multi-calibration device only





1.1.7 Programming Environment Connect Overview



Figure 1.8 : Calibration Board with PL7413 connect Overview

1. Please check the PC Device Management , calibration board driver is install and connect correct.

2.Please check "USBXpress Device" driver status is correct.

Device version 4.0.0.0 for WIN8/WIN7/WINXP.



Figure 1.9 : Check USB driver status

1.1.8 PL7413 Demo board I/F setting

PL7413 has three interface SPI/I2C/UART interface that operates at slave mode. It can communicate and access data with MCU. MCU should serve as the SPI/I2C/UART master and sends chip Select and clock signal to the PL7413.When Use the SPI I/F Data is written through SPI_DI and read through SPI_DO. .When Use the I2C I/F Data is written and read through SDA, .When Use the UART I/F Data is written through TX



and read through RX. Figure 1-6 to 1-8 shows the connection and pin definition:

IO Mode is latch when resetn is from low to high

- i2c_en = [mode, spi_cs]= 2'b00
- uart_en = [mode, spi_cs]= 2'b01
- spi_en = [mode, spi_cs]= 2'b10
- gpio_en = [mode, spi_cs]= 2'b11



Figure 1.10 : PL7413 Demo board I/F setting



1.1.8.1 PL7413 SPI Communication

- SPI Slave mode, supports mode 0 ,mode1, mode2 and mode 3
- Supports single and multi-byte read write
- Supports CRC data check

Calibration board setting

You can reference below bitmap to change the interface connect via SPI, First Please set Calibration Jump as follows :

Bottom board: CON18 :Short

CON24:Short CON22:Open

CON28:Open



Figure 1.11 : Calibration bottom board for SPI

Top Board:

DIP1 pin1→1 DIP2 pin1 →1	DIP3 pin1→1	DIP3 pin5→1
--------------------------	-------------	-------------

(reference red arrow)



Figure 1.12 : Calibration top board for SPI



PL7413 demo board J9 through by the SPI interface connect to the calibration board. J9-CAL_Sts(PIN1) does not need to connect to the GND of the calibration board. IO Mode: MODE=H, SPI_CS=L.



Figure 1.13 : PL7413 SPI Communication

1.1.8.2 PL7413 UART Communication

- Auto-baud rate learning
- Two hardware slave ID selection for cascade application
- Software ID programmable
- Supports single and multi-byte read write
- Supports CRC data check
- Supports UART timeout
- Supports IR38K carrier remove
- UART master mode for auto data rep

Calibration board setting

You can reference below bitmap to change the interface connect via UART,

Please set Calibration Jump as follow :

Bottom board: CON18 :Short

CON24:Short

CON22:Open

CON28:Open



Figure 1.14 : Calibration bottom board for UART



Top Board:



Figure 1.15 : Calibration top board for UART

PL7413 demo board J9 through by the UART interface connect to the calibration board. J9-CAL_Sts(PIN1) does not need to connect to the GND of the calibration board.

IO Mode: MODE=L, SPI_CS=H.



Figure 1.16 : PL7413 UART Communication

1.1.8.3 PL7413 I2C Communication

Calibration board setting

You can reference below bitmap to change the interface connect via I2C,

Please set Calibration Jump as follow : Bottom board: CON18 : Open CON24: Open CON22: Short CON28: Short



Figure 1.17 : Calibration bottom board for I2C



Top Board: DIP3 \rightarrow (reference red arrow)





PL7413 demo board J9 through by the I2C interface connect to the calibration board. J9-CAL_Sts(PIN1) does not need to connect to the GND of the calibration board. IO Mode: MODE=H, SPI_CS=H.



Figure 1.19 : PL7413 I2C Communication



1.2 Start SPI Communication

legister 1500	epointoad Config	1	V11	MP	_	Mea	surv	e													
Interface >	COTP >	[*	Reg	ist	er	Tab	le	`				, 1	814	ock	01	P		•	High By	te Addr	1 00
1	0000		0	1	2	3	4	5	6	7	8	9	A	8	c	D	E	1	8x88 +	0x20	
Connect	D1 D2 D3 D4	0								-			-				-		Write	Clear	Read
Open-1	step2	1																	Write	Clear	Read
Close-1	Clear Read	2																	Write	Clear	Read
Connect		3																_	Write	Clear	Read
Open-2	C DSP >	4	4																Write	Clear	Read
Class 2	Addr	5		-	-	_			1		-	1	-	-	-	-	1	_	Write	Clear	Read
Close-2	3000	6		_	_	_		_			_	_	_	_	_	_	-	_	Write	Clear	Read
Connect	D1 D2 D3 D4	7	1	-	-	-	_	_	_	_	_	_	-	-	-	_	-	_	Write	Clear	Read
Open-3	00 00 00 00		0	1	2	3	4	5	6	7	8	9	A	B	C	D	ε	F			26
Close-3	D5 D6	8								1									Write	Clear	Read
elect DUT	00 00	9		1	-	_			_		-	-	-	1	1	-	1	_	Write	Clear	Read
	Write Glear Read	A		-	-	_		-	_		-	-	-	-	-	-	-	_	Write	Clear	Read
DUT 01	step3	B	+	-	-	-		-	-		-	-	-	-	+	-	+	-	Write	Clear	Read
DUT 02	CEG >	C	+	-	-	-	-	-	-	-	-	-	-	+	+	-	+		Write	Clear	Read
	Addr 01	0	+	-	-	-	-	-	-	-	-	-	-	+	+	-	+-	-	Write	Clear	Read
DOT 03	3800 00	3	+	+-	+	-	-	-	-	-	-	+	+	+	+	+	+	-	Write	Clear	Read
		110-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Write	Clear	Kead
Mode int >	Write Clear Read	T	est	0×	00-	0×F	F		10	DSP	En	abl	Le (Che	ck				all	all	all
Read Mode	< RO/PROG >	-	DSP	En	abl	.e >		1													
Mode >	Addr pt		On		0	ff															
SPI .	4998 - 49	1	-	-	-		-														
	stepa	F.	Boa	rd	Fw.	Ver	>			_											
RESET >	Write Clear Read			1601	115	91	5	st	er	17											
Success	< GPIO Select>	-	-					1													
do	2 P2.0 - 2 P2.4			te	st																
IE Test >	ST02125 22:6	-	_					<u></u>													
Current of	0 P2.3 0 P2.7		Ana	log	Ke	ev.	A	nal	log	Mod	le	1									
Success	[GPIO]	1				-															
Test	ST DO High																				
		1																			
	Relay Output		De	vic	e S	eled	t		1												
						1.1.1															

Figure 1.20 : SPI communication Test

1.2.1 SPI Communication Test, Please refer to Step 0 ~ Step5,

- Step 1 : Select "Register" Page
- Step 2 : Open USB
- Step 3 : Select DUT
- Step 4 : Select "SPI" Interface
- Step 5 : Press "Reset" button to Reset PL7413
- Step 6 : Click "Test" to check the devices SPI connect Well.

It will auto test the interface (Communication) appear Pass" green word.

Note:

For Multi-device ,the Serial Number will different,

EX : DUT01 : Serial Number is 0001

DUT02 : Serial Number is 0002

DUT03 : Serial Number is 0003



1.2.2 Single or Multi-device Calibration Select , Please refer to Step 1 ~ Step 3,

- Step 1 : Select "1V1I MP" Page
- Step 2 : Select "Search USB Device", If you device ready will show green
- Step 3 : Press "Connect" button to connect with PL7413, If connect OK, will show green word" Success" .
- Step 4 : Press "Reset" to reset PL7413
- Step5 : Press "Test" button . If Interface test OK will show green word "Pass"
- Note1 : If you connect three calibration board and test well , We will depend on your select to do the calibration

If you select USB device "1", AP will show DUT 01

If you select USB device "2", AP will show DUT 01 and DUT02

If you select USB device "3", AP will show DUT 01 and DUT02 and DUT03

Note2: If make sure DUT and calibration board connect well,

You can ignore above step, Direct press "Auto Calibration" button, AP will do above of them.

Stendard Meter Data Step1 V A Phase V N OFF Auto Calibration PL7413-AutoLearn ierial Number 01 Serial Number 02 001 Serial Number 03 001 AEEAVMHOCPAutoLearn 001 02: NA 03: NA AEEAVMHOCPAutoLearn Search USB Device 1: NA Calibration :NA Test Point 1:NA Test Point 1:NA Search USB Device 2: NA Calibration :NA Test Point 1:NA Search USB Device 2: NA Test Point 1:NA Test Point 2:NA Search USB Device 2: DUT 01 DUT 02 DUT 03 USB Connect 01 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0:	Register Export-Download Conf	ig 1V1I MP Measure 1V1I Cal Er	ng Debug	
Serial Number 01 Serial Number 02 001 001 <th>itandard Meter Data V A Pr</th> <th>ase W ON OFF</th> <th>Auto Calibration PL74</th> <th>413-AutoLearn</th>	itandard Meter Data V A Pr	ase W ON OFF	Auto Calibration PL74	413-AutoLearn
D1: NA O2: NA O3: NA Calibration :NA Test Point 1:NA Test Point 2:NA DUT 01 DUT 02 DUT 03 Search USB Device Search USB Device Start Start Start Test Point 1:NA Test Point 2:NA DUT 01 DUT 02 DUT 03 Start Start <th>Gerial Number 01 001</th> <th>- Serial Number 02 001</th> <th>-Serial Number 03-</th> <th><pl7411 mode=""> AFE+AVM+OCP+AutoLearn <</pl7411></th>	Gerial Number 01 001	- Serial Number 02 001	-Serial Number 03-	<pl7411 mode=""> AFE+AVM+OCP+AutoLearn <</pl7411>
Calibration :NA Test Point 1:NA Test Point 2:NA DUT 01 Calibration :NA Test Point 1:NA Test Point 2:NA DUT 02 DUT 03 Calibration :NA Test Point 1:NA Test Point 2:NA DUT 03 Calibration :NA Test Point 1:NA Test Point 2:NA Calibration :NA Test Point 1:NA Test Point 2:NA Connect 01 02 03 Success NA NA Step3 Connect Connect Discon Discon Discon)1:NA	02:NA	03 :NA	Search USB Device
Test Point 2:NA Test Point 2:NA DUT 02 DUT 03 DUT 01 DUT 02 DUT 03 USB Connect 01 02 03 Success NA Step3 Success NA Connect NA Step3 Success NA Discon NA Discon Discon Discon Discon Discon	Calibration :NA Test Point 1:NA	Calibration :NA Test Point 1:NA	Calibration :NA Test Point 1:NA	3 - Start _{step2}
DUT 01 DUT 02 DUT 03 DUT 03 DUT 03 DUT 03 DUSB Connect 01 02 03 Success NA NA Step3 Connect Connect Discon Discon Discon	Test Point 2:NA	Test Point 2:NA	Test Point 2:NA	<mark>01</mark> 02 03
USB Connect 01 02 03 Success NA NA Step 3 Connect Connect Discon Discon Discon	OUT 01	DUT 02	DUT 03 ^	
Image: Supersonal system Image: Superson				USB Connect
Discon Discon Discon				01 02 03 Success NA NA
Discon Discon Discon				Connect Connect
, Interface Test				Discon Discon
		<	4	Interface Test
UT 01 Meter A DUT 02 Meter A DUT 03 Meter A 01 02 03	UT 01 Meter ^	DUT 02 Meter Voltage(V)	DUT 03 Meter A Voltage(V)	01 02 03
Outget(Y) Current(A) Current(A) Pass NA nwer(W) Power(W) Power(W) Power(W)	urrent(A)	Current(A) Power(W)	Current(A) Power(W)	Pass NA NA
F PF Test Test req(Hz) Freq(Hz) Freq(Hz) Step 5 Test	F req(Hz)	PF Freq(Hz)	PF Freq(Hz)	5 Test Test Test
F Count CF Count CF Count CF Count Reset	F Count WH(W)	CF Count KWH(W)	CF Count KWH(W) Ster	A Reset Reset Reset
voltage(%) voltage(%) voltage(%) urrent(%) Current(%) Current(%) power(%) Power(%) Power(%)	oltage(%) urrent(%)	Voltage(%)	Voltage(%) Current(%) Power(%)	

Figure 1.21 : SPI communication and Device Select



1.3 Troubleshooting

1.3.1 Check "USB" CONNECT FAIL (Figure 1.9)

- 1. Please check the PC Device Management , calibration board driver is install and connect correct..
- 2. Please check "USBXpress Device" driver status is correct.

Device version 4.0.0.0 for WIN8/WIN7/WINXP.

Register Export-Download Config	1V1I MP Measure 1V1I Cal En	g Debug	
Standard Meter Data V A Phas	e W ON OFF	Auto Calibration PL74	413-AutoLearn
Serial Number 01	Serial Number 02 001	-Serial Number 03 001	<pl7411 mode=""> AFE+AVM+OCP+AutoLearn ></pl7411>
01: NA Calibration :NA Test Point 1:NA Test Point 2:NA	02: NA Calibration :NA Test Point 1:NA Test Point 2:NA	03: NA Calibration :NA Test Point 1:NA Test Point 2:NA	Search USB Device
DUT 01	DUT 02	DUT 03	$\overline{\bullet}$ $\overline{\bullet}$ $\overline{\bullet}$

Figure 1.22 : Connect fail for "USB"



Figure 1.23 : Check USB connect









1.3.2 Check process for Interface communication fail (Figure 1.12)





Figure 1.26 : PL7413 Pin diagram(QFN24)



1. Please check calibration board connect to PL7413 demo board status. (Figure 1.14).



Figure 1.27 : Calibration board connect Pin information

2. Check the pin (Reset, VPP, GND, VDD, DO, DI, CLK, CS) from Calibration board connect to SPI of PL7413 demo board

Please reference Section 1.1.8.



1.4 Verify DSP Firmware Information

1.4.1 Project name and CFG Code/DSP Code/RO Codes names

If you have the some projects, you can modify the project name to discriminate them. Maybe the DSP codes

will not the same, also you can modify CFG Code/DSP Code/RO Cods names.

Please open Explorer_Config.ini for modifying them:

State S
檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)
[Global]
Project Information=PL7413-AutoLearn //PL7211-PL7411-PL7413
Project_Version=PL74II-MultiPort-AP-I-2-1(MultiPort-20170426)
FUNCTION_Mode=AFE+AVM+OCP+AutoLearn
//AFE+AVM+UCP+AutoLearn Function ************************************
AutoLearn_CFG_Code=CFG_20161028_1_CAL_No_Load.rom;
AutoLearn_RO_Code=RO_20161028_2_CAL_No_Load.rom;
AutoLearn_DSP_Code=DSP_OTP_v4_ZX_Auto_Learn_20161028_3.rom;
Win Einvertoer (Beakage Function
Leakage_CFG_Code=CFG_20160914.rom;
Laskaga DO Cada-DO 20160014 raws

Executive Exploer_Engineering_AP.exe, you can see the project name in the upper right corner:

Standard M	Neter Data V A Ph:	se W ON OF	F Auto C	alibration PL'	7413- A	lutol	Learn
Serial Num	ıber 01	-Serial Number 02	Serial	Number 03	- <pl7411 mod<br="">AFE+AVM+O</pl7411>	l e > CP+AutoLear	n v
01 :	NA	02:	NA 03:	NA	Search US	6B Device	
	Calibration :NA Test Point 1:NA Test Point 2:NA	Calibra Test Po Test Po	tion :NA	Calibration :NA Test Point 1:NA Test Point 2:NA	3 ~	Star 02	E
DUT 01	ŕ	DUT 02	^ DUT 03				
					USB Conne	:t	
					01	02	03
					NA	NA	NA
					Connect	Connect	Connect
					Discon	Discon	Discon
			· ·		- Interfac	e Test	
	Notor	DUT 02 Meter	A DUT 03	Meter	01	02	03
Voltage(V)	Meter	Voltage(V)	Voltage(Λ <u></u>			
Current(A)		Current(A)	Current(A)	NA	NA	NA
Power(W)		Power(W)	Power(W		Test	Test	Test
PF		PF Frog(Hz)	PF Erog(Hz)		lest	lest	Test
Freq(Hz)		CE Count	CE Count				
CF Count		KWH(W)	KWH(W)		Reset	Reset	Reset
Voltage(%)		Voltage(%)	Voltage(S	6)			
Current(%)		Current(%)	Current(%)			
Power(%)	-	Power(%)	T Power(%)		Ŧ		

 Register
 Export-Download
 Config
 1V1I MP
 Measure
 1V1I Cal Eng
 Debug



1.4.2 CHECK CFG CODE, DSP CODE AND RO CODE PATH

please refer to Figure 1.15.

⊘ ⊽ <mark>⊯</mark> ⊧ ¹	電腦 ▶ 本機磁碟((C:) ▶ Explorer ▶ Multi ▶ AFE ▶ AFE+A	VM+OCP+AutoLearn	CFG		
(F) 編輯(E)	檢視(V) 工具(T)) 說明(H)				
à管理 ▼	加入至媒體櫃 ▼	共用對象 ▼ 新増資料夾				
我的最愛	^ *	2稱	修改日期	類型	大小	
볃騁梄		CFG_20161028_1_CAL_No_Load.rom	2016/10/27 下午	ROM 檔案	1	KB
лка≘нд Э.÷.ин						_
x() # #()		ﷺ (C:) ▶ Explorer ▶ Multi ▶ AFE ▶ AFE	+AVM+OCP+AutoLearr	n ▶ DSP		
Hell) Marrie	, <u>(x))(()</u>					
且合管理 ▼	加入至媒體櫃 ▼	共用對象 ▼ 新増資料夾				
숡 我的最愛	<u> </u>	名稱 ^	修改日期	類型	大小	
篇 煤體櫃 ■ 文件 ■ 音樂		DSP_OTP_v4_ZX_Auto_Learn_2016102	2016/11/7 下午 0	ROM 檔案		5 KB
	電腦 ▶ 本機磁码	ឌី (C:) ▶ Explorer ▶ Multi ▶ AFE ▶ AFE+	AVM+OCP+AutoLearn	• RO		
柴(F) 漏輯(E)	磁視(V) ⊥具((I)				
1合管理 ▼	加入至媒體櫃 🔻	共用對象 ▼ 新増資料夾				
👆 我的最愛	Â	名稱	修改日期	類型	大小	
> 媒體櫃 ■ 文件 ▶ ↔↔	L	RO_20161028_2_CAL_No_Load.rom	201(<mark>/</mark> 12/1 下午 0	ROM 檔案		2 KB

Figure 1.28 : CFG/DSP/RO code path



1.4.3 Check DSP firmware code information

Open the "DSP.Rom" to check the information on last line.

DSP_OTP_v4_	ZX_Auto_L	earn_2016	51028_3.rom	記事本
檔 <mark>案(F) 編輯(E)</mark>	格式(O)	檢視(V)	説明(H)	
f8054124				
487f3a62				
f8d52ala				
JUSCAUDZ				
203ca162				
287ca162				
08f82e24				
08f92e24				
58f82e24				
58792124 fbfd2a2a				
fc7d76ee				
f8fd3f2a				
000080f4				
f8fd3f2a				
8000b0f5				
181d312a 187f2f1				
1071510e 10fe2e04				
08fe2e04				
10fe2e04				
18fe2e04				
DOff2e04				
J8ff2e04				
JUICZEU4 18fc2c04				
20fc2e04				
28fc2e04				
20f82e04				
28f82e04				
30f82e04				
181dZeU4 fe2daoff				
1050C011 f8fd3f2a				
0000e0fd				
0004e0fd				
d8c53f2a				
c04d002c				
dUfdbeU4				
cordaeu4 78fa2a04				
f0f92e04				
f0fe2e04				
48b9010e				
f89daala				
fbfdea38 6-950-04				
IC052004				
f83dc0df				
f8fd3f2a				
181d312a				
10103128 f8fd3f2g				
161028 a				

Figure 1.29 : DSP.rom content



1.4.4 Read DSP Firmware information with AP

Block is "RAM" and high byte address is 0x2F, Refer to "PL7413 register" Page , Operation method at next chapter .

PE/411-WultiPort-A	P-1-2-1(MultiPolt-20170426)(DS	P_01	v4_2	.X_AU	1 .	earn	_2010	102	.8_3.I	om)	- [EX	pioe	r Keç	gister	For	m] 					
Register Expo	ort-Download Config	1	.V11	MP		leas	sure		10	11	Cal	Eng	5	De	bug						
Interface >-	< OTP >	[<	Reg	iste	er 1	ab)	le :	>					B1o	ck:	DSP	Pro	gran	n 🔻	High By	te Addr:	2f
	0000		0	1	2	3	4	5	6	7	8	9	A	в	с	D	E	F	0x28 -	0x2F	
Connect	D1 D2 D3 D4	0	FC	A5	16	1A	FB	BD	30	27	FC	ØD	40	ØC	30	BE	71	22	Write	Clear	Read
Open-1	00 00 00 00	1	F8	45	01	0 4	48	87	01	22	F8	05	41	24	48	7F	ЗA	62	Write	Clear	Read
Close-1	Clear Read	2	F8	D5	2A	1A	00	ЗC	A0	62	0 8	7C	A0	62	20	ЗC	A1	62	Write	Clear	Read
Disconnect		3	28	7C	A1	62	0 8	F8	2E	24	0 8	F9	2E	24	58	F8	2E	24	Write	Clear	Read
Open-2	r≺ DSP >	4	58	79	21	24	FB	FD	2C	ЗE	FC	7D	76	EE	F8	FD	ЗF	2A	Write	Clear	Read
Class 2	Addr	5	00	00	80	F4	F8	FD	ЗF	2A	80	00	B0	F5	F8	FD	3F	2A	Write	Clear	Read
Close-2	3000	6	18	7F	3F	BE	00	FE	2E	04	08	FE	2E	04	10	FE	2E	04	Write	Clear	Read
Disconnect	D1 D2 D3 D4	7	18	FE	2E	04	00	FF	2E	04	08	FF	2E	04	00	FC	2E	04	Write	Clear	Read
Open-3	00 00 00 00		0	1	2	3	4	5	6	7	8	9	Α	В	C	D	E	F			
Close-3	D5 D6	8	08	FC	2E	04	20	FC	2E	04	28	FC	2E	04	20	F8	2E	04	Write	Clear	Read
alect DUT	00 00	9	28	F8	2E	04	30	F8	2E	04	F8	FD	2E	04	F8	3D	C0	FF	Write	Clear	Read
	Write Clear Read	A	F8	FD	3F	2A	00	00	E0	FD	00	04	E0	FD	D8	C5	3F	2A	Write	Clear	Read
DUT 01 2		B	CØ	4D	00	2C	D0	FD	6E	04	C8	FD	AE	04	78	FE	2E	04	Write	Clear	Read
DUT 02			FØ	F9	2E	04 	F0	FE	2E	04	48	B9	01	0E	F8	9D	AA	1A	Write	Clear	Read
	Addr p1	D	FB	FD	EA	38	FC	85	2E	04	28	3F	00	9E	F8	3D	00	DF	Write	Clear	Read
001 05	3800 00		F8	FD	31	2A 24	F8	FD	31	2A	F8	FD	31	2A	16	FD	35	2A	Write	Clear	Read
			FO	FU	5F	ZA	го	FU	DF	ZA	FO	FU	эг	ZA	10	10	20	ZA	Write	Clear	Kead
Mode inf >	Write Clear Read		est	ØxØ	90~0)×FI				SP	Ena	abl	e C	hec	k	8			all	all	all
Read Mode	< RO/PROG >	_<	DSP	Ena	able	• >															
Mode >	Addr D1		0n		01	ff															
RESET >	Write Clear Read	~	Boar	rd F	w \	/er	>														
Success			0	000	999	0															
do	4	Analog Key																			
IF Test >		A	nalo	og M	lode																
Test	5																				

Figure 1.30 : DSP firmware information in DSP RAM

Address: 0x2FFC~0x2FFE indicate HEX "16 10 28" It 's mean DSP firmware Information 2016/10/28



1.5 **PL7413 Register Operation Method**

1.5.1 **OPERATION PROCESS**

PL7413 OTP and Register mapping, please refer to Figure 1.21 ~ Figure 1.23. As below is inquire PL7413 data table process, please refer Figure 1.24 :

Step 0 : Select "PL7413 Register" Page

- Step 1 : Select DUT
- Step 2 : Press "Reset" button to Reset PL7413
- Step 3 : Click "Test" to check the devices SPI connect Well. It will auto test the interface appear "Pass" green word.
- Step 4 : Select inquire "Block" for OTP(OTP memory), DSP Program(DSP Code RAM), DSP(DSP Buffer), RAM CFG (Configuration Register), RAM DSP RO.
- Step 5 : Select high byte for inquire "Block" address.
- Step 6 : Click "Read All" button for "Block", so you can know PL7413 data table information

DCD Data data da manager (DO)	0x43FF
DSP Kead only memory (KO)	0x4000
CFG	
	0x3800
	0x3000
Dsp program code (2K Byte)	0,5000
Ok eta 1 1000 information klask	0x2800
ok ow + 1200 information block	0x0000

 address decode 		real address position
• 0x0000~0x27FF	: 8k OTP + 128B	(0x0000~0x207F)
• 0x2800~0x2FFF	: 2k dsp prog	(0x2800~0x2FFF)
• 0x3000~0x37FF	: 2k dsp buf	(0x3000~0x317f)
• 0x3800~0x3FFF	: 2k cfg	(0x3800~0x39FF)
• 0x4000~0x43FF	: 1k dsp ro	(0x4000~0x43FF)

Figure 1.31 : PL7413 (Register + OTP) Mapping



Figure 1.32 : OTP memory mapping diagram



Check PL7413 OTP information –1

Step 0 : Select "Measure" Page

Step 1 : Press "Read" button to Read PL7413 OTP information and DSP version

Step 2 : Check DSP usage Last version DSP is in Bank#2

7411 MultiPort AP 1.0.0(DSP 2016/04/21_2)	- [Measure Mode]					
ister Export-Download Con	fig 1V1I MP	Measure 1				
wer source control V I Freq 120.0 v 5.0 v 60	PF ▼ 1.0 ▼ C	DN OFF				
andard Meter V A Phase	• W					
Metering Data	02 Metering Da	ta	03 Metering Da	ta	-01	02
Read Timing : 1 🗸 (Second)	Read Timing : 1	↓ (Second)	Read Timing : 1	↓ (Second)		UL I
Read Start Read Stop	Read Start	Read Stop	Read Start	Read Stop	² Read	Read
Reset	Reset		Reset		2016/04/21	
DUT Item DUT 01	DUT Item	DUT 02	DUT Item	DUT 03		
Voltage(V)	Voltage(V)		Voltage(V)		RO DATA#3 0x207F	R0 DATA#3 0x207F
Current(A)	Current(A)		Current(A)		RO DATA#2 0x1P00	R0 DATA#2 0x1D80
Power(W)	Power(W)		Power(W)		DSP PR0G #1 0x1C00	DSP PROG #1 0x1C00
ver Factor(PF)	Power Factor(PF)		Power Factor(PF)	3	DSP PROG #1	DSP PROG #1 0x1400
requency(Hz)	Frequency(Hz)		Frequency(Hz)		DSP PROG #1 0x0400	DSP PROG #1 0x0400 CFG DATA #4
CF Count	CF Count		CF Count		CFG DATA #3 0x0300 0x0200	CFG DATA #3 0x0300 0x0200

Figure 1.33 : PL7413 OTP information

Check PL7413 OTP information –2

Step 0 : Select "PL7413 Register" Page, as operation method

Step 1 : Select Block "OTP " And write the DSP Bank#2 address 0x13xx

Step 2 : Press "Read all" button to Read PL7413 OTP information

Step 3 : Check DSP version in OTP address is in 0x13FC~0x13FF

Register Exp	port-Download Config	1V1I MP Measure	
< Interface >		r< Register Table >	
USB 👻	Addr	Block: OTP High Byte Addr: 13 S	Step1
	0000	0 1 2 3 4 5 6 7 8 9 A B C D E F 0x80 - 0x20	SP Bank2
Connect	D1 D2 D3 D4	0 F8 FD 3F 2A Write Clear Read	
Open-1	00 00 00 00	1 F8 FD 3F 2A Write Clear Read	XUCUU-UX14UU
Close-1	Clear Read	2 F8 FD 3F 2A Write Clear Read	
Disconnect		3 F8 FD 3F 2A Write Clear Read	
Open-2	< DSP >	4 F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A Write Clear Read	
Close-2	Addr	5 F8 FD 3F 2A F1 FD 7F 7F 2A F1 FD 7F	
	3000	6 F8 F0 3F 2A Write Clear Kead	
Disconnect	D1 D2 D3 D4	7 TO TO ST 24 WFITE CLEAR READ	
Open-3	00 00 00 00		
Close-3	05 06	6 76 70 37 24 76 70 37 24 76 70 37 24 76 70 37 24 76 70 37 24 Write Clear Read	
Select DUT		A F8 FD 3F 24 F8 FD 3F 24 F8 FD 3F 24 F8 FD 3F 24 Write Clear Read	
OUT 01	Write Clear Read	B F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A Write Clear Read	
		C F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A Write Clear Read	
O DUT 02	< CFG >	D F8 FD 3F 2A Write Clear Read	
C DUT 03	Addr D1	E F8 FD 3F 2A Write Clear Read	
	3800 00	F F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A F8 FD 3F 2A 16 04 21 2A Write Clear Read	
< Mode inf >	Write Clear Read	Test 0x00x0xEF	an2
		2016/04/21	·P2
Kead Mode	< RO/PROG >	< DSP Enable >	
< Mode >	Addr D1	On Off	
UART -	4000 00		
PESET >	Withol Clean Based	< Board Fw Ver >	
Current C	write clear keau	0000000	
Success	-		
		test	
< IF Test >-			
Success		Analog Key Analog Mode	
Test			
	Relay Output	Device Select	
	1 - Select	1 - Select	





2. Auto Calibration

2.1 Introduction

This document describes how to use the Multi-Device calibration AP to do the calibration for the application based on PL7413 chips.

2.2 Environment Setup

Please executive PL7413 Multi MP Tool.msi

After Install complete, In folder(C :\Program Files\Prolific\PL7413 Multi MP Tool). Will exist 4 file
 --"hscom.dll", "Three_PL7413_Config.ini", "PL7221AfeOcpMulti.EXE " and "SiUSBXp.dll" together.

2. Check file "DSP.rom" and "CFG.rom" inside folder in following path:

-->C:\PL7413\Multi\AFE\CFG\CFG_20141009.rom

-->C:\PL7413\Multi\AFE\DSP\DSP_20141009.rom

2.3 **Power Source Connection**

2.3.1 Voltage Connection

KP1001 has 4 Voltage lines(U1~U4), HS3103 has 3 Voltage lines(U1~U3). Please connect U1(+,-) to product 1; U2(+,-) to product2; U3(+,-) to product3.

Please reference the next page.

2.3.2 Current Connection

KP1001 and HS3103 has 1 current line(I). Please connect "I-" to product1, connect "I+" to product3. And uses the series connection method to connect product 1 to product2 to product 3;

Please reference the next page.



Figure 2.1 : Power Source Connect





Figure 2.2 : PL7413 device Connect with Power Source Block Diagram

2.4 Initialize Setting

Initialize Settings(Three_PL7413_Config.ini)

[Global]

Input_Key_Eable=true;

(1). If you don't want to input and modify the power, accuracy limit and target values setting, please set: Input_Key_Eable=false;

(2). If your PL7413 board has not the crystal, please select Inter OSC.



Figure 2.3 : Initialize setting



2.5 Configure Setting

1. Set the accuracy limit:

PL7411-Muli	tiPort-AP-1-2-1(MultiPort	-20170426)(DSP	_OTP_v4_ZX_Auto	o_Learn_201610	28_3.rom) - [Cor	nfiguration Mode]	
Register	Export-Download	Config	1V1I MP	Measure	1V1I Cal	Eng Debug	
-≺ DUT Cali Step1: P Calibra	bration Condition ower Source Sett tion Power Setting V 230 100	> ing. 5 Test Point I • 5.00 • % 100 %	: 1 Test Poi Freq Pi 50 - 0.5	nt 2 F			Power Source selection: HS3103 • Accuracy Limit COM Setting 3 • % COM9 • < Function >
							AFE+AVM+OCP+AutoLearn -

Figure 2.4 : Accuracy Setting

2. Power source setting :

Use HS3103 as power source, and select the RS232 COM port:

Register Export-De	ownload Config	1V1I MP Measure	1V1I Cal Eng Debug	
DUT Calibration Co Step1: Power Sour	ondition >			Power Source selection:
Calibration Power	V I 230 - 5.00 -	1 Test Point 2 Freq PF 50 + 0.5L +		HS3103 - Accuracy Limit COM Setting 3 - % COM9 -
	100 % 100 %			< Function > AFE+AVM+OCP+AutoLearn >

Figure 2.5 : Power Source COM port setting

3. Power Source Calibration Point Setting

4. Test Point 1 & 2 setting (for HS-3103 & KP1001, "NA" will not support)

Figure 2.6 : Save Setting



2.6 Calibration Process with the "NA" Power Source

- 1. If you have other power source, please select the "NA" power source type
- 2. If you just want to try it , not burn the codes into OTP, please enable "Calibration Test(No Burn)" in Function Setting. Else it will burn the codes into OTP after auto calibration success.
- 3. Select the "Production" form
- 4. Please follow the steps below.
 - Step1 : Key-in the serial number1~3.
 - Step2 : Wait your power source stable, then input the power information (V/I/Phase/W) in "Stand Meter

Data"

Step3 : Press button "Auto Calibration" Start.

Step4 : If the calibration pass, will show "PASS"

oreandered merce	r vata			steps	DIRA						
120.0 V 5.0	0 <mark>A</mark> 60.0 Ph	asc 300.0 W	step2	uto Calibrat	$_{ion}$ PL74	13-A	utol	learn			
						•					
Serial Number	01	Serial Numbe	er 02	Serial Num	iber 03	<pl7411 mo<="" th=""><th>de ></th><th></th></pl7411>	de >				
DUT1-001	step1	DUT2-001		DUT3-001		AFE+	AFE+AVM+OCP+Leakage 👻				
-	100 C										
91 .	PASS	02.	PASS	03.	PASS	Search USB Device					
						bear cir o	Device				
Ca	libration :OK		Calibration :OK		Calibration : OK						
Te	st Point 1:NA	step4	lest Point 1:NA		Test Point 1:NA	3 -	Star	t			
2016/04/21 Te	st Point 2:NA	2016/04/21	Test Point 2:NA	2016/04/21	Test Point 2:NA	01	02	03			
Start Date + 30	16/6/24 77 05-0	Start Date :	2016/6/24 77 05-0	A Start Date	· 2016/6/24 TA 054						
DUT 01 serial r	number : DUT1 D	DUT 02 seria	1 number : DUT2 D	DUT 03 se	rial number : DUT3 D						
Accuracy Limit	: 3 (%)	Accuracy Lim	it : 3 (%)	Accuracy L	mit : 3 (%)			$\overline{}$			
Step 1 : Initial	Process	Step 1 : Initi	al Process	Step 1 : In	itial Process	USB Conne	c+				
>DUT 01 C	heck USB Connec	>DUT 02	Check USB Connec	>DUT	03 Check USB Connec	01	07	02			
Auto Step 2 : L	JownLoad DSP Pro	Auto Step 2	: DownLoad DSP Pre	Auto Step	2 : DownLoad DSP Pr	01	02	05			
->Write RO Re	nister Start	->Write RO	Register Start	->Write R	C Register Start	NA	NA	NA			
>Write DSI	P RAM Start	->DUT Relay	Turn On Setting	->DUT Rel	ay Turn On Setting		114	ine.			
->DUT Relay T	urn On Setting	->DUT Relay	Turn On PASS	->DUT Rel	ay Turn On PASS	Connect	Connect	Connect			
->DUT Relay T	urn On PASS	DSP version	: 2016/04/21	DSP versio	n : 2016/04/21	connect	connect	connect			
DSP version : 4	2016/04/21										
						Discon	Discon	Discon			
		10				-					
٠ III	, ,			*		Interfac	e Test				
DUT 01	Matar	DUT 02	Meter	DUT 03	Meter	01	02	03			
Voltage(V)	119 991	Voltage(V)	120.065	Voltage(V)	119.991						
Current(A)	5.001	Current(A)	5.001	Current(A)	5.001	NA	NA	NA			
Power(W)	300.603	Power(W)	300.593	Power(W)	300.513						
PF	0.501	PF	0.501	PF	0.501	fest	lest	lest			
Freq(Hz)	59.976	Freq(Hz)	59.991	Freq(Hz)	59.991	1	1	1			
CF Count	0	KWH(W)	0 000	KWH(W)	0 000	Reset	Reset	Reset			
KWH(W)	0.000	Voltage(%)	-0.038	Voltage(%)	-0.100						
Voltage(%)	0.008	Current(%)	0.011	Current(%)	0.004						
Power(%)	-0.031 *	Power(%)	-0.035	Power(%)	-0.061 *						

Figure 2.7 : Select "NA" Meter Data setting

Note : If your power source have Phase input(Ex: PF=0.5L, Input Phase=60°), Please input as you need, Else input Phase=0 (PF=1.0).



2.7 Calibration Process with the "HS3103" Power Source

1. Please select the "HS3103" power source type

If you can control the "HS3103" (power source + USB to UART standard meter), please follow the steps below.

Step1 : Select COM setting

Step2 : Set "Accuracy Limit(%)" according to your requests.

Step3 : Select Power Setting at "Power Source Calibration Point Setting", "Test Point1" and "Test point 2"



Figure 2.8 : HS3103 Setting

Step4 : Press button "Auto Calibration" Start

Step5 : Here will show voltage, current, phase and instantaneous power that read from HS3103.

Step6: If the calibration pass, they will show "PASS"

Note: You just setting the Step1, Step2 and Step3 one time. then Press

"Save Setting" button, Next Execute the AP the parameter will the same.

Register E: Standbro He 120.0 V	xport-Download	Config Pha	1V1I MP	Measure Step2 _{FF}	Auto	step3	PL	741	3-A	utoL	learr		
Serial Numb	er 01	_	Serial Numb	er 02		Serial Numbe	r 03		- <pl7411 mod<="" th=""><th>• ></th><th></th></pl7411>	• >			
DUT1-001	step1		DUT2-001			DUT3-001			AFE+AVM+OCP+AutoLearn -				
01.	PASS 02 PASS					.	PASS		Search USB Device				
2016/10/28	Calibration Test Point 1 Test Point 2	: 0K : NA : NA	step4	Calibration : Test Point 1: Test Point 2:	ok NA NA	2016/10/28 T	alibration est Point 1 est Point 2	: <mark>OK</mark> L: NA 2: NA	3 - 01	Start 02	e 03		
Start Date : 2016/6/24 下午 05:(- DUT 01 serial number : DUT1_D Accuracy Limit : 3 (%) Step 1 : Initial Process >DUT 01 Check USB Connec Auto Step 2 : DownLoad DSP Prr ->Write CFG Register Start					ec Pro	Start Date : 2 DUT 03 serial Accuracy Limi Step 1 : Initia >DUT 03 Auto Step 2 : ->Write CFG	2016/6/24 下午 number : DUT t : 3 (%) al Process Check USB Coo DownLoad DS Register Start	05:(^ -3_D	USB Connect 01 02 03				
->Write RO >Write I ->DUT Relay ->DUT Relay	Register Start DSP RAM Start Turn On Setting Turn On PASS	,	->Write RO ->DUT Relay ->DUT Relay DSP version	Register Start / Turn On Setting / Turn On PASS : 2016/04/21		->Write RO R ->DUT Relay ->DUT Relay DSP version :	egister Start Turn On Settir Turn On PASS 2016/04/21	g	NA Connect	NA Connect	NA Connect		
DSP version	. 2010/04/21								Discon	Discon	Discon		
		-			-			-	Interface	Test			
	l	-	DUT 02	Meter	*	DUT 03	Meter	*	01	02	03		
Voltage0/0	Meter 119.991	- î	Voltage(V)	120.065		Voltage(V)	119.991						
Current(A)	5,001		Current(A)	5.001		Current(A)	5.001		NA	NA	NA		
Power(W)	300.603		Power(W)	300.593		Power(W)	300.513		L	1 1	1 1		
PF	0.501		PF	0.501		PF	0.501		Test	Test	Test		
Freq(Hz)	59.976		Freq(Hz)	59.991		Freq(Hz)	59.991						
CF Count	0		CF Count	0		CF Count	0		Reset	Reset	Reset		
KWH(W)	0.000		KWH(W)	0.000		KWH(W)	0.000						
Voltage(%)	-0.100		Voltage(%)	-0.038		Voltage(%)	-0.100						
Current(%)	0.008		Current(%)	0.011		Current(%)	0.004						
	0.004		21	1-11 11 222									

Figure 2.9 : HS3103 Calibration



2.8 Calibration Process with the "KP1001" Power Source

1. Please select the "KP1001" power source type

If you can control the "KP1001" (power source + USB to UART standard meter), please follow the steps below.

Step1 : Select COM setting

Step2 : Set "Accuracy Limit(%)" according to your requests.

PL7411 Multil	Port AP 1.0.0(DSP 2015/	1/06) - [Configu	ration Mode]		the strength of the strength o	
Register	Export-Download	Config	1V1I MP	Measure		
OCP Le	bration Condition ower Source Sett tion Power Setting 120.0 100 eakage AVM No	> ing. Test Point 5.0 - % 100 %	Freq 60 - 0	pint 2 PF .5L • DC		Power Source selection: (P1001 Accuracy Limit COM Setting 3 % COM6 Save Settings

Step3 : Select Power Setting at "Power Source Calibration Point Setting", "Test Point1" and "Test point 2"

Figure 2.10 : KP1001 Setting

Step4 : Press button "Auto Calibration" Start.

Step5 : Here will show voltage, current, phase and instantaneous power that read from KP1001.

Step6 : If the calibration pass, they will show "PASS"

Note : You just setting the Step1, Step2 and Step3 one time. then Press

"Save Setting" button, Next Execute the AP the parameter will the same.

Register Expo	rt-Download C	onfig	1V1I MP	Measure	step4				
Standard Meter 0.0 v0.0	Data 0 A 0.0	Pha	se <mark>0.0 W</mark>	ON OFF Aut	co Calibration	PL741	3-Au	toL	earn
Serial Number	01		Serial Number	n 02	Serial Number	03	- <pl7411 mod<="" td=""><td>• ></td><td></td></pl7411>	• >	
DUT1-001			DUT2-001		DUT3-001		AFE+A	oLearn -	
01:	PASS		02 :	PASS	03:	PASS	Search US	B Device	
Ca Te 2016/10/28	libration : st Point 1:1 st Point 2:1	<mark>dk</mark> Na Na	C T 2016/10/28	alibration : <mark>OK</mark> est Point 1:NA STEPD est Point 2:NA	Cinc Cinc Cinc Cinc Cinc Cinc Cinc Cinc	alibration : <mark>OK</mark> est Point 1:NA est Point 2:NA	3 - 01	Star 02	03
Start Date : 20 DUT 01 serial r Accuracy Limit	16/6/24 下午 05 number:DUT1_ :3 (%)	D =	Start Date : 2 DUT 02 serial Accuracy Limi	2016/6/24 下午 05:(number : DUT2_D t : 3 (%)	Start Date : 2 DUT 03 serial Accuracy Limit	016/6/24 下午 05:(^ number : DUT3_D : : 3 (%)			\bigcirc
Step 1 : Initial Process >DUT 01 Check USB Connec			>DUT 02	Check USB Connec	>DUT 03	Check USB Connec	USB Connec	t	
Auto Step 2 : [DownLoad DSP F	Pro	Auto Step 2 :	DownLoad DSP Pro	Auto Step 2 :	DownLoad DSP Pro	01	02	03
->Write RO Re	gister Start P RAM Start		->Write RO R ->DUT Relay	egister Start Turn On Setting	->Write RO R	egister Start Furn On Setting	NA	NA	NA
->DUT Relay T ->DUT Relay T	urn On Setting urn On PASS		->DUT Relay DSP version :	Turn On PASS 2016/04/21	->DUT Relay DSP version :	Furn On PASS 2016/04/21 tart	Connect	Connect	Connect
->Power On St [CalibrationPoi 120V, 5A, 60Hz	art nt Start] z, 0.5L		[CalibrationPo 120V, 5A, 60H	bint Start] Hz, 0.5L	[CalibrationPo 120V, 5A, 60H	int Start] Iz, 0.5L	Discon	Discon	Discon
m		*	٠	•	·	•	Interface	Test	
	Meter	-	DOT 02 Voltage(V)	120.065	Voltage(V)	MCICI	01	02	03
Surrent(A)	5.001		Current(A)	5.001	Current(A)	5.001	NA	NA	NA
Yower(W) YF	300.603 0.501		PF	0.501 step5	PF	0.501	Test	Test	Test
req(Hz)	59.976		CE Count	59.991	CE Count	0	1	1	
J Count	0 000		KWH(W)	0.000	KWH(W)	0.000	Reset	Reset	Reset
(oltage(%)	-0.100		Voltage(%)	-0.038	Voltage(%)	-0.100			
urrent(%)	0.008		Current(%)	0.011	Current(%)	0.004			
lower(%)	-0.031	-	Power(%)	-0.035 *	Power(%)	-0.061 *			

Figure 2.11 : KP1001 Calibration



2.9 Report Generator

Once the calibration is completed by the calibration AP, some data will be generated in the following path:

A: Report Data Path(.txt) --> "C:\Explorer\Calibration\Report\DUT_001.txt"

 $C:\label{eq:constraint} C:\label{eq:constraint} C:\l$

C:\Explorer\Calibration\Report\DUT_003.txt

Example:

DU11_0001.txt - 記事本
· 楢案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)
Start Date : 2016/3/11 <u>L</u> 47 10:25:03 DUT serial number : DUT_0001 Accuracy Limit : 1 (%)
V (%) I (%) W (%) CH:0 120V, 5A, 60Hz, 0.5L 0.027000(%), 0.011000(%), 0.038000(%), 120V, 0.1A, 60Hz, 1.0 0.027000(%), 0.550000(%), 0.273000(%), 120V, 10A, 60Hz, 1.0 0.027000(%), 0.083000(%), 0.132000(%),
PL7x11 Calibration Result : PASS VAGain : 0x0761 CH:0 IAGain : 0x3A27 CH:0 PAGain : 0x06B5 CH:1 PAGain : CH:1 PAGain : CH:2 PAGain : SampleCnt : 0x0F42 slRMS_SOms : 0x170DCFE7 OCP SMP : 0x00C3 CH:1 LTPUTH : CCP SMP : 0x00C3 CH:1 LTPUTH : CH:2 LTPUTH : CH:0 LTPUTH : CH:1 LTPUTH : CH:1 LTPUTH : CH:1 LTPUTH : CH:1 LTTH : CH:1 LTTH : CH:1 LTTH : CH:1 NoLoad_TH : CH:1 NoLoad_TH : CH:1 NoLoad_TH : CH:1 NoLoad_TH : TIARms : 00013FFEB4F7 IaRc : 0049B611 End Date : 2016/3/11 上午 10:26:24 End Date : 2016/3/11 上午 10:26:24

Figure 2.12 : Report Data and Path

B: Message Data Path(.txt) -->C:\Explorer\Calibration\Message\DUT_001.txt"

C:\Explorer\Calibration\Message\DUT_002.txt

C:\Explorer\Calibration\Message\DUT_003.txt

DUT1_001.txt - 記事本
檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)
Start Date : 2016/3/15 下午 01:22:47 DUT 01 serial number : DUTL_001 Accuracy Limit : 3 (%) Step 1 : Initial Process DUT 01 Check USB Connect Auto Step 2 : DownLoad DSP Process ->Write CFG Register Start ->Write CFG Register Start ->UT Relay Turn On Setting ->DUT Relay Turn On PASS DSP version : 2015/11/06
Stop 2 · Calibration Procogg
>Check Calibration Parameter >Calibrate Process Start
Power V:120.0
Power I:5.0
Power W:300.0 Power Phase:60 0
>Calibrate PF
Power V:120.0
Power I:5.0
Power W:500.0 Power Phase:60.0
>Calibrate Vrms
Power V:120.0
Power I:5.U Power W·300 0
Power Phase:60.0
>Calibrate Irms
Power V:120.0
Power I:5.0
Power Wiscold Power Phase:60.0
>Lalibrate Power >LT Setup 6 04 300 OSEC
>Inst Setup, 15.0A
>AVM Setting

Figure 2.13 : Message Data and Path



2.10 How to export DSP / RO / CFG to file

Please select the Export-Download Page,

Step 1: Click Export DSP Program / Export CFG data / Export RO data button

Register	Export-Dow	nload	Production M	ode
_≺ DSP Buf	fer >			
0x3000~0x3	3005 :		0x3060~0x	3065 :
0x3006~0x3	300B :		0x3066~0x	306B :
0x300C~0x3	3011:		0x306C~0x	3071:
0x3012~0x3	3017:		0x3072~0x	3077:
0x3018~0x3	301D:		0x3078~0x	307D :
0x301E~0x3	3023:		0x307E~0x	3083:
0x3024~0x3	3029:		0x3084~0x	3089:
0x302A~0x3	302F:		0x308A~0x	308F :
0x3030~0x3	3035:	0x3090~0x	3095 :	
0x3036~0x3	303B:	0x3096~0x	309B :	
0x303C~0x3	3041:	0x309C~0x	30A1:	
0x3042~0x3	3047:		0x30A2~0x	30A7 :
0x3048~0x3	304D :		0x30A8~0x	30AD :
0x304E~0x3	3053:		0x30AE~0x	3083:
0x3054~0x3	3059:		0x30B4~0x	3089:
0x305A~0x3	305F:		0x30BA~0x	30BF :
Run	Stop	<mark>⊢≺ Lo</mark> a	ad File and	Writ
Kun	3000	• DS	SP ORO O	CFG
Export 0	TP data		Load File	
Export D	SP Data	- Wri	te to OTP #1	-
Export DS	P Program	V. Wroj	te to Shadow	RAM
Export C	FG data		Write DSP	
Export F	RO data		Write RO	
	1			

Figure 2.14: AP export code

Step 2: Save DSP.rom / CFG.rom / RO.rom to your specify path

Save in:	👪 DSP	E 📸 🚽	
C.	Name	Date modified	Туре
	CFG.rom	8/12/2015 3:56 PM	ROM File
Necenit Flaces	DSP.rom	8/12/2015 3:55 PM	ROM File
	RO.rom	8/12/2015 3:56 PM	ROM File
Desktop			
Libraries			
Network			
	• [,
	File name: DSP.rom	•	<u>S</u> ave
	Save as type: * rom		Cancel

Figure 2.15: AP save code



3. Power Protection Function Description

The power protection function of PL7413 prevents overload condition which may cause equipment overheat or even catch fire.

When the load current exceeds the rated current (or pre-configured current threshold, ILT/ST) for a specified time, the relay will be switched off to prevent overheat condition. Both the overload threshold current and delay time to switch off relay can be configured through the AP provided by Prolific.

3.1 **Power Protection Operation**

The operation of protection is shown as below Figure.

If the load current (ILOAD) is less than or equal to ILT/ST, the relay is always ON.

If the load current (ILOAD) is larger than ILT/ST, the delay time (TOFF) to switch off relay will be shorter. Please refer to section 6.2.2 to calculate (TOFF).

Both the ILT/ST and TLT/ST can be configured by the application software provided by Prolific.





Figure 3.1 : Long/Short time protection (ILOAD = ILS/ST)



3.2 Calculate the delay time to switch off relay

The delay time, T_{OFF}, can be calculated by the following equation:

$$T_{OFF} = T_{LT/ST} \times \left(\frac{I_{LT/ST}}{I_{LOAD}}\right)^2$$

For example,

- > Short time threshold current (I_{ST}) is set as 30A
- T_{ST} is set as 5sec
- > Exact load current is 50A.

We can obtain the delay time to switch off delay is:

$$T_{OFF} = 5 \times \left(\frac{30}{50}\right)^2 = 1.8 \,\mathrm{sec}$$



3.3 OCP Protection

Ex: In Our Demo board, If Calibration current is 5A: 6A (1.2X) ~9.5A (1.9X) relay pick time = [T=240/ (1.2) ^2] ~ [T=240/ (1.9) ^2] 10A (2.0X) ~14.5A (2.9X) relay pick time = [T=20/ (2.0) ^2] ~ [T=20/ (2.9) ^2] 15A (3.0X) ~49.5A (9.9X) relay pick time = 1ms



Figure 3.3 : Programmable Range

3.4 OCP Threshold

LT_PU:	1.2X	PICK TIME	300	LT_PU^2*T = 432
INST:	3X	Trip time is 1		millisec
		SampleCnt		1953

 Table 3.1 : Leakage and OCP setting Table



3.5 AVM (Auto Voltage Margin)

PL7413 has two ADC input channels, It can be one voltage input and one current input or two current inputs. It depends on the DSP program definition. The DSP have 2K words instruction memory space and 48 words data space.

Prolific had provided some pre-defined power monitor functions, like, AVM, Power Protection.

3.6 AVM introduction

By setting AX /BX/ CX/ DX, you can use PL7413 AVM function shown as follow figure.

PL7413 will auto switch relay on/off when input voltage threshold are setting

In Hysteresis region relay will keep before status, until over /under region.

Point	Voltage	Relay	Ratio
Ax	66	relay off	0.6
Bx	88	relay on	0.8
Сх	132	relay on	1.2
Dx	154	relay off	1.4

Table 3.2 : AVM threshold



3.7 DSP AVM flow





Figure 3.4 : AVM DSP flow

For example , if the sample counts/second is 3906(0xF42), then the AVM sample count2 is $3/60^{*}(0xF42) = 195(0xC3)$

$$VTH = \left(\frac{V_{RMS} - V_{offset}}{V_{gain}/2^{18}}\right) \times SC2$$

3.8 Introduce Auto Learn ZCC

PL7413 demo board have embedded the Auto learn function , DSP will auto lean when 1st relay on/off, Relay on base on V (voltage) and Relay off base on I(current), When on load, relay off will base on V. VB channel is use for load voltage detection:



If the PL7413 can do Zero crossing control, then it is also on behalf of it can do random phase control ??

Answer:

- (1) Yes, because the random phase control is zero, but the only difference is that zero crossing is zero and the random phase is nonzero.
- (2) Part of the zero is divided into two, one voltage, the other is the current, the current auto learn ZCC, Power On after 3 (relay on / off) is learning,
- (3) 3 times after the completion of learning, relay on is to see the voltage zero, relay off is to see the current zero, so you can achieve random phase control.



AC Calculate Method

3.9 Parameter Address and Mapping

Those parameter is mapping in DSP As below

0x3000~0x3005	VC	VB	VA	0x3060~0x3065	VArms	0x30C0~0x30C5	IA2_ACC	0x3120~0x3125	PA
0x3006~0X300B	VCOS	VBOS	VAOS	0x3066~0X306B	VBrms	0x30C6~0X30CB	ia2_sum	0x3126~0X312B	PB
0x300C~0X3011	VC_LLCNT	VB_LLCNT	VA_LLCNT	0x306C~0X3071	IArms	0x30CC~0X30D1	STACC_IA	0x312C~0X3131	CF_CNTA
0x3012~0X3017	VC_LLIDX	VB_LLIDX	VA_LLIDX	0x3072~0X3077	IBrms	0x30D2~0X30D7	LTACC_IA	0x3132~0X3137	CF_CNTB
0x3018~0X301D	ZXCCnt	ZXBCnt	ZXACnt	0x3078~0X307D	TVA_rms	0x30D8~0X30DD	IB2_ACC	0x3138~0X313D	PAO
0x301E~0X3023	ZXCStart	ZXBStart	ZXAStart	0x307E~0X3083	TVB_rms	0x30DE~0X30E3	IB2_SUM	0x313E~0X3143	VARMS_ACC
0x3024~0X3029	ZXCStop	ZXBStop	ZXAStop	0x3084~0X3089	TIA_rms	0x30E4~0X30E9	LeakACC_IB	0x3144~0X3149	
0x302A~0X302F	VCZXTO	VBZXTO	VAZXTO	0x308A~0X308F	TIB_rms	0x30EA~0X30EF	TMP9	0x314A~0X314F	PBO
0x3030~0X3035	VCState	VBState	VAState	0x3090~0X3095	TPA	0x30F0~0X30F5	UV_L_Value	0x3150~0X3155	
0x3036~0X303B	Temp_Cnt		VA0	0x3096~0X309B	TPB	0x30F6~0X30FB	UV_H_Value	0x3156~0X315B	
0x303C~0X3041	IC	IB	IA	0x309C~0X30A1	KWHVAL1	0x30FC~0X3101	OV_L_Value	0x315C~0X3161	
0x3042~0X3047	ICOS	IBOS	IAOS	0x30A2~0X30A7	KWHVAL2	0x3102~0X3107	OV_H_Value	0x3162~0X3167	
0x3048~0X304D	IC_LLCNT			0x30A8~0X30AD		0x3108~0X310D	mAH_Val_VA	0x3168~0X316D	
0x304E~0X3053	IC_LLIDX			0x30AE~0X30B3		0x310E~0X3113	mAH_Val_VB	0x316E~0X3173	VARMS_AVM
0x3054~0X3059	SZX_CNT			0x30B4~0X30B9		0x3114~0X3119	mAH_Val_IA	0x3174~0X3179	MAX_IA2
0x305A~0X305F	TMP4		IA0	0x30BA~0X30BF	Relay_Trip	0x311A~0X311F	mAH_Val_IB	0x317A~0X317F	MAX_IB2

Table 4-1 : DSP Buffer of 1V1I(AFE+AVM+OCP+Leakage)

	-								
0x3005 ~ 0x3000	Relay_Trip_C	VB	VA	0x3065 ~ 0x3060	VArms	0x30C5 ~ 0x30C0	IA2_ACC	0x3125 ~ 0x3120	PA
0X300B ~ 0x3006	Relay_Trip_B	VBOS	VAOS	0X306B ~ 0x3066	ISrms	0X30CB ~ 0x30C6	IA2_SUM	0X312B ~ 0x3126	PB
0X3011 ~ 0x300C	Relay_Trip_A	IS_LLCnt	VA_LLCNT	0X3071 ~ 0x306C	lArms	0X30D1 ~ 0x30CC	STACC_IA	0X3131 ~ 0x312C	CF_CNTA
0X3017 ~ 0x3012	TRIP_CTLA	IS_LLIdx	VA_LLIDX	0X3077 ~ 0x3072	IBrms	0X30D7 ~ 0x30D2	LTACC_IA	0X3137 ~ 0x3132	CF_CNTB
0X301D ~ 0x3018	TRIP_CTLB	ZXBCnt	ZXACnt	0X307D ~ 0x3078	TVA_rms	0X30DD ~ 0x30D8	IB2_ACC	0X313D ~ 0x3138	PA0
0X3023 ~ 0x301E	TRIP_CTLC	ZXBStart	ZXAStart	0X3083 ~ 0x307E	TIS_rms	0X30E3 ~ 0x30DE	IB2_SUM	0X3143 ~ 0x313E	VARMS_ACC
0X3029 ~ 0x3024	RLY_ZXA	ZXBStop	ZXAStop	0X3089 ~ 0x3084	TIA_rms	0X30E9 ~ 0x30E4	STACC_IB	0X3149 ~ 0x3144	PC
0X302F ~ 0x302A	RLY_ZXB	VBZXTO	VAZXTO	0X308F ~ 0x308A	TIB_rms	0X30EF ~ 0x30EA	LTACC_IB	0X314F ~ 0x314A	
0X3035 ~ 0x3030	RLY_ZXC	VBState	VAState	0X3095 ~ 0x3090	TPA	0X30F5 ~ 0x30F0	IC2_ACC	0X3155 ~ 0x3150	CF_CNTC
0X303B ~ 0x3036	ISSign	HV1	VA0	0X309B ~ 0x3096	TPB	0X30FB ~ 0x30F6	IC2_SUM	0X315B ~ 0x3156	KWHVAL3
0X3041 ~ 0x303C	IC	IB	IA	0X30A1 ~ 0x309C	KWHVAL1	0X3101 ~ 0x30FC	STACC_IC	0X3161 ~ 0x315C	
0X3047 ~ 0x3042	ICOS	IBOS	IAOS	0X30A7 ~ 0x30A2	KWHVAL2	0X3107 ~ 0x3102	LTACC_IC	0X3167 ~ 0x3162	MAX_IC2
0X304D ~ 0x3048	IC_LLCNT	IB_LLCNT	IA_LLCNT	0X30AD ~ 0x30A8	ICrms	0X310D ~ 0x3108	ISum2	0X316D ~ 0x3168	VARMS_HALF
0X3053 ~ 0x304E	IC_LLIDX	IB_LLIDX	IA_LLIDX	0X30B3 ~ 0x30AE	TIC_rms	0X3113 ~ 0x310E	PB0	0X3173 ~ 0x316E	VARMS_AVM
0X3059 ~ 0x3054	PSU_UVPCNT		ISIGN	0X30B9 ~ 0x30B4	TPC	0X3119~0x3114	PC0	0X3179 ~ 0x3174	MAX_IA2
0X305E ~ 0x305A	TMP4		IAO	0X30BE ~ 0x30BA		0X311E ~ 0x311A		0X317E ~ 0x317A	MAX IB2

Table 4.2 : DSP Buffer of 1V13

3.10 Calculate Vrms method

Below table explains how to calculate the Vrms(V) method via the mapping address:

Calculate Vrms(V) Value										
Vrms register	Vrms register address : 0x3078~0x307D,									
0x3078 addre	0x3078 address is Low Byte, 0x307D address is High Byte.									
Register address	Register address 0x3078 0x3079 0x307A 0x307B 0x307C 0x307D									
Register	Data[0] =	Data[1] =	Data[2] =	Data[3] =	Data[4] =	Data[5] =				
Data	0xBA	0x49	0x6C	0x77	0x00	0x00				
Example :										
Vrms value =	119.423(V)									
Data[5]=0x00)									
Data[4]=0x0	0									
Data[3]=0x77	Data[3]=0x77									
Data[2]=0x60	2									



Data[1]=0x49

Data[0]=0xBA

Vrms value = {(Data[5]*256^5) +(Data[4]*256^4) +(Data[3]*256^3) +

(Data[2]*256^2) + (Data[1]*256) + Data[0]} / (2^24)

= (0x0000776C49BA) / (2^24)

= 2003585466 / (2^24)

= 119.423 (V)

Table 4.3 : Calculate Vrms

3.11 Calculate Irms method

Below table explains how to calculate the Irms(A) method via the mapping address for 1V1I/1V3I:

Calculate Irms(A) Value									
Irms register address : 0x3084~0x3089,									
0x3084 address is Low Byte, 0x3089 address is High Byte.									
Register address	ister address 0x3084 0x3085 0x3086 0x3087 0x3088 0x3089								
Register	Data[0] =	Data[1] =	Data[2] =	Data[3] =	Data[4] =	Data[5] =			
Data	0x35	0x50	0xFB	0x00	0x00	0x00			
Example :									
Irms value = 2	2.405964 (A)								
Data[5]=0x00)								
Data[4]=0x00)								
Data[3]=0x00)								
Data[2]=0xFE	3								
Data[1]=0x50)								
Data[0]=0x35	j								
Irms value ={(Data	a[5]*256^5) +(D	ata[4]*256^4) +	-(Data[3]*256^3)) + (Data[2]*256	6^2) +				
(Dat	a[1]*256) + Dat	a[0]} / (2^30)							
= (0x0	00000FB5035)	/ (2^30)							
= 1647	70069 / (2^30)								
= 2.40	5964 (A)								

Table 4.4 : Calculate Irms(A)

Below table explains how to calculate the Irms(B) method via the mapping address for 1V3I DSP

only ,the algorithm is same as Irms(A):

Calculate Irms(B) Value								
Irms register address : 0x308A~0x308F,								
0x308A address is Low Byte, 0x308F address is High Byte.								
Register address	Register address0x308A0x308B0x308C0x308D0x308E0x308F							
Table 4.5 : Calculate Irms(B)								



Below table explains how to calculate the Irms(C) method via the mapping address for 1V3I DSP

only ,the algorithm is same as Irms(A):

Calculate Irms(C) Value								
Irms register address : 0x30AE~0x30B3,								
0x30AE address is Low Byte, 0x30B3 address is High Byte.								
Register address	0x30AE	0x30AF	0x30B0	0x30B1	0x30B2	0x30B3		

Table 4.6 : Calculate Irms(C)

3.12 Calculate Active Power method

Below table explains how to calculate the Active Power(Wa) method via the mapping address for 1V1I/1V3I::

		Calculat	e Active Po	wer(Wa) Va	lue	
ActivePower	egister addre	ess :0x3090~0	x3095			
0x3090 addre	ss is Low By	te , 0x3095 ad	dress is High Byt	te.		
Register address	0x3090	0x3091	0x3092	0x3093	0x3094	0x3095
Register	Data[0]=	Data[1]=	Data[2]=	Data[3]=	Data[4]=	Data[5]=
Data	0x77	0x9C	0x22	0x74	0x09	0x00
Example :						
ActivePower	value = 242	0.1352(W)				
Data[5]=0x00						
Data[4]=0x09						
Data[3]=0x74						
Data[2]=0x22						
Data[1]=0x9C						
Data[0]=0x77						
Active Power value	e = [(Data[5]*	^{256^5)} + (Data	a[4]*256^4) + (Da	ata[3] *256^3)+		
	(Data[2]	*256^2)+(Data	[1]*256) +Data[0)]]/(2^24)		
	= [(0x00*2	56^5) + (0x09*	256^4) + (0x74*2	256^3) +		
	(0x22*25	56^2)+ (0x9C*2	256) + 0x77] / (2⁄	^24)		
	= (0x00097	74229C77) / (2	^24)			
	=(4060313	80999) / (2^24)				
	= 2420.13	52 (W)				

Table 4.7 : Calculate Active Power(Wa)



Below table explains how to calculate the Active Power(Wb) method via the mapping address for 1V3

DSP only ,the algorithm is same as Power(Wa):

		Calculat	e Active Po	wer(Wb) Va	llue	
ActivePower r	egister addr	ess :0x3096~0	x309B			
0x3096 addre	ss is Low By	/te, 0x309B ad	dress is High By	te.		
Register address	0x3096	0x3097	0x3098	0x3099	0x309A	0x309B
Table 4.9 · Calquista Astiva Dawar(M/b)						

 Table 4.8 : Calculate Active Power(Wb)

Below table explains how to calculate the Active Power(Wc) method via the mapping address for 1V3

DSP only ,the algorithm is same as Power(Wa):

		Calculat	te Active Po	wer(Wc) Va	lue	
ActivePower r	egister add	ress :0x30B4~()x30B9 Idross is High By	<i>t</i> o		
Register address	0x30B4	0x30B5	0x30B6	0x30B7	0x30B8	0x30B9

 Table 4.9 : Calculate Active Power(Wc)

3.13 Calculate PF and Phase angle method

Below table explains how to calculate the Power Factor (PF) and phase angle method via the mapping address:

Calculate Power Factor(PF) Value and Phase Angle Value
PF value = ActivePower / (Vrms × Irms)
Phase Angle value = arcCos(PF)
Active Power value and Vrms value and Irms value are known, so use rule to calculate PF and Phase Angle.
Active Power value = 275.00(W)
Irms value = 5.00 (A)
Vrms value = 110.00 (V)
Example : PF value = 0.5000
PF value = (ActivePower) / (Vrms × Irms)
= (275) / (110.00 × 5.00)
= 0.5
Phase Angle value = arcCos(PF)
$= \operatorname{arcCos}(0.5)$
= 60 (Degree)





3.14 Calculate Accumulate power Method

Below table explains how to calculate the Accumulate Energy(Wa) method via the mapping address for 1V1I/1V3I:

	Ca	alculate Ac	cumulate Er	nergy (Wa)	Value	
Accumulate Er	nergy value	= CF_Count *0	.3125 WH			
		= 38580 (WH)				
		= 38.58 (KWH))			
CF_Count regi	ster address	: 0x312C~0x3	3131,			
0x312C addres	ss is Low Byte	e, 0x3131 addr	ess is High Byte.			
Register address	0x312C	0x312D	0x312E	0x312F	0x3130	0x3131
Register	Data[0] =	Data[1] =	Data[2] =	Data[3] =	Data[4] =	Data[5] =
Data	0x40	0xE2	0x01	0x00	0x00	0x00
Example : Cl	Count value	e = 123456 (im	p)			
CF_Count valu	ue = (Data[5]*	256^5) + (Data	[4]*256^4) + (Da	ta[3] *256^3)+		
	(Data[2]	*256^2)+(Data	[1]*256) +Data[0]			
	= (0x00*25	6^5) + (0x00*	256^4) + (0x00*2	256^3) +		
	(0x01*25	56^2)+ (0xE2*2	56) + 0x40			
	= 0x00000	001E240				
	= 123456(i	mp)				
Accumulate Er	nergy Value	= CF_Count *C).3125			
		= 123456*0.31	25			
		= 38580 (WH)				
		= 38.58 (KWH)			

Table 4.11 : Calculate Accumulate Energy (Wa)

Below table explains how to calculate the Accumulate Energy(Wb) method via the mapping address for

1V3I DSP only ,the algorithm is same as Accumulate Energy(Wa):

Calculate Accumulate Energy (Wb) Value						
Accumulate E	Energy value	= CF_Count *0.3	3125 WH			
		= 38580 (WH)				
		= 38.58 (KWH)				
CF_Count ree	gister address	: 0x3132~0x31	37,			
0x3132 addre	ess is Low Byte	e,0x3137 addres	s is High Byte.			
Register address	0x3132	0x3133	0x3134	0x3135	0x3136	0x3137

Table 4.12 : Calculate Accumulate Energy (Wb)



Below table explains how to calculate the Accumulate Energy(Wc) method via the mapping address for 1V3I

DSP only ,the algorithm is same as Accumulate Energy(Wa):

	Ca	alculate Acc	umulate En	ergy (Wc) V	/alue	
Accumulate E	Energy value	= CF_Count *0.	3125 WH			
		= 38580 (WH)				
		= 38.58 (KWH)				
CF_Count re	gister address	: 0x3150~0x31	155,			
0x3150 addre	ess is Low Byte	e ,0x315c addre	ss is High Byte.			
Register address	0x3150	0x3151	0x3152	0x3153	0x3154	0x3155

 Table 4.13 : Calculate Accumulate Energy (Wc)

3.15 Calculate Frequency method

Below table explains how to calculate the Frequency (Freq) method via the mapping address:

		Calculate	Frequency	/(Hz) Value	e	
Frequency val	ue = {((ZccC)	nt-1) / 2) / ((Z	CcStop - ZccSt	art) / SampleC	nt) }= 49.9992	(Hz)
ZccCnt registe	r address : 0x3	018~0x3019,				
0x3018 address	s is Low Byte, 0	x3019 address	s is High Byte.			
Register address	0x3018	0x3019				
Register	Data[0] =	Data[1] =				
Data	0x64	0x00				
Example : Zcc	Cnt value = 1	00				
ZccCnt value =	= (Data[1]*256)	+Data[0]				
=	= (0x00*256) +	0x64				
=	=0x0064					
=	=100					
ZccStart regist	er address : 0x	301E~0x301F,				
0x301E address	s is Low Byte, (0x301F addres	s is High Byte.			
Register address	0x301E	0x301F				
Register	Data[0] =	Data[1] =				
Data	0x20	0x00				
Example : Zcc	Start value =	32				
ZccStart value	= [(Data[5]*256	6^5) +(Data[4]*	256^4)+(Data[3]*256^3)+		
	(Data[2]*25	6^2)+(Data[1]*	256) +Data[0]]			
	= (0x00*256^5) + (0x00*256^	4) + (0x00*256	^3)+		
	$(0x00^{2}56^{2}) + (0x00^{2}56) + 0x20$					
	= 0x00000000	0020				
	= 32					



ZccStop regist 0x3024 addres	er address : 0x ss is Low Byte,	3024~0x3025, 0x3025 addres	ss is High Byte.			
Register address	0x3024	0x3025				
Register	Data[0] =	Data[1] =				
Data	0x3B	0x0F				
Example : Zcc	Stop value = 3	3899				
ZccStop value	= [(Data[5]*256	3^5) +(Data[4]*	256^4)+(Data[3	3]*256^3)+		
	(Data[2]*256	^2)+(Data[1]*2	:56) +Data[0]]			
	= (0x00*256^5) + (0x00*256^	4) +(0x00*256	^3)+		
	(0x00*256^2) +(0x0F*256)	+ 0x3B			
	= 0x00000000	OF3B				
	= 3899					
SampleCnt ma	apping address	(from CFG Re	gister mapping	for AFE) : ()x3809~0x380/	Α,
0x3809 addres	ss is Low Byte,	0x380A addres	ss is High Byte.			-
Register address	0x3809	0x380A				
Register	Data[0] =	Data[1] =				
Data	0x42	0x0F				
Example : San	npleCnt value	= 3906				
SampleCnt va	lue = (Data[1] *	256)+Data[0]				
	= (0x0F*2	256) + 0x42				
	= 0x0F42	2				
	= 3906					
Frequency val	ue = {((ZccCnt	-1)/2)/((Zo	cStop - ZccSta	ırt) / SampleCn	it)}	
	= {((100-1) /	2)/((3899-3	2)/(3906))}			
	= (49.5) / (0	0.9900153)				
= 49.9992 Hz						

Table 4.14 : Calculate Frequency (Hz)

3.16 OCP Parameter Calculate method

Follow is explanation how to calculate the OCP sample count -OCP_SMPA method for 1V1I/1V3I:

Calculate OCP_SMPA Value
OCP_SMPA=SampleCnt / 25
SampleCnt register address : 0x3809~0x380A,
0x3809 address is Low Byte, 0x380A address is High Byte.
OCP_SMPA register address : 4036~0x4037,
0x4036 address is Low Byte, 0x4037 address is High Byte.

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Example :

ADCDIV = 0x3801 bit3~0.

ADC clock = Crystal Clock/[ADCDIV+1]=16M/8=2M

SampleCnt = ADC clock/ OSR512 /Mux number

2MHz /512/2

=200000/512/2

=1953

 $OCP_SMPA = DEC2HEX (1953/25)$

= 0x4E

Table 4.15 : Calculate OCP_SMPA Value

Follow is explanation how to calculate the Instance sample count -INST_SMP method for 1V1I/1V3I:

Calculate INST_SMP Value

INST_SMP =SampleCnt/1000

SampleCnt register address : 0x3809~0x380A,

0x3809 address is Low Byte, 0x380A address is High Byte.

INST_SMP register address : 0x4048~0x4049,

0x4048 address is Low Byte, 0x4049 address is High Byte.

Example :

SampleCnt =1953

INST_SMP =DEC2HEX(1953/1000)

=0x01.

Table 4.16 : Calculate INST_SMP Value

Follow is explanation how to calculate the Long time pickup threshold LTPUTHA method, for 1V1I/1V3I:

	С	alculate LT	PUTHA \	/alue		
LTPUTHA =IArms_50m	s*(LT_PU^2)					
IArms_50ms register ad	ldress : 0x30	C0~0x30C5,				
0x30C0 address is Low	Byte, 0x30C	5 address is Hi	gh Byte.			
Register address	0x30C0	0x30C1	0x30C2	0x30C3	0x30C4	0x30C5
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
LT_PUTHA register add 0x4126 address is Low	ress : 0x4120 Byte, 0x4128	6∼0x412B, 3 address is Hi(gh Byte.	I		
Register address	0x4126	0x4127	0x4128	0x4129	0x412A	0x412B
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
Step1. Set OCPA	EN to 0(add	dress=0x3804	bit2) , 0x3804	&= ~ 0x04		

	Step2. Set LTPUTHA = 0X7FFFFFF
	Step3. Set OCPA_EN to 1(address=0x3804 bit2) , 0x3804 = 0x04
	Step 4. Wait 2 SECS, read IArms_50ms
	Step 5. LTPUTHA =IArms_50ms*(LT_PU^2)
Exam	ple :
T_PL	J = 1.2X
Arms	_50ms= 0x2F37809
T_PL	JTHA=(0x2F37809)* (1.2^2)
	= 0x43FE00C

Table 4.17 : Calculate LTPUTHA Value

Below table explains how to calculate Long time pickup threshold LTPUTHB method via the mapping address

for 1V3I DSP only, the algorithm is same as LTPUTHA:

Calculate LTPUTHB Value						
LTPUTHB =IBrms_50m	s*(LT_PU^2)					
IBrms_50ms register ad	ldress : 0x30l	D8~0x30DD,				
0x30D8 address is Low	Byte, 0x30D	D address is Hi	igh Byte.			
Register address	0x30D8	0x30D9	0x30DA	0x30DB	0x30DC	0x30DD
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
LT_PUTHB register add	lress : 0x4050	C~0x4061,				
0x405C address is Low	Byte, 0x4061	I address is Hig	gh Byte.			
Register address	0x405C	0x405D	0x405E	0x405F	0x4060	0x4061
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
Table 4.18 : Calculate LTPUTHB Value						

Below table explains how to calculate Long time pickup threshold **LTPUTHC** method via the mapping address for **1V3I DSP only, the algorithm is same as LTPUTHA:**

Calculate LTPUTHC Value						
LTPUTHC =ICrms_50m	s*(LT_PU^2)					
ICrms_50ms register ad	ldress : 0x30	F0~0x30F5,				
0x30F0 address is Low	Byte, 0x30F5	address is Hig	gh Byte.			
Register address	0x30F0	0x30F1	0x30F2	0x30F3	0x30F4	0x30F5
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
LT_PUTHC register address : 0x4168~0x416D, 0x4168 address is Low Byte, 0x416D address is High Byte.						
Register address	0x4168	0x4169	0x416A	0x416B	0x416C	0x416D
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]

Table 4.19 : Calculate LTPUTHC Value



						/i.		
		Calculate	ETTHA \	/alue				
LTTHA= (IArms_50ms	s*20)* (LT_PL	J^2)*PICK TIM	IE					
IArms_50ms register	address : 0x3	0C0~0x30C5,						
0x30C0 address is Lo	w Byte, 0x30	C5 address is	High Byte.					
Register address	gister address 0x30C0 0x30C1 0x30C2 0x30C3 0x30C4 0x30C5							
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
LTTHA register addres 0x412C address is Lo	ss : 0x412C ~ w Byte, 0x41	0x4131, 31 address is	High Byte.					
Register address	0x412C	0x412D	0x412E	0x412F	0x4130	0x4131		
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
Step1. Set OCI	PA_EN to 0(a	ddress=0x380	4 bit2) , 0x38	04 &= ~ 0x04				
Step2. Set LTT	HA = 0X7FFF	FFFFFFFF						
Step3. Set OCI	PA_EN to 1(a	ddress=0x380	4 bit2) , 0x38	04 = 0x04				
Step 4. Wait 2	SECS, read I	Arms_50ms						
Step 5. LTTHA:	= (IArms_50n	ns*20)*(LT_PL	I^2)*PICK TIN	ΛE				
Example :								
PICK TIME=300 s								
LT_PU = 1.2X								
IArms_50ms= 0x2F37809								
LTTHA= [{ (0x2F37809)* 20}*(1.2^2)*300]								
=0x6399132FC	=0x6399132FC0							

Follow is explanation how to calculate the Long time threshold LTTHA method ,for 1V1I/1V3I:

Table 4.20 : Calculate LTTHA Value

Follow is explanation how to calculate the Long time threshold LTTHB method via the mapping address for 1V3I DSP only , the algorithm is same as LTTHA:

Calculate LTTHB Value									
LTTHB= (IBrms_50ms*2	LTTHB= (IBrms_50ms*20)* (LT_PU^2)*PICK TIME								
IBrms_50ms register ad	ldress : 0x30I	D8~0x30DD,							
0x30D8 address is Low	Byte, 0x30D	D address is H	ligh Byte.						
Register address	0x30D8	0x30D9	0x30DA	0x30DB	0x30DC	0x30DD			
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]			
LTTHB register address : 0x4144 ~0x4149, 0x4144 address is Low Byte, 0x4149 address is High Byte.									
Register address	0x4144	0x4145	0x4146	0x4147	0x4148	0x4149			
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]			

Table 4.21 : Calculate LTTHB Value



Follow is explanation how to calculate the Long time threshold LTTHC method via the mapping address for

1V3I DSP only, the algorithm is same as LTTHA:

	gontinin is sa		\.					
		Calculate	e LTTHC \	/alue				
LTTHC= (ICrms_50n	ns*20)* (LT_P	U^2)*PICK TI	ME					
ICrms_50ms register	address : 0x3	30F0~0x30F5,	,					
0x30F0 address is Lo	ow Byte, 0x30	F5 address is	High Byte.					
Register address	s 0x30F0 0x30F1 0x30F2 0x30F3 0x30F4 0x30F5							
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
LTTHC register addre	ess : 0x414A~	0x414F,						
0x414A address is Lo	ow Byte, 0x41	4F address is	High Byte.					
Register address	0x414A	0x414B	0x414C	0x414D	0x414E	0x414F		
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
		Table 4.22 : C	alculate LTTH	IC Value				
ollow is explanation h	now to calculat	te the Instance	e threshold INS	STA_TH meth	od, for 1V1I/1	V3I:		
	(Calculate	INSTA_TH	l Value				
INSTA_TH= (IArms_	50ms/OCP_S	MPA)*2*(INST	۲^2)*0.9					
IArms_50ms register	address : 0x3	3066~0x306B,	1					
0x3066 address is Lo	ow Byte, 0x0x	306B address	is High Byte.					
Register address	0x30C0	0x30C1	0x30C2	0x30C3	0x30C4	0x30C5		
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
INSTA_TH register a	ddress : 0x40	D2 ~0x40D7,						
0x40D2 address is L	ow Byte, 0x40	D7 address is	High Byte.					
Register address	0x40D2	0x40D3	0x40D4	0x40D5	0x40D6	0x40D7		
Register Data	Data[0]	Data[1]	Data[2]	Data[3]				
Step1. Set OC	PA_EN to 0(a	ddress=0x380	04 bit2) , 0x38	04 &= ~ 0x04	•			
Set INS	STA_EN to 0(a	ddress=0x380	04 bit5) , 0x38	04 &= ~ 0x20				
Step2. Set INS	STA_TH = 0X7	7FFFFFF						
Step3. Set OCPA_EN to 1(address=0x3804 bit2) , 0x3804 = 0x04								
Set INSTA_EN to 0(address=0x3804 bit5) , 0x3804 = 0x20								
Step 4. Wait 2	Step 4. Wait 2 SECS,Read IArms_50ms							
Step 5. INSTA	_TH= (IArms_	_50ms/OCP_S	SMPA)*2*(INST	Г^2)*0.9				
Example :								

INST =3X

IArms_50ms= 0x2F37809

OCP_SMPA=0x4E

INSTA_TH= (0x2F37809/ 0x4E)*2*(3^2)*0.9

= 0x9CE7B3

Table 4.23 : Calculate INSTA_TH Value



Follow is explanation how to calculate the Instance threshold INSTB_TH method , via the mapping address

for 1V3I DSP only , the algorithm is same as INSTA_TH:

Calculate INSTB_TH Value						
INSTB_TH= (IBrms_50)ms/OCP_SI	MPA)*2*(INST	^2)*0.9			
IBrms_50ms register a	ddress : 0x3	0D8~0x30DD	,			
0x30D8 address is Lov	v Byte, 0x30	DD address is	High Byte.			
Register address	0x30D8	0x30D9	0x30DA	0x30DB	0x30DC	0x30DD
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
INSTB_TH register address : 0x4162 ~0x4167, 0x4086 address is Low Byte , 0x4089 address is High Byte.						
Register address	0x4162	0x4163	0x4164	0x4165	0x4166	0x4167
Register Data	Data[0]	Data[1]	Data[2]	Data[3]		
Table 4.24: Calculate INSTB TH Value						

Follow is explanation how to calculate the Instance threshold INSTC_TH method, via the mapping address for

1V3I DSP only, the algorithm is same as INSTA_TH:

(Calculate I	INSTC_TF	I Value				
INSTC_TH= (ICrms_50ms/OCP_SMPA)*2*(INST^2)*0.9							
address : 0x3	30F0~0x30F5,	,					
0x30F0 address is Low Byte, 0x30F5 address is High Byte.							
0x30F0	0x30F1	0x30F2	0x30F3	0x30F4	0x30F5		
Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]		
INSTC_TH register address : 0x416E ~0x4173, 0x416E address is Low Byte , 0x4173 address is High Byte.							
0x416e	0x416f	0x4170	0x4171	0x4172	0x4173		
Data[0]	Data[1]	Data[2]	Data[3]				
	50ms/OCP_S address : 0x3 w Byte, 0x30 0x30F0 Data[0] ddress : 0x41 w Byte , 0x4 0x416e Data[0]	50ms/OCP_SMPA)*2*(INS) address : 0x30F0~0x30F5 w Byte, 0x30F5 address is 0x30F0 0x30F1 Data[0] Data[1] ddress : 0x416E ~0x4173, ow Byte , 0x4173 address is 0x416e 0x416f Data[0] Data[1]	50ms/OCP_SMPA)*2*(INST^2)*0.9 address : 0x30F0~0x30F5, ow Byte, 0x30F5 address is High Byte. 0x30F0 0x30F1 0x30F0 0x30F1 0x30F0 0x30F1 0ata[0] Data[1] Data[2] ddress : 0x416E ~0x4173, ow Byte , 0x4173 address is High Byte. 0x416e 0x416f 0x416i 0x4170 Data[0] Data[1]	50ms/OCP_SMPA)*2*(INST^2)*0.9 address : 0x30F0~0x30F5, ow Byte, 0x30F5 address is High Byte. 0x30F0 0x30F1 0x30F2 0x30F3 Data[0] Data[1] Data[2] Data[3] ddress : 0x416E ~0x4173, ox416E ox416f 0x4170 0x4171 Data[0] Data[1] Data[2] Data[3]	50ms/OCP_SMPA)*2*(INST^2)*0.9 address : 0x30F0~0x30F5, ow Byte, 0x30F5 address is High Byte. 0x30F0 0x30F1 0x30F2 0x30F3 0x30F4 Data[0] Data[1] Data[2] Data[3] Data[4] ddress : 0x416E ~0x4173, ox4173 address is High Byte. 0x416e 0x416f 0x4170 0x4171 0x4172 Data[0] Data[1] Data[2] Data[3] Data[7]		

Table 4.25 : Calculate INSTC_TH Value

3.17 AVM Calculate method

Follow is explanation how to calculate the SampleCnt and capture as below:

Calculate AVM SampleCnt Value

SampleCnt = ADC clock/OSR512/Mux number

SampleCnt register address : 0x3809~0x380A,

0x3809 address is Low Byte, 0x0x380A address is High Byte.



Example :

 $ADCDIV = 0x3801 \text{ bit}3\sim0.$

ADC clock = Crystal Clock/[ADCDIV+1]=16M/8=2M

SampleCnt = ADC clock/OSR512/Mux number

=2MHz /512/2

=2000000/512/2

=1953=0x7a1

Table 4.26 : Calculate AVM SampleCnt Value

Follow is explanation how to calculate the AVM_SMPA and capture as below:

Coloulata	A\/N/		
Calculate	AVIVI	SIVIPA	Valle

AVM_SMPA = SampleCnt / (1000/period)

AVM_SMPA register address : 0x403C~0x403D,

0x403C address is Low Byte, 0x403D address is High Byte.

Example :

SampleCnt= 0x07A1

Period=50ms

SampleCnt2 = {0x07A1/(1000/50)}

= 0x61

Table 4.27 : Calculate AVM_SMPA Value

Follow is explanation how to calculate the AVM_DLY and capture as below:

Calculate AVM_DLY Value

AVM_DLY = SampleCnt / (1000/ Relay Delay Time)

AVM_DLY register address : 0x4042~0x4043,

0x4042 address is Low Byte, 0x4043 address is High Byte.

Example :

SampleCnt= 0x07A1

Relay Delay Time =125ms

 $AVM_DLY = \{0x07A1/(1000/125)\}$

= 0xF4

Table 4.28 : Calculate AVM_DLY Value

Follow is explanation how to calculate the AVM threshold value method via the mapping address

Calculate AVM Value

UV_THL(Ax) = VA_RMS_AVM * (Ax^2) UV_THH(Bx) = VA_RMS_AVM * (Bx^2) OV_THL(Cx) = VA_RMS_AVM * (Cx^2) OV_THH(Dx) = VA_RMS_AVM * (Dx^2)



VA_RMS_AVM	register addr	ess : 0x316E	~ 0x3173,	to		
Register address	0x316E	0x3175 add	0x3170	0x3171	0x3172	0x3173
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
UV_THL(Ax) re	egister addres	s : 0x415C~()x4161,			
0x415C addres	s is Low Byte	, 0x4161 add	ress is High By	te.		
Register address	0x415C	0x415D	0x415E	0x415F	0x4160	0x4161
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
UV_THH(Bx) re	egister addres	s : 0x4162~0)x4167,			
0x4162 address	s is Low Byte,	0x4167 add	ress is High Byt	te.		
Register address	0x4162	0x4163	0x4164	0x4165	0x4166	0x4167
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
OV_THL(Cx) re	egister addres	s : 0x4168~0)x416D,			
0x4168 addres	s is Low Byte	, 0x416D add	dress is High By	/te.		
Register address	0x4168	0x4169	0x416A	0x416B	0x416C	0x416D
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
OV_THH(Dx) r	egister addres	s : 0x416E~(0x4173,			
0x416E addres	s is Low Byte	, 0x4173 add	dress is High By	/te.		
Register address	0x416E	0x416F	0x4170	0x4177	0x4172	0x4173
Register Data	Data[0]	Data[1]	Data[2]	Data[3]	Data[4]	Data[5]
Example : TVA_RMS = 0> Ax ration = 0.6	(63EC2CE X					
Bx ration = 0.8	Х					
Cx ration = 1.2	х					
Dx ration = 1.4 X						
UV_THL(Ax) = 0X63EC2CE * (0.6^2) = 0x23F8DCF						
UV_THH(Bx)= 0X63EC2CE * (0.8^2)						
= 0x13FF34FE						
OV_THL(Cx) = 0X63EC2CE * (1.2^2)						
= 0x8FE373D						
OV_THH(Dx)=	0X63EC2CE	* (1.4^2)				
= 0xC	3D924C					

Table 4.29 : Calculate AVM Value



Follow is explanation how to calculate the LED_BLK_TH and capture as below:

Calculate LED_BLK_TH Value
LED_BLK_TH = SampleCnt(1s) / (1000 / Pulse_width)
LED_BLK_TH register address : 0x4084~0x4085,
0x4084 address is Low Byte, 0x0x4085 address is High Byte.
Example :
SampleCnt = 0x07A1
Pulse_width =500 ms
LED_BLK_TH = {0x07A1/(1000/500)}
= 0x3D0

Table 4.30 : Calculate PUL_TH Value

4. Register Setting and Indicate

4.1 UART Auto Baud Rate

PL7413 auto baud rate default is enable, UART interface will detect baud rate after Master send command, the result of UART baud rate will save in 0x3918~0x3919 address.

If you want to disable UART auto baud rate, please set 0x380d[5]=0, then 0x3918~0x3919 will been f	ixed.
--	-------

0x380D	iocfg	7:0	Default:0xFF	Access:RW
	uart_bau_en	5	1: enable baud rate detection	
			0: disable	

0x3918	BitWidthNum_B0	7:0	Default:	Access:R
		7:0	BitWidthNum[7:0]	
0x3919	BitWidthNum_B1	5:0	Default:	Access:R
		5:0	BitWidthNum[13:8]	
0x391A	BitWidthDen	4:0	Default:	Access:R
		4:0	BitWidthDen[4:0]	

Figure 5.1: UART Baud Rate register

UART baud rate= system clock * BitWidthDen(0x391A[4:0]) / (BitWidthNum[13:0], 0x3919[5:0]+0x3918[7:0])

= 16M * 8/0x0459=115004.

	Ŭ									E	3100	ck:	RAM	CFG	Reg	i -	High Byte Addr: 39
	0	1	2	3	4	5	6	7	8	9	А	в	С	D	Е	F	0x38 - 0x39
0	FF	FF	0 6	30	00	01	22	00	D8	05	D4	00	70	00	80	80	Write Clear Read
1	<u>00</u>	00	00	<u>00</u>	20	00	80	60	59	04	08	FF	00	48	80	4F	Write Clear Read
2	FF	FF	FF	FF	FF	FF	00	07	00	00	6C	FE	FF	FF	FF	FF	Write Clear Read
з	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	<u>00</u>	<u>00</u>	<u>00</u>	Write Clear Read
4	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	Write Clear Read
5	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	Write Clear Read
5	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	Write Clear Read
7	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	Write Clear Read
	0	1	2	3	4	5	6	7	8	9	А	в	c	D	E	F	

Figure 5.2: UART Baud Rate register

Negaster

4.2 OCP and INST Protect Indicate

PL7413 have OCP and Instantaneous protect function, The function enable/disable table as below (Please reference PL7413_Leakage and OCP and AVM Demo Board User Manual.pdf):

Address	Bits	Description
0x3803~	15	
0x3804	14	OWP_EN
	13	HANDSHK_EN
	12	ZCC_Auto_Learn
	11	CLEAR_FLAG
	10	INST_IA_EN
	09	Leakage_INST_EN
	08	Leakage_EN
	07	CF_CNTB_EN
	06	NOLOAD_EN
	05	OCPA_EN
	04	CF_CNTA_EN
	03	KWH_EN
	02	RELY_ON_EN
	01	ZX_Half
	00	AVM_EN

Figure 5.3: PL7413 1V1I(AFE+AVM+OCP+AutoLearn)function flag register

DSP has OCP and INST protect happened indicates:

0x3916	FlagReg_B2	7:0	Default:	Access:R
		6	LTIA_TRIP: Indicate la currer	nt >= OCP long time protect current
5 5		STIA_TRIP: Indicate Ia current >=OCP short time protect current		
		2	INSTA_TRIP: Indicate la curr	ent >= INST protect current

Figure 5.4: PL7413 OCP and INST register

OCP long time and short time accumulate values:

STACC_IA	0x30CC~0X30D1
LTACC_IA	0x30D2~0X30D7

OCP Threshold (PL7413 1V1I support LT+ST+INST , PL7413 1V3I support LT+ INST):

LTPUTHA	0x412B ~ 0x4126
LTTH_IA	0x4131 ~ 0x412C
INSTA_TH	0x40D7 ~ 0x40D2

IA-RMS 50ms value:

IA2_ACC 0x30C0~0x30C5



[OCP Long Time Protect]

If your long time current setting is 6A, 300 sec, and OCPA_EN(0x3803[5]) is 1, then you use the hair dryers to test it, IA current =8.9A,You can check IA2_ACC(IA-RMS 50ms), if IA2_ACC > LTPUTHA, LTACC_IA will been accumulated. OCP long time will happened after serval second. You can check LTACC_IA, if LTACC_IA > LTTH, then LTIA_TRP(0x3916[6]) will rise to 1.

[INST Protect]

If your INST current setting is 15A, 1ms, and INST_IA_EN(0x3804[2]) is 1, then you use three hair dryers to test it, Ia current =15.5A, INST protect will happened immediately. You can check INSTA_TRP(0x3916[2]) will rise to 1

[Clear OCP Indicate]

Set OCPA_EN(0x3803[5])=0, LTIA_TRP(0x3916[6]) and STIA_TRP(0x3916[5]) will been cleared.

[Clear INST Indicate]

Set INST_IA_EN(0x3804[2])=0 and DSP Enable(0x3802[7])=0, INSTA_TRP(0x3916[2]) will been cleared.

4.2.1.1 OCP Long Time Protect Indicate

Please use PL7413 MP tool to help you to check it. First please check your OCP long time protect settings, then enter engineer mode, and find the "debug" form. In the debug form, you can find OCP_EN and OCP_READ(read IA2_ACC), LTPUTHA, LTTH, LT_SUM(LTACC_IA), LTIA_TRIP.

■ You can check your setting,



Figure 5.5: PL7413 OCP setting



Please enter engineer mode

Register Export	-Download Con	fig 1V1I MP	Measure			
Power source co V 120.0 • 5	ontrol I Freq 5.0 - 60	• 1.0 • 0	1 N OFF			
Standard Meter V	A Phase	e W				
01 Metering Da	ta	02 Metering Da	ta	03 Metering Data	-01	02 03
Read Timing : Read Start Reset	1 • (Second) Read Stop	Read Timing : 1 Read Start Reset	<pre> (Second) Read Stop </pre>	Read Timing : 1 (Second) Read Start Read Stop Reset	Read	Read
DUT Item	DUT 01	DUT Item	DUT 02	DUT Item DUT 03		
Voltage(V)		Voltage(V)		Voltage(V)	R0 DATA#3 0x207F	R0 DATA#3 0x207F
Current(A)		Current(A)		Current(A)	R0 DATA#2 0x1D80	R0 DATA#2 0x1D80
Power(W)		Power(W)		Power(W)	DSP PROG #1 0x1C00	DSP PROG #1 0x1C00
Power Factor(PF)		Power Factor(PF)		Power Factor(PF)	DSP PROG #1 0x1400 0x0C00	DSP PROG #1 0x1400 0x0C00
Frequency(Hz)		Frequency(Hz)		Frequency(Hz)	CFG DATA #4 0x0400	0x0400
CF Count		CF Count		CF Count	CFG DATA #3 0x0300	CFG DATA #3 0x0300
Energy(WH)		Energy(WH)		Energy(WH)	CFG DATA #2 0x0100 CFG DATA #1 0x0100	CFG DATA #2 0x0100 CFG DATA #1 0x0100
Voltage Error(%)		Voltage Error(%)		Voltage Error(%)		
Current Error(%)		Current Error(%)		Current Error(%)		
Power Error(%)		Power Error(%)		Power Error(%)	2	
				J.	MP Mode]

Figure 5.6: PL7413 MP mode

Please select the debug form

PL7411-MultiPort-AP-1-2-1(MultiPort-2017)	0426)(DSP_OTP_v4_ZX_AutogLearn_20161028_3.m	om) - [Measure Mode]		
Register Export-Download Co	nfig 1V1I MP Measure	Debug		
Power source control V I Fre 120.0 • 5.0 • 60	q PF • 1.0 • ON OFF			
Standard Meter V A Pha	se W			
01 Metering Data	02 Metering Data	03 Metering Data	01	02
Read Timing : 1 🗸 (Second)	Read Timing : 1 - (Second)	Read Timing : 1 🗸 (Second)	V -	-
Read Start Read Stop	Read Start Read Stop	Read Start Read Stop	Read	Read
Reset	Reset	Reset		
DUT Item DUT 01	DUT Item DUT 02	DUT Item DUT 03		
Voltage(V)	Voltage(V)	Voltage(V)	RO DATA#3 0x207F	RO DATA#3 0x20
Current(A)	Current(A)	Current(A)	R0 DATA#2 0r1D80	R0 DATA#2
Power(W)	Power(W)	Power(W)	R0 DATA#1 0x1000	R0 DATA#1 0x1C
Power Factor(PE)	Power Factor(PE)	Power Factor(PE)	DSP PROG #1 0x1400	DSP PROG #1 0x144
			DSP PR0G #1 0x0C00	DSP PROG #1 0x0C
CE Count			CFG DATA #4 0x0300	CFG DATA #4 0x030
			CFG DATA #2 0x0200	CFG DATA #2
Energy(WH)	Energy(WH)	Energy(WH)	CFG DATA #1 0x0100	CFG DATA #1 0x01
Voltage Error(%)	Voltage Error(%)	Voltage Error(%)		
Current Error(%)	Current Error(%)	Current Error(%)		
Power Error(%)	Power Error(%)	Power Error(%)		
	J	J <u></u>	Engineer Mode	

Figure 5.7: PL7413 Engineer Mode



- Press "Read All".
- Please enable "RLY_ON_EN"
- Enable "OCPA_EN" for long time and short time
- Press "OCP_READ", it will read IA2_ACC
- If IA2_ACC > LTPUTH, then you press "LT_SUM", SUM will been accumulated.
- If IA current =6.1A, press "LT_SUM", LTIA_TRIP will 1 after SUM > LTTH about 29 SECS.
- Check LTIA_TRIP indicate.

Register E	xport-Download Config	1V1I MP Measure 1V1I Cal Eng Debug	
)CP+AVM+Lea	ikage GPIO/MUX DC 1V		-Select DUT
Leakage ILeak_50ms ILEAK_PUTH ILEAK_TH ILEAK_inst_T	00000000000 Rea 000000000000000000000000000000000000	. [Enable:0x3803~0x3804 [0x3916~0x3917 Flag] ZCC [15] 0x3916~0x3917 [15] 0000 [14] OWP_EN [15] 0000 0000 [12] ZCC Auto Learn [13] NDIFF TH 0000000 [11] CLEAR FLAG [12] VDIFF TH 00000000 [11] CLEAR FLAG [12] 000000000 NO_LOAD_50ms [00] Leak_INST_EN [10] LeakIB_TRIP 0000000000 0000000000 [00] Leak_INST_EN [00] LeakIB_TRIP 00000000000 0000000000 [07] CF CNIB EN [00] SOLUVP_TRIP ZX Half 00000000000 [003] KWH EN 3 [003] [003] Write All	© DUT 01 DUT 02 DUT 03
AVM_SMPA	0000 Write Rea	IOI AVM_EN IOI OWP TRIP	
AVM_ON_DLY	0000 Write Rea		
AVM_OFFDLY	0000 Write Rea	I LTTH STTH InstTH RC EN 0000000 Write	
VA-RMS	00000000000 Rea	i 002441755064 FFFFFFFFF 00E3FE46 PF FULL 00010000 Write Read Write Read VIA-RMS 000000000000	
UV_THE	00000000 Write Rea	LTPUTH STPUTH InstCnt Ia RC 00000000 00009AB0E379 FFFFFFFF 03 Read All	
OV_THL	00000000 Write Rea	Write Read Write Read	
OV_THH	00000000 Write Rea	I IA2_ACC(50ms) OCP_DIV_RATE 2	
AVM_AutoTH	00000000000 Write Rea		
Vol_120	00000000000 Write Rea	i 002441776766 ST_SUM Write Read	
Vol_220	00000000000 Write Rea	LT SUM 6 Write All Read All 2	
LED_BLK_TH	0000 Write Rea	OWP ACC(100ms)	
VcVbVa State	Write All Read All	OWP_SMPA 0000 Write All 0000000000 Acc READ OWP_ACC_TH 00000000000 Read All Read All Read All Read All	

Figure 5.8: PL7413 OCP Long time Debug Flow



4.2.1.2 INST Protect Indicate

Please use our AP to help you to check it. First please check your OCP INST protect settings,

then enter engineer mode, and find the "debug" form. In the debug form, you can find INST_IA_EN and InstTH, INSTA_TRIP.

- Please select the debug form
- Press "Read All".
- Please enable "RLY_ON_EN"
- Enable "OCPA_EN" for OCP
- Enable "INST_IA_EN" for Inst
- If IA current =15.1A, then check INSTA_TRIP indicate..



Figure 5.9: PL7413 OCP Instantaneous Debug Flow



4.3 AVM Protect State

PL7413 1V1I support this function , some of AVM State as below:

0x3030~0X3035 VCState VBState	VAState
-------------------------------	---------

PS: We only use VAState

By setting AX /BX/ CX/ DX, you can use PL7413 AVM function shown as follow figure.

PL7413 will auto switch relay on/off when input voltage threshold are setting

In Hysteresis region relay will keep before status, until over /under region. Calibration voltage is 120V.

Point	Voltage	Relay	Offset Voltage
Ax	100	relay off	20
Bx	110	relay on	10
Сх	130	relay on	10
Dx	140	relay off	20





Test Case1:

InputVoltage	VA State	LED1
0~99	0	Off
100~109	1	Blink
110~120	2	On
130~139	3	Blink
140~164	4	Off

Table 5.2 : AVM Case1 State

Test Case2:

InputVoltage	VA State	LED1
165~199	0	Off
200~209	1	Blink
210~220	2	On
230~239	3	Blink
240~	4	Off

Table 5.3 : AVM Case2 State



You can check your setting,

UT Calibration Condition : epl: Power Source Setti Calibration Power Setting V 120.0 - 100 :	ing. Test Point 1 Test Po I Freq F 5.00 - 60 - 0. % 100 %	int 2 9F 5L -		Power Source selection: HS3103 • Accuracy Limit COM Setting 3 • % COM9 •
 Leakage AVM No Penable OVP 2 W High Limit: 140 V W Low Limit: 130 V 	Load Zcc RC AVM_ONDLY 125 r AVM_OFFDLY 125 r	AC Lose OWP	GPIO MUX 4	AFE+AVM+OCP+AutoLearn
VEnable UVP V High Limit: 110 V V Low Limit: 100 V Enable Auto Switch Switch Voltage 165 V	AVMSMP_CNT 200 m Pulse Width 500 m Set 1xxV TH 120 V Set 2xxV TH 230 V	15 15 /		Relay Pin Default High For Calibration Calibration Test (No Burn)

Figure 5.10: PL7413 AVM setting

Please use our AP to help you to check it. First please check your AVM protect settings,

then enter engineer mode, and find the "debug" form. In the debug form, you can find AVM_EN and VcVbVa State.

- Please select the debug form
- Press "Read"
- Please enable "RLY_ON_EN"
- Enable "AVM_EN"
- If VA =120V,press "READ_ALL", VcVbVa State will 2.
- Read 0x3916~0x3917: [07]VA_TRIP=0.

If VA=141V, VcVbVa State will 4. 0x3916~0x3917: [07]VA_TRIP=1



Figure 5.11: PL7413 AVM Enable



4.4 Leakage Protect Indicate

0x3917	FlagReg_B2	7:0	Default:	Access:R
		3	LeakINST_TRIP: Indicate Ib	current >= Leakage INST protect
			current(ILeak_1SMP=10xILeak)	
		2	LeakIB_TRIP: Indicate Ib current >=Leakage protect current(ILeak)	
		2	LeakIB_TRIP: Indicate Ib current >=Leakage protect current(ILeak)	

DSP has Leakage protect happened indicates:

Figure 5.12: PL7413 Leakage register

Leakage Threshold(Please reference PL7413_Leakage and OCP and AVM Demo Board User Manual.pdf):

IbRMS 50ms(ILeak 50ms) value:				
Leak_inst_TH	0x4143 ~ 0x413E			
LeakTH_IB	0x413D ~ 0x4138			
LeakPUTH_IB	0x4137 ~ 0x4132			

IB2_ACC 0x30D8~0X30DD

[Clear Leak Protect Indicate]

Set Leak_EN(0x3804[0])=0, LeakIB_TRP(0x3917[2]) will been cleared.

[Clear Leak Inst Protect Indicate]

Set Leak_INST_EN(0x3804[1])=0, LeakINST_TRP(0x3917[3]) will been cleared.

4.4.1 Leakage Protect Indicate

Please use PL7413 MP tool to help you to check it. First please check your Leakage protect settings, then enter engineer mode, and find the "debug" form. In the debug form, you can find Leak_EN and ILeak_50ms(read IB2_ACC), ILEAK_PUTH, ILEAK_TH, , LeakIB_TRIP.

■ You can check your setting,

Explorer AP 1	for LiteOn 151013	- [Production	Mode]			
Register Export-Download Production Mode Dewnload Mode Debug						
-< DUT Cali	-< DUT Calibration Condition >					
Step1: P	ower Source	Setting.				
Calibra	tion Power Se	tting Tes	t Point 1 Tes	t Point 2		
		v	I Freq	PF		
	12	20.0 - 5.	0 - 60 -	0.5L -	ON OFF	
Step2: W	aitting Volt	age, Cur	rent, Phase,	Instantane	ous Power Stable	-
-> 0.0583	00 V 0.005	200 _A 0	.000000 Phas	e 0.00000	м	
Step3: M	anual input	DUT seri	al number.			
->Serial	number: 00	1			Kesu l'	
Calibrat	ion point: R	esult				
Test 1 pe	oint: R	esult				
Test 2 pt	51/1C: K	esuit				
DC Calib	ration: R	esult				
DS	P FW VER					
						Þ
OCP Le	akage AVM	No Loa	dizcc irg	в мих		
ccurage		12	1	1	1 1	
🔽 Enable	e Leakage	2				
ILeak	0.006 A					
Trip Time	2 ms					
ILeak_1SMP	10 x					
Flash	1.0 Sec					

Figure 5.13: PL7413 Leakage setting



Please select the debug form

- Press "Read All".
- Press "Read"
- Please enable "RLY_ON_EN"
- Enable "Leakage_EN"
- Press "READ", it will read ILeak_50ms(IB2_ACC)
- If IB current =0.06A, ILeak_50ms > ILEAK_TH, LeakIB_TRIP will 1.

orer Engineering AP 151007 - [Manual Calibration]					
ster Export-Download Debug Production Mode Download Mode					
+AVM+Leakage	DC 1V 3	RGB			
eakage Leak_50ms @ LEAK_PUTH @ LEAK_TH @ LEAK_inst_TH @	0000003460E1 000000001FF1 000000003FE2 0000000051E7	Write (Write (Write (Read Read Read Read	[Enable] [15] [15] [14] [13]HANDSHK_EN [12] [11]CLEAR_FLAG [10]INST_IA_EN [00]Leak_INST_EN [00]Leak_INST_EN [00]Leak[LabALAN]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[0]LEAL[
VM	Write All	Read	All Read	107 [CF CHTB ⁻ EN [07] [06]NOLOAD EN [06]LTIA TRIP [05]OCPA_EN [05]STIA_TRIP [05]KWH EN [04] [02]RLY ON EN [03] [00]AVM_EN [00] Read [00]	
VM_DLY	F4	Write	Read		
VA-RMS	000077E735DD 13FE8FEC	Write	Read	STIH LITH InstTH 001B30010F2E 000A320065B1 0081279B Write Read Write	

Figure 5.14: PL7413 Leakage Debug setting

4.4.2 Leakage INST Protect Indicate

Please use PL7413 MP tool to help you to check it. First please check your Leakage INST protect settings, then enter engineer mode, and find the "debug" form. In the debug form, you can find Leak_INST_EN and ILeak_50ms(read IB2_ACC), ILEAK_inst_TH, , LeakINST_TRIP.

- Please select the debug form
- Press "Read All".
- Press "Read"
- Please enable "RLY_ON_EN"
- Enable "Leak_INST_EN"
- If IB current =0.07A, LeakINST_TRIP will 1.
- If you want to check ILeak_50ms(IB2_ACC), please enable Leak_EN
- Press "READ", it will read ILeak_50ms(IB2_ACC)



Figure 5.15: PL7413 Leakage Debug Flow

4.5 Auto Learn ZCC

Prolific

DSP will auto lean when 1st relay on/off

RLY on base on V and off base on I

When on load, relay off will base on V.

Control the functions enable in CFG register (0x3803~0x3804):

Address	Bits	Description
0x3803~	15	
0x3804	14	OWP_EN
	13	HANDSHK_EN
	12	ZCC_Auto_Learn
	11	CLEAR_FLAG
	10	INST_IA_EN
	09	Leakage_INST_EN
	08	Leakage_EN
	07	CF_CNTB_EN
	06	NOLOAD_EN
	05	OCPA_EN
	04	CF_CNTA_EN
	03	KWH_EN
	02	RELY_ON_EN
	01	ZX_Half
	00	AVM_EN

Table 5.4 : Auto Lean setting



CFG_12 Force_Learn =1

- 0 ZCC -- when on off
- 1 ZCC_Lean as "6" (3/On, 3/OFF)

0x3804 bit4(CFG_12) is 1, DSP will force to auto counting the zero-crossing.3 times after the completion of learning,

- CFG_1 ZX_Auto =1
 - 0 ZX_Htime set by ZX_Half
 - 1 ZX_Htime auto calculate



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Prolific Technology Inc.

7F, No. 48, Sec. 3, Nan Kang Rd. Nan Kang, Taipei 115, Taiwan, R.O.C. Telephone: +886-2-2654-6363 Fax: +886-2-2654-6161 E-mail: <u>sales@prolific.com.tw</u> Website: http://www.prolific.com.tw