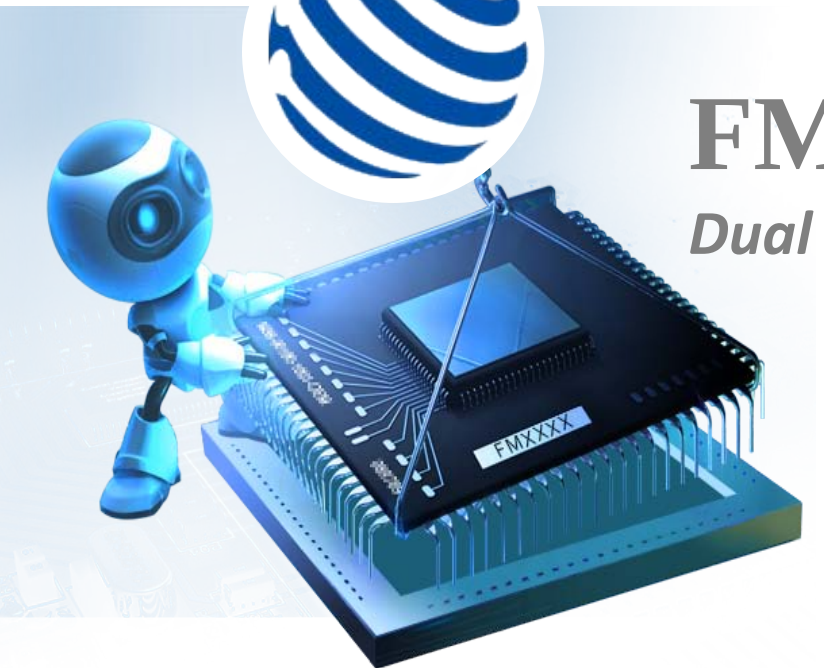

FM13DT160 Introduction

Dual Frequency Three Interface Temperature Sensor and Logger IC

Shanghai Fudan Microelectronics Group Co., Ltd.

2021-04-14

Three Interfaces

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•Contactless-UHF

- ➢EPC Global C1G2 V1.2.0
- ➢Operating Frequency：840~960MHz
- ➢Temperature measurement sensitivity (battery assistant mode)：-25dBmive

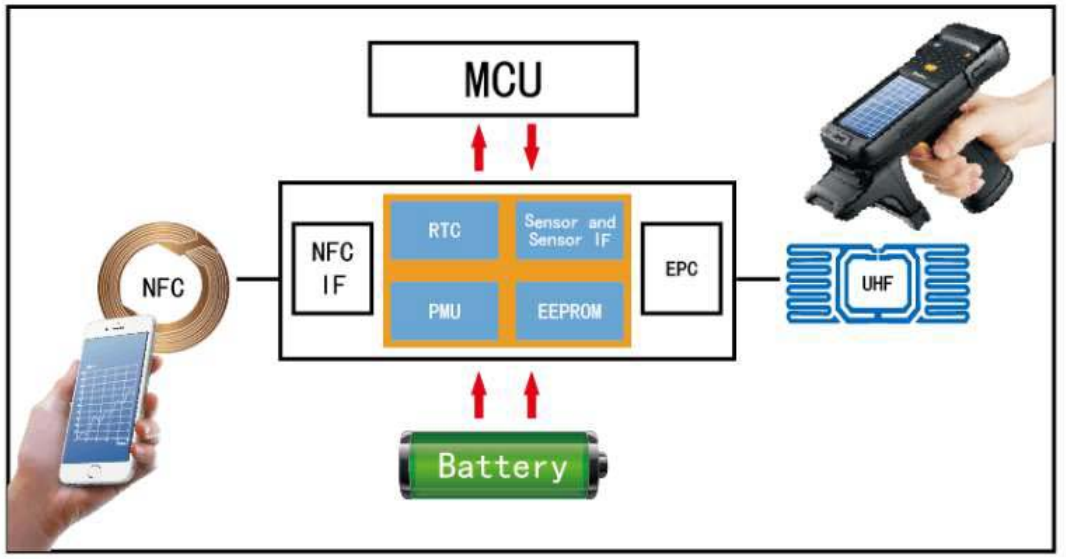
•Contactless-HF (NFC)

- ➢ISO/IEC 15693 (NFC T5T) or ISO/IEC 14443 (NFC T2T)
- ➢Operating Frequency：13.56MHz
- ➢Resonant capacitance：23.5pF
- ➢Temperature measurement distance：5cm（NFC phone reader）
- ➢Communication baud rate：26k bps or 106 bps

•Contact

- ➢I2C
- ➢Power supply：2.7V~3.6V
- ➢Communication baud rate：100k bps

To C & To B



Application Field

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- **Cold Chain temperature monitor for the logistics company and the manufacturer:**
  - Pharmaceutical such as vaccine
  - Food material transportation for the fast food restaurant
  - Food transportation for the supermarket
  - Special chemicals
- **Real time temperature measurement & Inventory management**
- **NFC sensor for body or environment temperature measurement**
- **Pressure measurement**

Temperature Measurement and Logging

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- Battery Supply Voltage：**1.1V~1.65V**
- Temperature Accurate Measurement Range：**-35℃~50℃**
- Temperature Sensor Absolute Accuracy：**±0.5℃ @ -35℃~50℃**
- RTC Measurement Interval: **1s ~ 65535s**
- Configurable Delay time for starting RTC logging: **1m~10days**
- Configurable stop time for the logging process
- Multiple modes selectable for logging: **normal mode or limit mode etc**
- RTC accuracy：**±2%@-35℃~50℃**

Logging Temperature Data Storage Format Introduction

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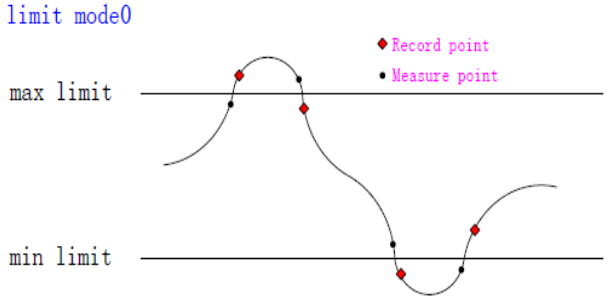
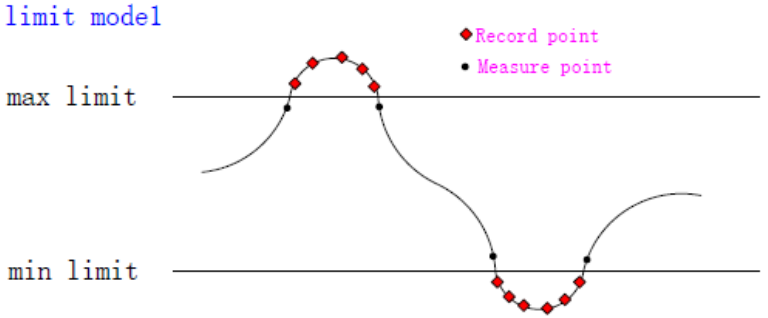
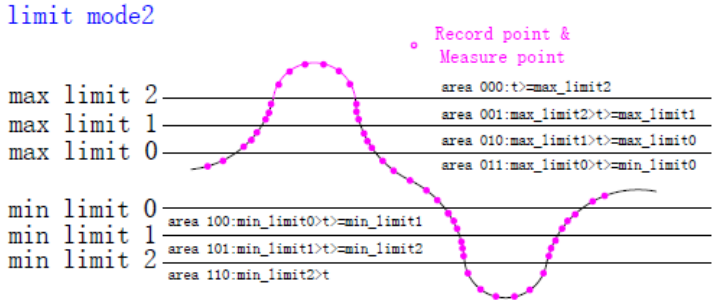
<table>
<tr><th>Mode</th><th>Brief description</th><th>Potential Logging points</th><th>Actual Logging points</th></tr>
<tr><td>limit mode 0</td><td>There are high threshold and low threshold in the limit mode0. The logging data will be memoried one time only when its value is just beyond the threshold. Every logging data occupies one block.
<table>
<tr><th>bit31</th><th>bit30-16</th><th>bit15-12</th><th>bit9-0</th></tr>
<tr><td>parity</td><td>time number</td><td>flag</td><td>temperature value</td></tr>
</table></td><td>Measure point 65535
Record point 5120</td><td>Measure point65535
Record point 4864</td></tr>
<tr><td>limit mode 1</td><td>There are high threshold and low threshold in the limit mode1. The all logging data will be memorized when their values beyond the range threshold. Every logging data occupies one block.
<table>
<tr><th>bit31</th><th>bit30-16</th><th>bit15-12</th><th>bit9-0</th></tr>
<tr><td>parity</td><td>time number</td><td>flag</td><td>temperature value</td></tr>
</table></td><td>Measure point 65535
Record point 5120</td><td>Measure point65535
Record point 4864</td></tr>
<tr><td>limit mode 2</td><td>The full temperature range is divided into 7 zones by 3 high thresholds and 3 low thresholds. The logging data will be compared with the thresholds to select which zone it will locate in after the measurement completed. Only the zone number will be memoried whose length is 4bits.
<table>
<tr><th>bit7</th><th>Bit6-4</th><th>bit3</th><th>bit2-0</th></tr>
<tr><td>flag</td><td>temperature area number</td><td>flag</td><td>temperature area number</td></tr>
</table></td><td>Measure and Record point 40960</td><td>Measure and Record point 38912</td></tr>
</table>







Logging Temperature Data Storage Format Introduction

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<table>
<tr><th>Mode</th><th>Brief description</th><th>Potential Logging points</th><th>Actual Logging points</th></tr>
<tr><td>normal mode（default）</td><td>There is only one logging data saved in one block in this mode.
<table>
<tr><th>bit31</th><th>bit30-16</th><th>bit15-12</th><th>bit9-0</th></tr>
<tr><td>parity</td><td>time number</td><td>flag</td><td>10 bit temperature value</td></tr>
</table></td><td>Measure and Record point 5120</td><td>Measure and Record point 4864</td></tr>
<tr><td>compress mode 0</td><td>The length of the logging data is 8bits.
<table>
<tr><th>bit31 -24</th><th>bit23-16</th><th>Bit15-8</th><th>bit7-0</th></tr>
<tr><td>Temperature value3</td><td>Temperature Value2</td><td>Temperature value1</td><td>Temperature value0</td></tr>
</table></td><td>Measure and Record point 20480</td><td>Measure and Record point 19456</td></tr>
<tr><td>compress mode1</td><td>The logging data is 10bits. There are 3 temperature datas in one block
<table>
<tr><th>bit31</th><th>bit30</th><th>bit29-20</th><th>bit19-10</th><th>bit9-0</th></tr>
<tr><td>parity</td><td>flag</td><td>10bit Temperature value2</td><td>10bit Temperature value1</td><td>10bit Temperature value0</td></tr>
</table></td><td>Measure and Record point 15360</td><td>Measure and Record point 14592</td></tr>
<tr><td>compress mode 2</td><td>The logging data is 10bits which is saved in the data area one by one. The left space that is less than 10bits is used to store a part of the next data.
<table>
<tr><th>bit31 -30</th><th>bit29-20</th><th>bit19-10</th><th>bit9-0</th></tr>
<tr><td>temperature value3[1：0]</td><td>10bit Temperature value2</td><td>10bit Temperature value1</td><td>10bit Temperature value0</td></tr>
</table></td><td>Measure and Record point 16384</td><td>Measure and Record point 16332</td></tr>
</table>

Logging Temperature Data Storage Format Introduction

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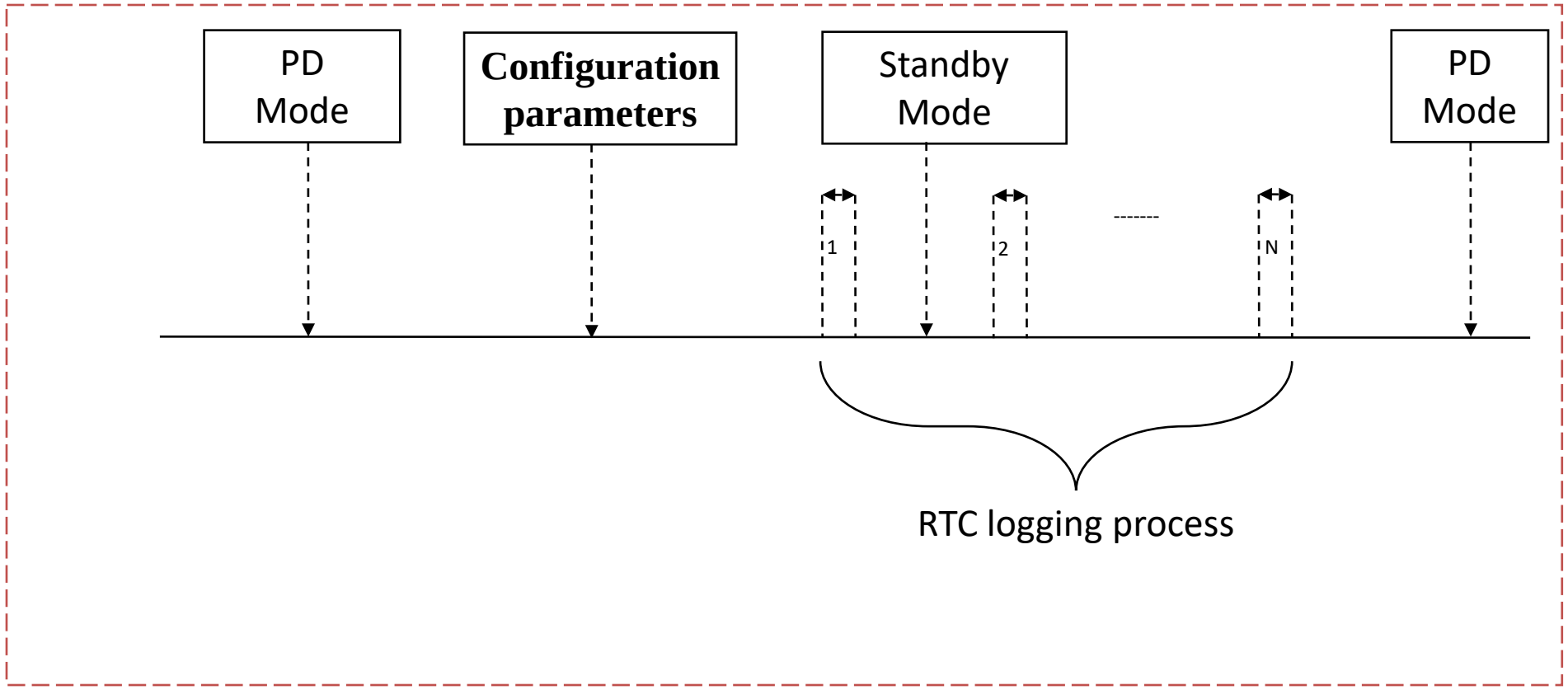
<table>
<tr><th>Mode</th><th>Brief description</th><th>Potential Logging points</th><th>Actual Logging points</th></tr>
<tr><td>Original mode</td><td>In this mode, the original measurement data is saved which is the temperature logging data or the measurement result of off-chip sensors such as pressure or humidity.
<table>
<tr><th>bit31</th><th>bit30</th><th>Bit28-16</th><th>bit15</th><th>bit14</th><th>bit12-0</th></tr>
<tr><td>parity</td><td>flag</td><td>13bit Temperature value1</td><td>parity</td><td>flag</td><td>13bit Temperature value0</td></tr>
</table></td><td>Measure and Record point 10240</td><td>Measure and Record point 9728</td></tr>
</table>

normal mode temperature value $T=vdet\_a*x(t)+vdet\_b+offset$

x(t): Original mode temperature value； **vdet_offset** address： 0xb04a~0xb04b；
vdet_a address： 0xb04c~0xb04d； **vdet_b** address： 0xb04e~0xb04f

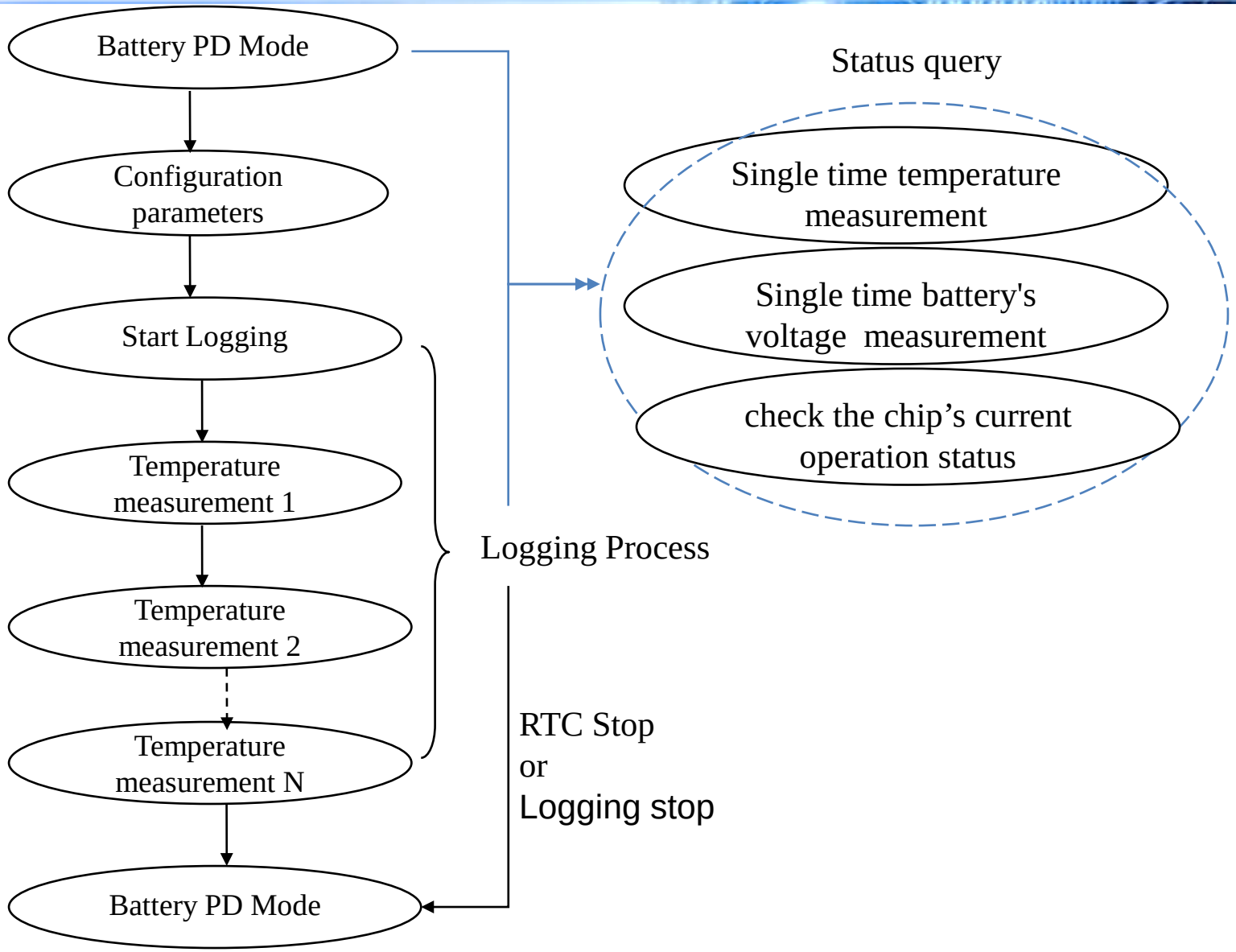
Configuration	EEPROM Address	Function Description
user_cfg0.temp_format_cfg[2:0]	0xb040~0xb043	Configuration of the temperature data storage format 000： compress mode 0 001： compress mode 1 010： compress mode 2 011： normal mode 100： limit mode 0 101： limit mode 1 110： limit mode 2 111： original data mode

Tag Working Process



Note：In configuration parameters process, When the chip receives the UHF communication signal such as ACK, the chip's semi-active mode will be waked up to enhance the sensitivity of the UHF interface. The chip will go back to PD mode when the interval between any two UHF command is larger than 1.6s.

Tag Working Process



Electrical characteristics

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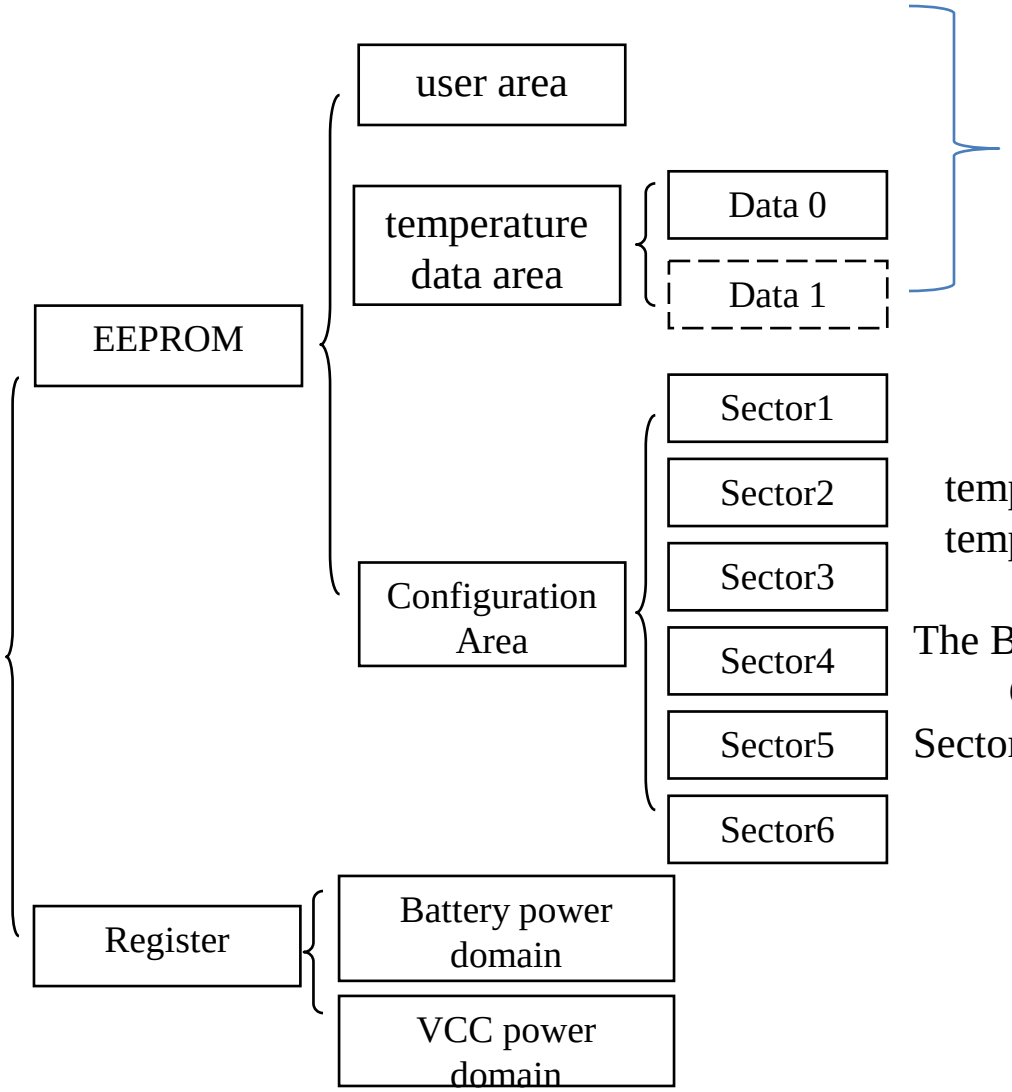
Symbol	Parameter	Conditions	Min	TYP	Max	Unit
Vbat	Battery supply voltage		1.1	1.5	1.65	V
I_{BAT-PD}	Supply current in power down mode	25℃, Vbat=1.5v		0.06	0.1	uA
$I_{BAT-SEMI-ACT}$	Supply current in semi-active mode, RTC do not work, not write EEPROM	25℃, Vbat=1.5v		280		uA
$I_{BAT-STD}$	Supply current in standby mode, RTC is working	25℃, VBat=1.5v		0.6	1	uA
I_{BAT-OP}	Battery current in temperature measurement	25℃， VBat=1.5v		440		uA
I_{BAT-EE_WR}	Battery current when Writing EEPROM	25℃， VBat=1.5v		640		uA

Memory



20KBytes

Total： 164kbits

Two sensor data area whose size is configurable: Max 160kbits

User area is configurable： 0~8kbits

Potential temperature point**: 20000**

user area： 1k(1024)bytes， address:0x0000h~0x03FFh

temperature data area 0： 19kbytes， address:0x1000h~0x5BFFh

temperature data area 1： 0kbytes。

Register： include Battery power domain and VCC power domain.

The Battery register under VBAT power domain is effective only when VBAT powers on.

Configuration Area ：

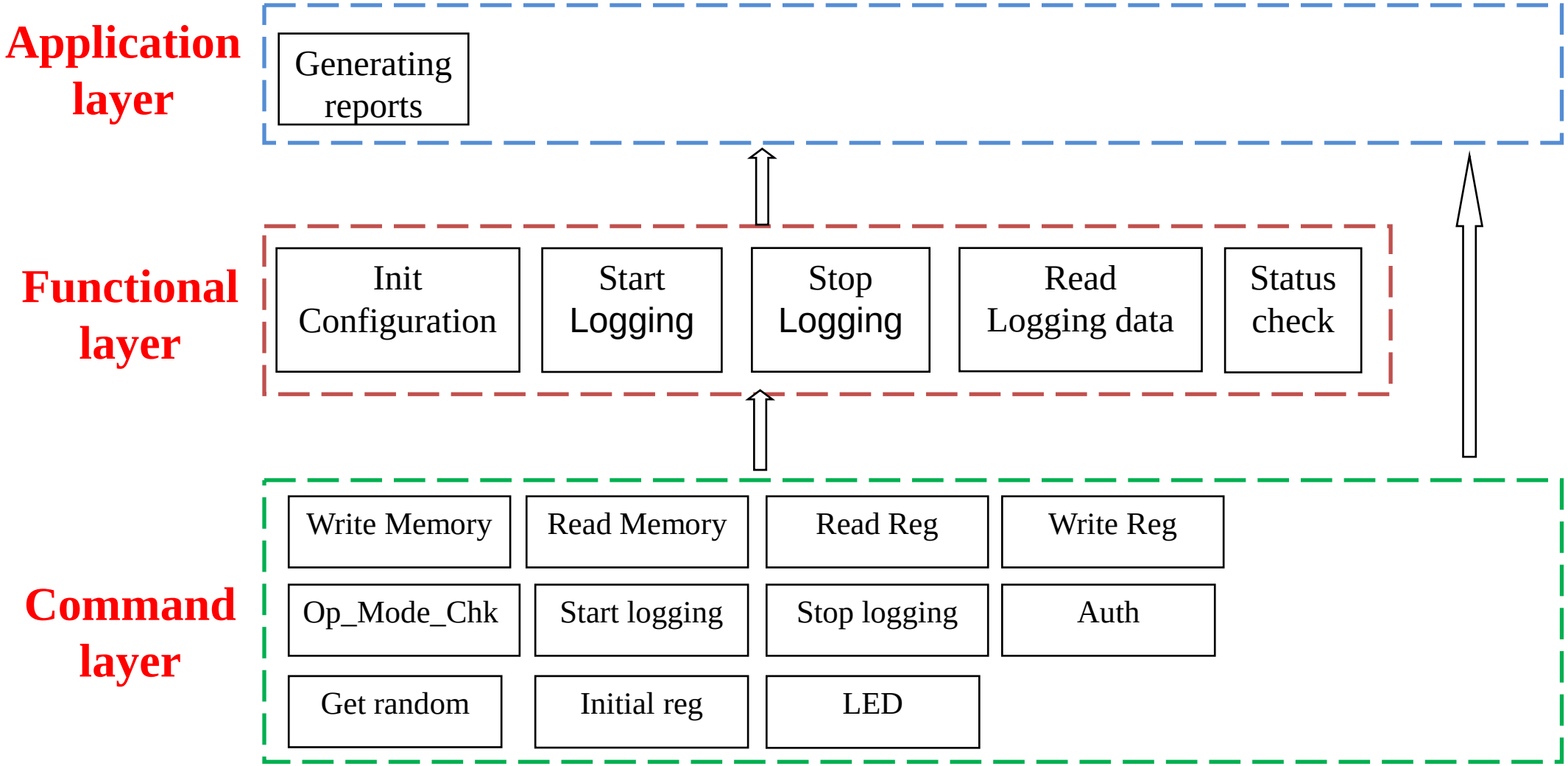
Sector1/Sector2/Sector3： This three sector about temperature para, surport lock.

Sector4： This sector about lock and password

Sector5： This sector serves as the configuration memory for UHF interface.

Sector6： This sector stores some indication information is read only.

Software Architecture Reference



System framework reference

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A

Label Print & Start Logging

Label Sticker

Stock Out

B

Stock in
Acquisition UID, temperature logging data

UID
Parameter configuration

UID
Outgoing Information

UID
Storage Information
Transport process temperature logging data

Data Platform

Data reporting

Abnormal handling

HF Mobile APP data platform

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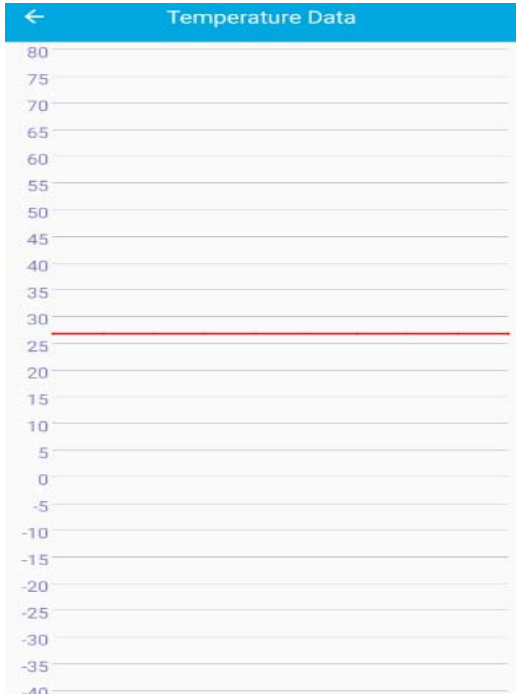
A Location (Out of stock)

NFC

B Location
Obtain temperature data for transport processes, generate data files and charts

测温状态	测温结束
最高温度	29.0℃
最低温度	28.25℃
当前测温次数	10 / 10
当前设置测温范围	[0℃,40℃]
当前测温间隔时间	1s
当前测温开始时间	2019-10-17 14:53:44
当前测温超过最低温度次数:	0
当前测温超过最高温度次数:	0
2019-10-17 14:53:44	29.0℃
2019-10-17 14:53:45	28.75℃
2019-10-17 14:53:46	28.75℃
2019-10-17 14:53:47	28.5℃
2019-10-17 14:53:48	28.5℃
2019-10-17 14:53:49	28.5℃
2019-10-17 14:53:50	28.25℃
2019-10-17 14:53:51	28.25℃
2019-10-17 14:53:52	28.25℃
2019-10-17 14:53:53	28.25℃



Data Platform

UHF data platform: multiple labels operate simultaneously

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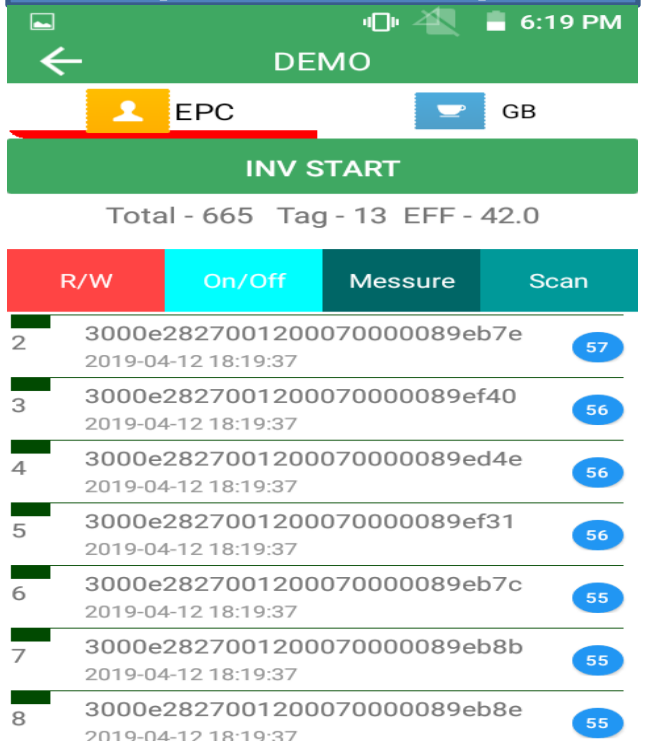
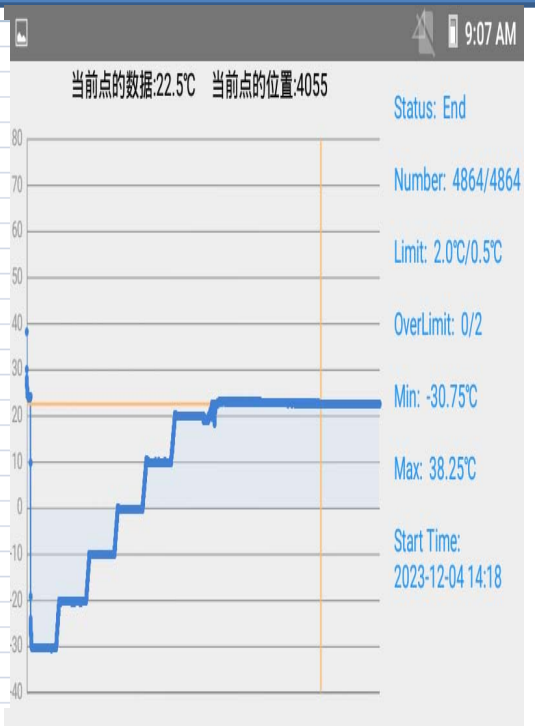
A Location (Out of stock)



B Location
Obtain temperature data for transport processes, generate data files and charts

Category	Information
TAG Name	e282700120007000008b0a80
Logging Points	5
Limited Temperature Range	[0℃,40℃]
Time Interval	1s
Start Time	2020-03-09 09:57:13
Number of Over Low Threshold	0
Number of Over High Threshold	0
e282700120007000008b0a80 Temperature 1	17.25℃
e282700120007000008b0a80 Temperature 2	17.00℃
e282700120007000008b0a80 Temperature 3	17.00℃
e282700120007000008b0a80 Temperature 4	17.00℃
e282700120007000008b0a80 Temperature 5	17.00℃
TAG Name	e282700120007000008b0577
Logging Points	5
Limited Temperature Range	[0℃,40℃]
Time Interval	1s
Start Time	2020-03-09 09:57:14
Number of Over Low Threshold	0
Number of Over High Threshold	0
e282700120007000008b0577 Temperature 1	17.00℃
e282700120007000008b0577 Temperature 2	17.00℃
e282700120007000008b0577 Temperature 3	17.00℃
e282700120007000008b0577 Temperature 4	17.00℃
e282700120007000008b0577 Temperature 5	17.00℃



Data Platform

UHF data platform: multiple tags current temperature acquisition

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Freq : 915.25MHz Power : 15dBm Antenna : fixed ch 4 Data Encoding : Miller2

Index	Sec	PC	EPC	Rssi	Ch	Count	Freq	Time
1	--	3000	e28270012000700008b0a80	-34	4	1	915250	2020/3/9 10:52:22
2	--	3000	e28270012000700008b0577	-29	4	1	915250	2020/3/9 10:52:22

```
2020/3/9 10:52:27 e28270012000700008b0a80  Current temperature: 17.50℃
2020/3/9 10:52:27 e28270012000700008b0577  Current temperature: 17.75℃
```

Ordering information (General configuration)

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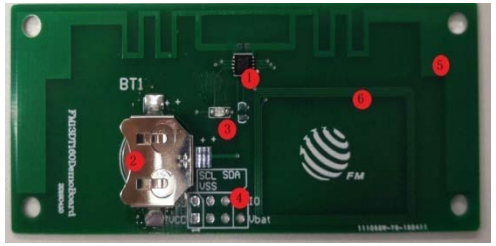
1、 TDFN10

Type name	Package	Pack	Description
FM13DT160-T2T-DNC-T-G	TDFN10	Reel	D2NI configuration，Dual frequency (ISO14443+UHF)
FM13HT160-T5T-DNC-T-G	TDFN10	Reel	H5NI configuration，HF frequency ISO15693)

2、 Bare die with Gold bump

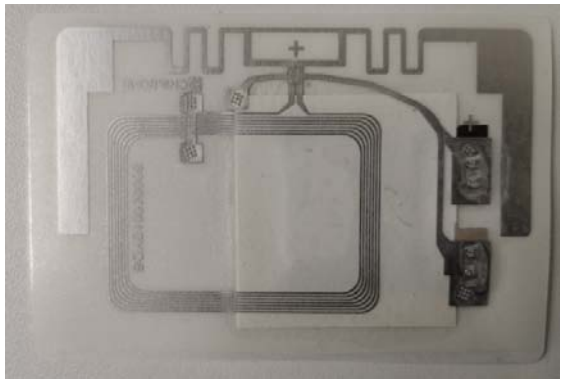
Type name	Package	Pack	Description
FM13DT160-T2T-WIB5-DP	Bump wafer	8inch bump wafer (sawn,150um thickness)	D2NI configuration, Dual frequency （ISO14443+UHF)
FM13DT160-T2T-WIS5	Sawn wafer	8inch wafer (sawn,150um thickness)	D2NI configuration, Dual frequency （ISO14443+UHF)
FM13HT160-T5T-WIB5-DP	Bump wafer	8inch bump wafer (sawn,150um thickness)	H5NI configuration, HF frequency ISO15693)
FM13HT160-T5T-WIS5	Sawn wafer	8inch wafer (sawn,150um thickness)	H5NI configuration, HF frequency ISO15693)

Samples

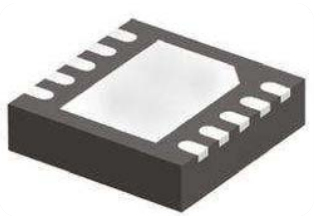


PCB DEMO

PCB Double Frequency Tag
with Silicon package
Anti-water & Drop resistance

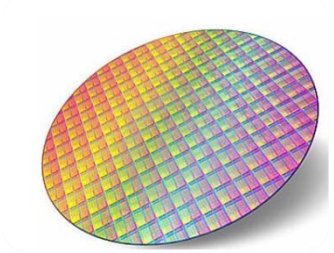


Double Frequency Tag Inlay
with Full Print Paper Battery



TDFN10

PCB Single Frequency Tag



Wafer

Technical support

复旦微电子集团
Fudan Microelectronics Group

- Datasheets of chip and label
- Application manual
- HF demo APP and source code(Android and IOS)
- UHF demo APP and firmware source code base on R2000 FW2.6.0 (UHF READER IC) and SAM7S256 (MCU)
- https://github.com/FudanMicro/FM13DT160

THANK YOU!