

# Data Sheet

# TOS<sup>TM</sup>

Touch On Steel  
[Model : WJM1051]

**Revision History**

Revision	Revision Date	Description
Rev. 1	2015. 12. 23	First Draft

**CONTENTS**

<b>1. INTRODUCTION</b>	<b>6</b>
.....	
1.1 Overview	6
1.2 Key Features	6
<b>2. HARDWARE ARCHITECTURE</b>	<b>7</b>
.....	
2.1 Block Diagram	7
2.2 Pin Configurations	8
2.3 Module Dimension	9
2.4 Film Dimension	10
<b>3. REFERENCE DESIGN</b>	<b>11</b>
.....	
3.1 Schematic	11
<b>4. ELECTRICAL DATA</b>	<b>12</b>
.....	
4.1 DC Characteristics	12
4.2 Power Consumption	12
4.3 Electro Static Discharge(ESD)	12

<b>5. INTERFACES</b>	<b>13</b>
<hr/>	
5.1 Command Response	13
5.2 Timing Chart	13
5.3 Command Register Map	14
5.3.1 How to access	14
5.3.2 Read Register	14
5.3.3 Write Register	16
5.3.4 Details	18
1) Event	18
2) Channel Number	18
3) MOT (Max On Time)	18
4) Run Mode	18
5) Impedance Raw Data	18
6) Impedance Reference	19
7) Impedance Threshold	19
8) Impedance Hysteresis	19
9) Sub Sensing	19
10) Scan Cycle	20
11) NKS	20
12) Sleep Mode	20
13) Run Mode & Calibration	20
14) Reset	20

# 1. INTRODUCTION

## 1.1 Overview

**TOS (Touch on Steel, trade mark) is an unique technology that enables touch buttons on especially metallic plate. This technology is based on Impedance sensing and strain sensing method.**

**It allows the user to apply touch button on flat as well as rounded shape plate.**

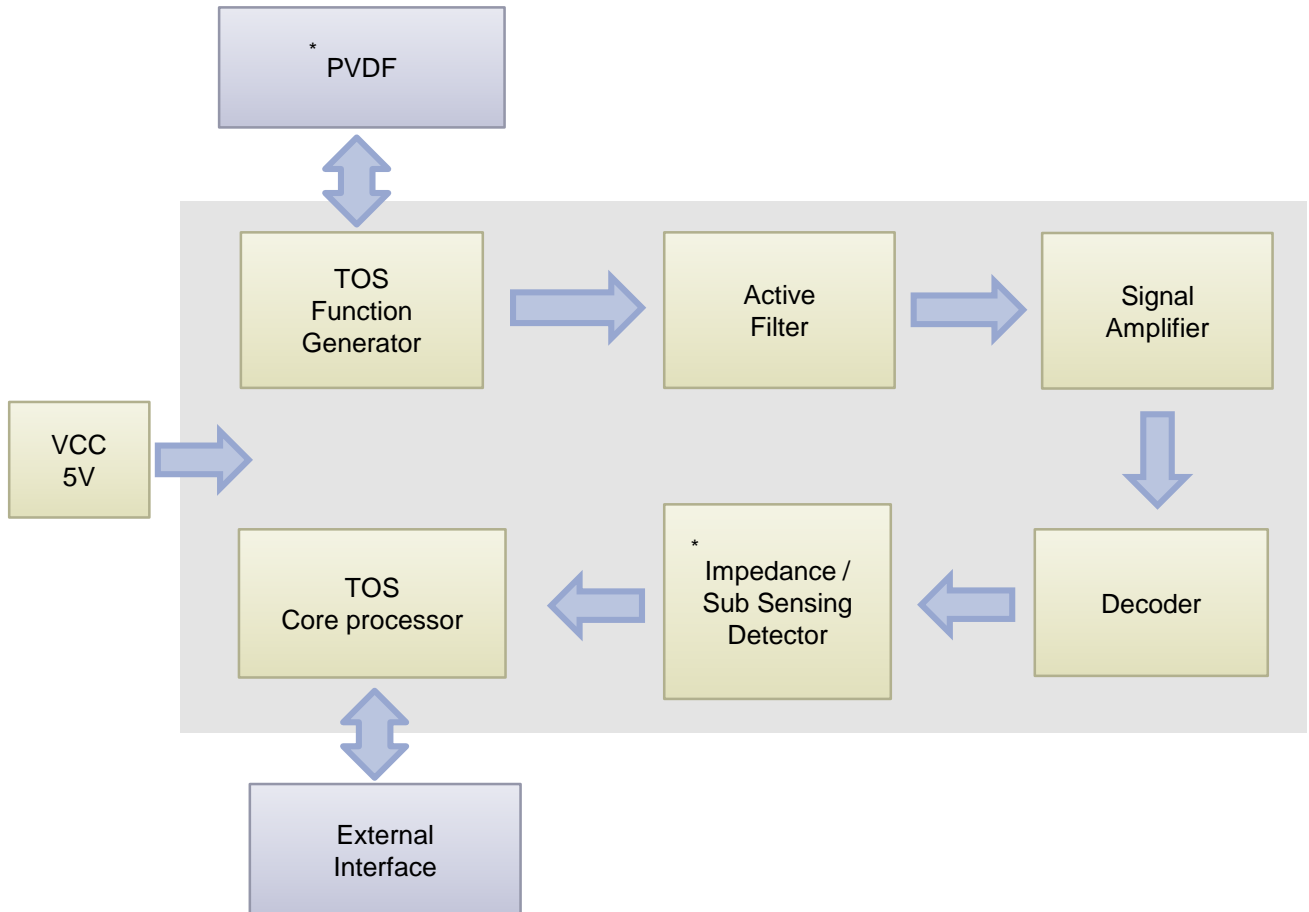
**In addition, TOS offers very easy production and lower cost. User need to attach piezo film to touching area by using double sided adhesive type.**

## 1.2 Key Features

- **WJM1051B : 8 configurable channels (WJM1051A : 1 channel)**
- **Multi-key (pressing more than two buttons) function possible**
- **Long-time (pressing and holding button) function possible**
- **Preventing water drop effect**
- **Thickness of metal : 0.1 ~2.0mm**
- **TOS on coated metal : possible but need engineering tuning**
- **Operating voltage : 5V**
- **Power consumption :**
  - Idle - 5.6mA
  - Run - 18.2mA
  - Sleep – 3mA
- **Operating temperature : -20 ~ +85°C**
- **Recommended adhesive tape : 3M**
- **Serial communication : I<sup>2</sup>C (Up to 400KHz)**
- **RoHS compliant**

## 2. HARDWARE ARCHITECTURE

### 2.1 Block Diagram

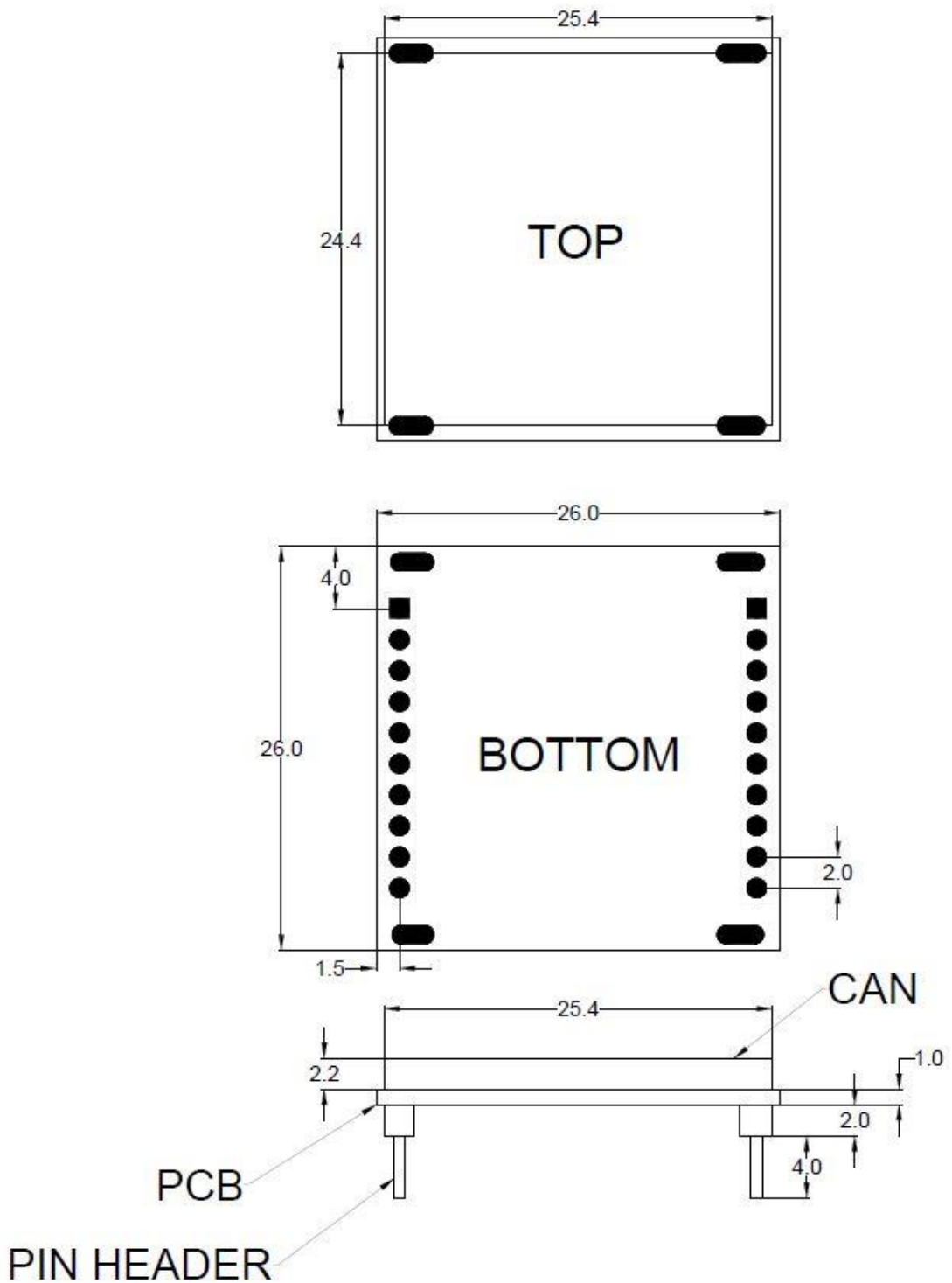


- A : Impedance Detector
- B : Sub Sensing Detector
- Hybrid = A + B
- PVDF : Polyvinylidene fluoride

## 2.2 Pin Configuration

No.	Name	Description
1	GNDK1	Key Ground group 1
2	KEY1	Key in 1
3	KEY2	Key in 2
4	KEY3	Key in 3
5	KEY4	Key in 4
6	KEY5	Key in 5
7	KEY6	Key in 6
8	KEY7	Key in 7
9	KEY8	Key in 8
10	NC	Must be open
11	NC	Must be open
12	/EVENT	Touch Detection Signal (Active Low)
13	I2CADD	I2C Address Selection (0:0x2A, 1:0x2B)
14	/RESET	Hardware Reset
15	SDA	I2C Data
16	SCL	I2C Clock
17	GND	Ground
18	NC	Must be open
19	GND	Ground
20	VCC	DC +5V

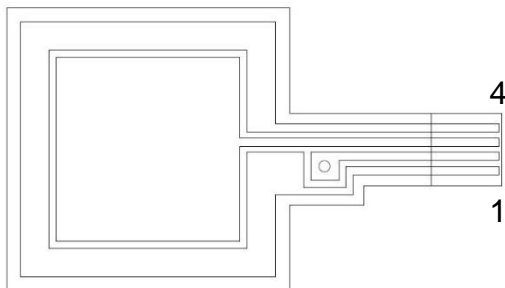
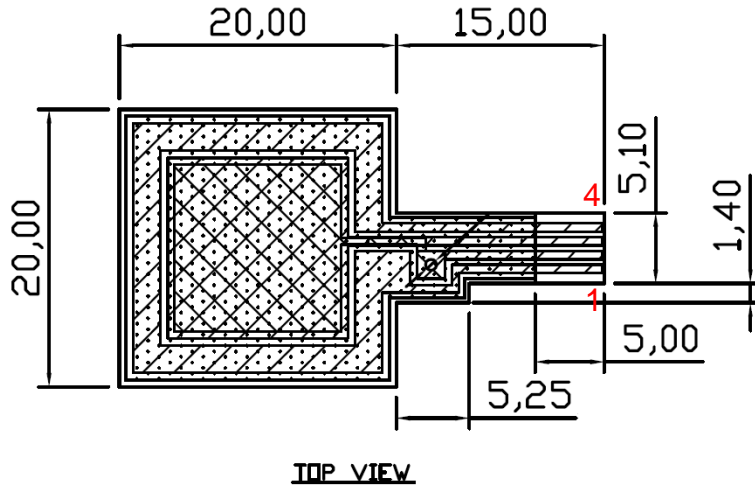
### 2.3 Module Dimension





## 2.4 Film Dimension

[ PVDF for 1 buttons ]

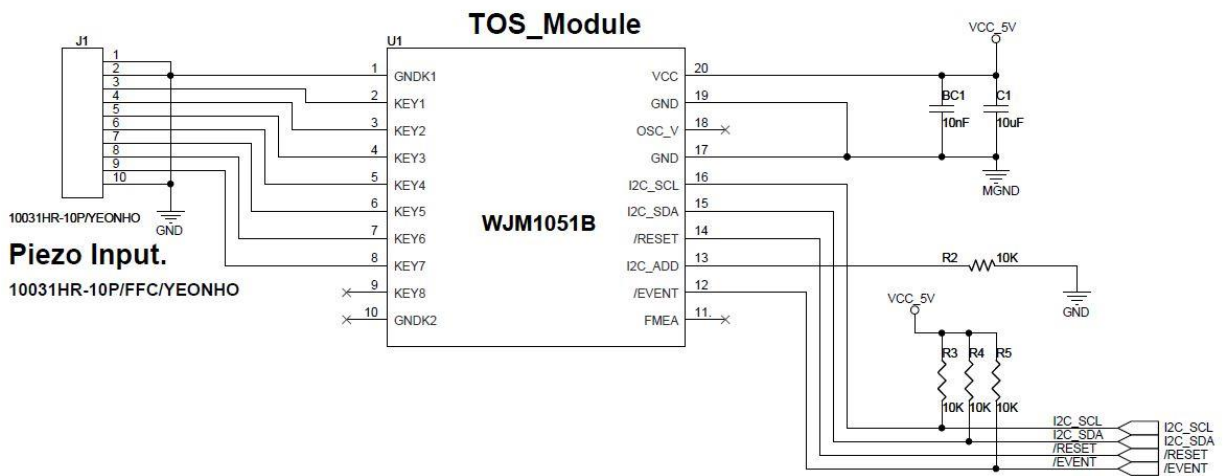
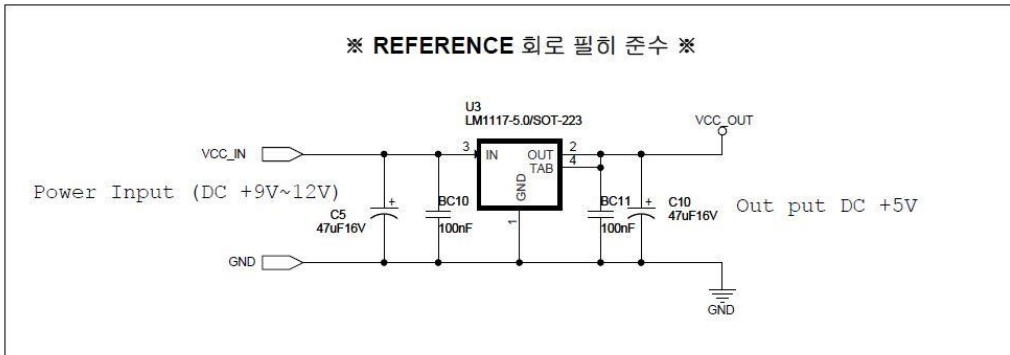


\* Bottom Layer Contact

NO	Description
4	GND
3	GND
2	Key in
1	GND

### 3. REFERENCE DESIGN

#### 3.1 Schematic



## 4. ELECTRICAL DATA

### 4.1 DC Characteristics

\*Notes : 1. Typical Values at 25 °C

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>CC</sub>	Input Voltage	4.75	5	5.25	V
V <sub>IL</sub>	Input Low Voltage	-0.5		0.3V <sub>CC</sub>	V
V <sub>IH</sub>	Input High Voltage	0.7V <sub>CC</sub>		V <sub>CC</sub> + 0.5	V
V <sub>OL</sub>	Output Low Voltage			0.7	V
V <sub>OH</sub>	Output High Voltage	4.3			V
I <sub>IL</sub>	Input Leakage Current I/O Pin			1	uA
I <sub>IH</sub>	Input Leakage Current I/O Pin			1	uA

### 4.2 Power Consumption

Symbol	Parameter	Min	Typ	Max	Unit
I <sub>CC</sub>	Idle Mode			5.6	mA
	Run(Active Mode)			18.2	mA
	Sleep Mode			3	mA

### 4.3 Electro Static Discharge(ESD)

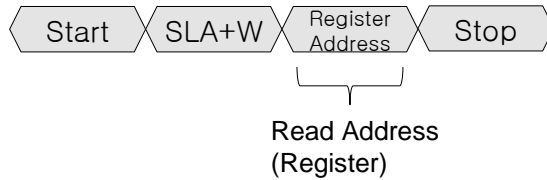
Mode	Level	Unit
Human Body Model	±1.0K	V



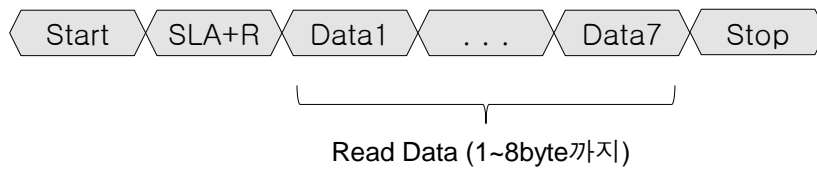
## 5. INTERFACE

### 5.1 I<sup>2</sup>C Command Response

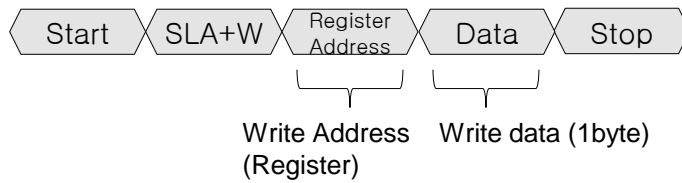
Set address pointer



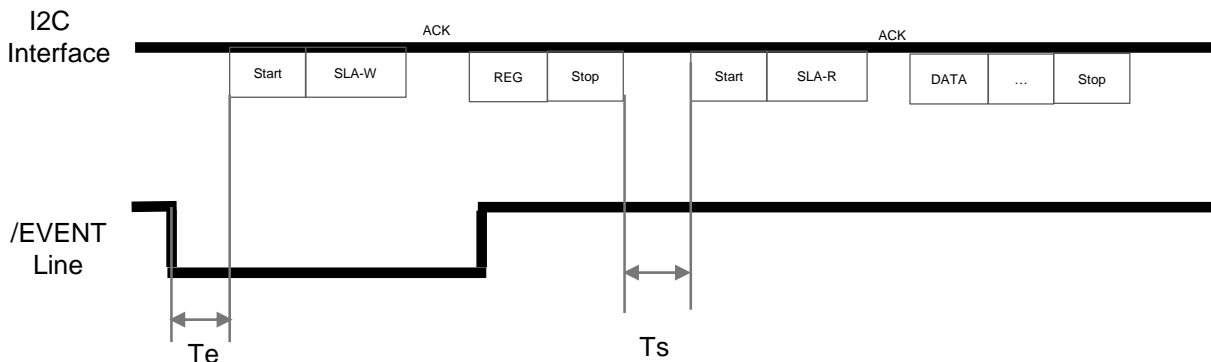
Read data



Write data



### 5.2 Timing Chart



Te : /EVENT 신호가 LOW로 된 후 5ms 이내에 I2C Data를 읽어야 한다

Ts : I2C Register address를 Write 한 후 Stop Restart 조건에서 1ms 이상 지연을 하여야 한다.

## 5.3 Command Resistor Map

### 5.3.1 How to access

- 1) Register 0x00의 Touch Event를 확인
- 2) Register 0x01의 Touch Status로 Touch가 발생한 Channel 확인
- 3) Data Read/Write는 최대 8byte 까지 가능

# Slave Address : 0x2A / 0x2B ( Jumper설정 : Default 0x2A )

### 5.3.2 Read Register

Register Address	R/W	Data ( 8 Bit )								비고
		7(MSB)	6	5	4	3	2	1	0(LSB)	
0 (0x00)	R					Impedance Sensing	Sub Sensing		Touch Event	Event
1	R	Touch CH7	Touch CH6	Touch CH5	Touch CH4	Touch CH3	Touch CH2	Touch CH1	Touch CH0	Impedance Status
2	R								Sub	Sub Status
3	R	Channel Number								Max 8
4	R	Reserved								
5	R	Reserved								
6	R	Mod								per 1sec
7	R	Reserved								
8	R	Reserved								
9	R	Reserved								
10	R	Reserved								
11	R	Run Mode								2:Hybrid, 0:Impedance
...										
24 (0x18)	R	Impedance data [ ch 0 ]								Impedance Raw data ( 0 ~ 255 )
25	R	Impedance data [ ch 1 ]								
26	R	Impedance data [ ch 2 ]								
27	R	Impedance data [ ch 3 ]								
28	R	Impedance data [ ch 4 ]								
29	R	Impedance data [ ch 5 ]								
30	R	Impedance data [ ch 6 ]								
31	R	Impedance data [ ch 7 ]								
32 (0x20)	R	Impedance Reference [ ch 0 ]								Impedance Reference ( 0 ~ 255 )
33	R	Impedance Reference [ ch 1 ]								
34	R	Impedance Reference [ ch 2 ]								
35	R	Impedance Reference [ ch 3 ]								
36	R	Impedance Reference [ ch 4 ]								
37	R	Impedance Reference [ ch 5 ]								
38	R	Impedance Reference [ ch 6 ]								
39	R	Impedance Reference [ ch 7 ]								

40 (0x28)	R	Impedance Threshold [ ch 0 ]	Impedance Threshold -> 모듈에 현재 Setting 되어 있는 값
41	R	Impedance Threshold [ ch 1 ]	
42	R	Impedance Threshold [ ch 2 ]	
43	R	Impedance Threshold [ ch 3 ]	
44	R	Impedance Threshold [ ch 4 ]	
45	R	Impedance Threshold [ ch 5 ]	
46	R	Impedance Threshold [ ch 6 ]	
47	R	Impedance Threshold [ ch 7 ]	
48 (0x30)	R	Impedance Hysteresis [ ch 0 ]	Active Hysteresis -> 모듈에 현재 Setting 되어 있는 값
49	R	Impedance Hysteresis [ ch 1 ]	
50	R	Impedance Hysteresis [ ch 2 ]	
51	R	Impedance Hysteresis [ ch 3 ]	
52	R	Impedance Hysteresis [ ch 4 ]	
53	R	Impedance Hysteresis [ ch 5 ]	
54	R	Impedance Hysteresis [ ch 6 ]	
55	R	Impedance Hysteresis [ ch 7 ]	
56 (0x38)	R	Sub Raw	Scan cycle : - Scan Time (*10ms)
57	R		
58	R	Sub Reference	
59	R		
60	R	Idle Scan Cycle X 10ms	
61	R	Sub Threshold	
62	R	Sub Hysteresis	
63	R		
88 (0x58)	R	NKS[ ch 0 ]	Setting NKS Group ( 0 ~ 5 ) 0 : NONE NKS GROUP -> 모듈에 현재 Setting 되어 있는 값
89	R	NKS[ ch 1 ]	
90	R	NKS[ ch 2 ]	
91	R	NKS[ ch 3 ]	
92	R	NKS[ ch 4 ]	
93	R	NKS[ ch 5 ]	
94	R	NKS[ ch 6 ]	
95 (0x5F)	R	NKS[ ch 7 ]	

### 5.3.3 Write Register

Register Address	R/W	Data ( 8 Bit )								비고
		7(MSB)	6	5	4	3	2	1	0(LSB)	
128 (0x80)	W	Channel Number								
129	W	Reserved								
130	W	Reserved								
131	W	Mod								
132	W	Reserved								
133	W	Reserved								
134	W	Reserved								
135	W	Reserved								
144 (0x90)	W	Impedance Threshold [ ch 0 ]								
145	W	Impedance Threshold [ ch 1 ]								
146	W	Impedance Threshold [ ch 2 ]								
147	W	Impedance Threshold [ ch 3 ]								
148	W	Impedance Threshold [ ch 4 ]								
149	W	Impedance Threshold [ ch 5 ]								
150	W	Impedance Threshold [ ch 6 ]								
151	W	Impedance Threshold [ ch 7 ]								
152 (0x98)	W	Impedance Hysteresis [ ch 0 ]								
153	W	Impedance Hysteresis [ ch 1 ]								
154	W	Impedance Hysteresis [ ch 2 ]								
155	W	Impedance Hysteresis [ ch 3 ]								
156	W	Impedance Hysteresis [ ch 4 ]								
157	W	Impedance Hysteresis [ ch 5 ]								
158	W	Impedance Hysteresis [ ch 6 ]								
159	W	Impedance Hysteresis [ ch 7 ]								
160 (0xA0)	W	Sub Threshold								Scan cycle : - Scan Time ( *10ms)
161	W	Sub Hysteresis								
162	W	Idle Scan cycle X 10ms								
163	W									
164	W									
165	W									
166	W									
167	W									

176 (0xB0)	W	NKS[ ch 0 ]								Setting NKS Group ( 0 ~ 5 ) 0 : NONE NKS GROUP  -> 모듈에 현재 Setting 되어 있는 값
177	W	NKS[ ch 1 ]								
178	W	NKS[ ch 2 ]								
179	W	NKS[ ch 3 ]								
179	W	NKS[ ch 4 ]								
179	W	NKS[ ch 5 ]								
179	W	NKS[ ch 6 ]								
179	W	NKS[ ch 7 ]								
...										
240 (0xF0)	W	Sleep Mode								1 : sleep start, other : wake up
241 (0xF1)	W	Run Mode & Calibration								0xF0 : hybrid, 0xF1 : Impedance only
242 (0xF2)	W	Reset								0xF0 : S/W Reset, 0xF1 : Calibration & S/W Reset



## 5.3.4 Details

### 1) Event

0 (0x00)	R					Impedance Sensing	Sub Sensing		Touch Event	Event
1	R	Touch CH7	Touch CH6	Touch CH5	Touch CH4	Touch CH3	Touch CH2	Touch CH1	Touch CH0	Impedance Status
2	R								Sub	Sub Status

Event : 현재 감지된 Touch 의 종류와 Event 발생 여부

- 0 : 이벤트 없음
- 1 : 이벤트 있음

### 2) Channel Number

Channel Number	Max 8
----------------	-------

활성 Key 수

- 1 ~ 8 : Default 1

### 3) MOT(Max On Time)

Mod	per 1sec
-----	----------

- Long Key 인정 시간이며, 설정된 시간이 지나면 Disable
- 예상치 못하게 오랫동안 키가 동작될 때 방어하기 위해서도 사용
- 1 ~ 255 : Default 10

### 4) Run Mode

Run Mode	2:Hybrid, 0:Impedance
----------	-----------------------

동작 모드 설정

- 0 : Impedance 전용 mode
- 1 : Hybrid 전용 mode → Sub sensing + Impedance sensing

### 5) Impedance Raw data

24 (0x18)	R	Impedance data [ ch 0 ]	Impedance Raw data ( 0 ~ 255 )
25	R	Impedance data [ ch 1 ]	
26	R	Impedance data [ ch 2 ]	
27	R	Impedance data [ ch 3 ]	
28	R	Impedance data [ ch 4 ]	
29	R	Impedance data [ ch 5 ]	
30	R	Impedance data [ ch 6 ]	
31	R	Impedance data [ ch 7 ]	

Raw data : 현재 해당 Key 에 대한 Raw data

- 0 ~ 255

## 6) Impedance Reference

32 (0x20)	R	Impedance Reference [ ch 0 ]	Impedance Reference ( 0 ~ 255 )
33	R	Impedance Reference [ ch 1 ]	
34	R	Impedance Reference [ ch 2 ]	
35	R	Impedance Reference [ ch 3 ]	
36	R	Impedance Reference [ ch 4 ]	
37	R	Impedance Reference [ ch 5 ]	
38	R	Impedance Reference [ ch 6 ]	
39	R	Impedance Reference [ ch 7 ]	

Impedance Reference : 현재 설정되어 있는 각 Key에 대한 Reference value

- 0 ~ 255

## 7) Impedance Threshold

Impedance Threshold [ ch 0 ]	Impedance Threshold -> 모듈에 현재 Setting 되어 있는 값
Impedance Threshold [ ch 1 ]	
Impedance Threshold [ ch 2 ]	
Impedance Threshold [ ch 3 ]	
Impedance Threshold [ ch 4 ]	
Impedance Threshold [ ch 5 ]	
Impedance Threshold [ ch 6 ]	
Impedance Threshold [ ch 7 ]	

Impedance Threshold : 해당 Key 에 대한 Threshold → 감도에 영향을 미친다

- 0 ~ 255

## 8) Impedance Hysteresis

Impedance Hysteresis [ ch 0 ]	Impedance Hysteresis -> 모듈에 현재 Setting 되어 있는 값
Impedance Hysteresis [ ch 1 ]	
Impedance Hysteresis [ ch 2 ]	
Impedance Hysteresis [ ch 3 ]	
Impedance Hysteresis [ ch 4 ]	
Impedance Hysteresis [ ch 5 ]	
Impedance Hysteresis [ ch 6 ]	
Impedance Hysteresis [ ch 7 ]	

Impedance Hysteresis : 해당 Key 에 대한 Hysteresis

- 0 ~ 100 %

## 9) Sub Sensing

Sub Raw	
Sub Reference	
Sub Threshold	
Sub Hysteresis	

Sub sensing 에 대한 Raw, Reference, Threshold, Hysteresis 값

## 10) Scan Cycle

Idle Scan Cycle X 10ms

Idle 상태에서 Sensing를 위해 Scan하는 시간/주기

- 0 ~ 255 : default 5

## 11) NKS (Neighbor Key Suppression)

NKS[ ch 0 ]	Setting NKS Group ( 0 ~ 5 ) 0 : NONE NKS GROUP  -> 모듈에 현재 Setting 되어 있는 값
NKS[ ch 1 ]	
NKS[ ch 2 ]	
NKS[ ch 3 ]	
NKS[ ch 4 ]	
NKS[ ch 5 ]	
NKS[ ch 6 ]	
NKS[ ch 7 ]	

- 인접 키가 영향을 받을 수 있는 환경, 조건에서 가장먼저 반응한 채널이 동작하게 하는 기능
- 같은 그룹으로 설정을 하면 같은 그룹의 해당 채널은 멀티 키 동작이 되지 않음
- 0 ~ 5 : default 0 ( 0 : 사용 않함, 1~5 : NKS 그룹 설정 )

## 12) Sleep Mode

240 (0xF0)	W	Sleep Mode	1 : sleep start, other : wake up
------------	---	------------	----------------------------------

Sleep mode :

- 1 / other : default 0 ( 1 : Sleep mode, other : Wake up)

## 13) Run Mode & Calibration

241 (0xF1)	W	Run Mode & Calibration	0xF0 : hybrid, 0xF1 : Impedance only
------------	---	------------------------	--------------------------------------

Run mode : Run mode 설정 : 모드 설정 후 Software reset 이 됨.

- F0 : Hybrid 전용 모드
- F1 : Impedance 전용 모드

## 14) Reset

242 (0xF2)	W	Reset	0xF0 : S/W Reset, 0xF1 : Calibration & S/W Reset
------------	---	-------	-----------------------------------------------------

Reset : 설정 후 Software reset 이 됨.

- F0 : 설정 후 Software reset 이 됨.
- F1 : Calibration