

# **NCB 3051**

**Multi-Touch Controller**

**DATA SHEET**

*Nuvoton Technology Corporation*

*NuTouch NT00*

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# 1. General Description

NCB3051 is a multi-touch controller IC designed for I2C interface that supports touch screen of 56 sensing channels I/O for one chip solution. Besides of one chip solution, NCB3051 also provide cascade function for up to four chips. Therefore, NCB3051 provides flexibility and selective functionality solution for the variety touch screen size from 5"~10.1" for single chip up to 20" for four chips

Because of integrated powerful noise suppression circuit, charge distribution sensing technic, micro-controller and combining signal analysis with advanced algorithm, NCB3051 can supplies auto self-calibration for wide operating temperature range, noise rejection for LCM noise, charger noise, high performance multi-touch tracking function and 1mm stylus support . It can be capable for any touch screen application combined with high performance controller and friendly user interfaces.

## 1.1 Features

- Touch screen
  - Support 10 concurrent true multi-touch in real times
  - Up to 10.1" diagonal screen size for single chip
  - Cascade function for up to 4 chips
- Number of Channels
  - Support 56 channels
  - Programmable scan line
- Signal Processing
  - Advanced digital filtering using hardware engine
  - Built-in DSP for software filtering
  - Auto self-calibration
  - Auto drift compensation
- Full programmable scan sequence with Individual sensor channel
- No external component for translator
- Sensor sense synchronized to LCM
- Sensors
  - Works with PET and glass sensors
  - Works with 1mm passive stylus<sub>(notes)</sub>
  - Works with several general sensor patterns
- Support I2C interface up to 1 Mhz
- Operating voltage
  - VDD:2.7~5.5V
- Power Consumption
  - Active @ 3.3V/100Hz: 30mA

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Table No. : 1220-0002-02-B

- Sleep : 15uA
- Temperature range: -40 ~ +85°C

Note: Support 3mm stylus and 1mm stylus further with external booster.

## 1.2 Application

NCB3051 applies to wide screen size range of touch application. The typical applications are list as followings:

- Tablet pc
- Ebook
- Netbook
- Notebook
- Portable instruments
- Touch screen monitors
- Gaming machines
- POS devices
- PC peripherals

## 2 Pin Assignment and Descriptions

### 2.1 Pin Assignment

Pin configuration of 88 pin QFN is as below:



Figure 0-1 Package pin configuration (QFN88)

## 2.2 Pin Descriptions

Pin listing table of 88 pin QFN is as below:

Table 2-1: Pin Listing of NCB3051

Pin No.	Name	Type	Descriptions
1	CLK		
2	S0	I/O	Touch sensor channel
3	S1	I/O	Touch sensor channel
4	S2	I/O	Touch sensor channel
5	S3	I/O	Touch sensor channel
6	S4	I/O	Touch sensor channel
7	S5	I/O	Touch sensor channel
8	S6	I/O	Touch sensor channel
9	S7	I/O	Touch sensor channel
10	S8	I/O	Touch sensor channel
11	S9	I/O	Touch sensor channel
12	S10	I/O	Touch sensor channel
13	S11	I/O	Touch sensor channel
14	S12	I/O	Touch sensor channel
15	S13	I/O	Touch sensor channel
16	S14	I/O	Touch sensor channel
17	S15	I/O	Touch sensor channel
18	S16	I/O	Touch sensor channel
19	S17	I/O	Touch sensor channel
20	S18	I/O	Touch sensor channel
21	S19	I/O	Touch sensor channel
22	S20	I/O	Touch sensor channel
23	AVDD	P	Analog Power
24	S21	I/O	Touch sensor channel
25	S22	I/O	Touch sensor channel
26	S23	I/O	Touch sensor channel
27	S24	I/O	Touch sensor channel
28	S25	I/O	Touch sensor channel
29	S26	I/O	Touch sensor channel
30	S27	I/O	Touch sensor channel
31	S28	I/O	Touch sensor channel
32	S29	I/O	Touch sensor channel
33	S30	I/O	Touch sensor channel
34	S31	I/O	Touch sensor channel
35	S32	I/O	Touch sensor channel
36	S33	I/O	Touch sensor channel

37	S34	I/O	Touch sensor channel
38	S35	I/O	Touch sensor channel
39	nRST	I	Reset Low. Has internal pull-up resistor allowing power-on reset by connecting a capacitor to GND
40	ICP_DAT	I/O	ICP(In Circuit Program) DATA
41	ICP_CK	I/O	ICP(In Circuit Program) CLK
42	S36	I/O	Touch sensor channel
43	S37	I/O	Touch sensor channel
44	S38	I/O	Touch sensor channel
45	S39	I/O	Touch sensor channel
46	S40	I/O	Touch sensor channel
47	S41	I/O	Touch sensor channel
48	VDDPST	P	IO Power supply
49	INT	O	Interrupt to Host. Low active
50	SCL	OD	I2C: Serial interface CLK
51	SDA	OD	I2C: Serial interface DATA
52	S42	I/O	Touch sensor channel
53	S43	I/O	Touch sensor channel
54	S44	I/O	Touch sensor channel
55	S45	I/O	Touch sensor channel
56	S46	I/O	Touch sensor channel
57	S47	I/O	Touch sensor channel
58	PD.10		
59	PD.11		
60	SPISS20		
61	SPICLK2		
62	MOSI20		
63	MISO20		
64	LDOCAP	P	LDO output pin, connected with 4.7uF capacitor
65	DVDD	P	Digital power
66	GND	P	Ground
67	S48	I/O	Touch sensor channel
68	S49	I/O	Touch sensor channel
69	S50	I/O	Touch sensor channel
70	S51	I/O	Touch sensor channel
71	S52	I/O	Touch sensor channel
72	S53	I/O	Touch sensor channel
73	S54	I/O	Touch sensor channel
74	S55	I/O	Touch sensor channel
75	32V	P	Booster Pin, connected with 1uF capacitor
76	C3P	P	Booster Pin, connected with 1uF capacitor
77	C3N	P	Booster Pin, connected with 1uF capacitor

78	C2P	P	Booster Pin, connected with 1uF capacitor
79	C2N	P	Booster Pin, connected with 1uF capacitor
80	C1P	P	Booster Pin, connected with 1uF capacitor
81	C1N	P	Booster Pin, connected with 1uF capacitor
82	VDDBT	P	internal boost power supply
83	5V		
84	VDD25	P	LDO output pin, connected with 1uF capacitor
85	VREF	P	Common reference voltage pin
86	VDD18	P	LDO output pin, connected with 1uF capacitor
87	BUSY	O	Scan busy pin
88	TRIG		

I      Input only                      O                      Output only, push-pull  
 P      Ground or power            I/O                  Input and output  
 OD    Open drain output

## 3 System Description

### 3.1 Architecture Overview

NCB3051 is composed of four main blocks that includes (1) Touch Sensor Interface Blocks, (2) Noise Suppression Blocks, (3) Micro-controller and (4) Host Interface. Figure3-1 is the architecture of NCB3051. And the function of these blocks will be described as following.

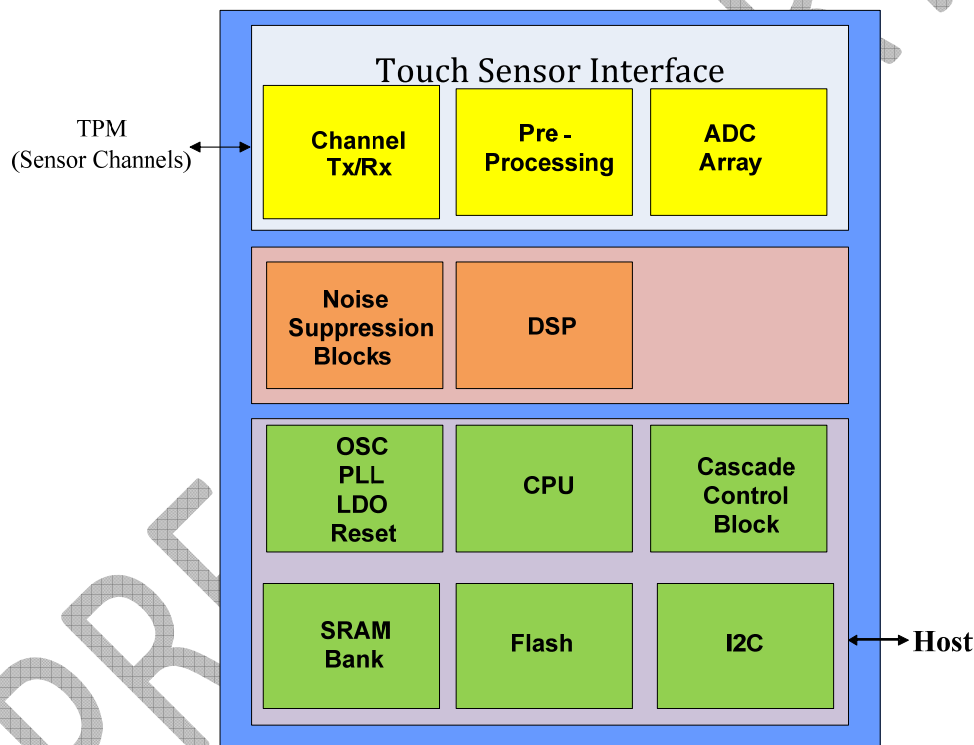


Figure3-1 NCB3051 block diagram

#### (1) Touch Sensor Interface Blocks

The main function for the touch sensor interface controller is that use charge distribution sensing to scan the touch panel by sending AC signals to Transmit (TX) sensor and receive the signal from Receive (RX) sensor to detect the variation of capacitor in touch sensor.

#### (2) Noise Suppression Blocks

The noise suppression blocks have built-in more hardware filtering, switching circuit



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and DSP to avoid noise. The noise will be suppressed before it impacts measurement accuracy and get the higher signal-to-noise ratio (SNR).

### (3) Micro-controller

The complex sensor image data generated by sensor interface blocks is processed by the algorithm that implemented by firmware. The powerful MCU is needed to execute the complex algorithm faster and detect the touch reliably.

### (4) Host interface

The host interface in NCB3051 is I2C slave interface. NCB3051 use I2C bus to communicate with host. When the point data is ready, NCB3051 will use “INT” signal to indicate Host. Host can get data through the I2C interface.

## 3.2 Operation Mode

NCB3051 operates the following three modes. Each mode will be configured by host through I2C interface.

- Active mode: NCB3051 scans the panel at full rate to detect the touch in this mode.
- Idle mode: When in this mode, NCB3051 scans the panel at 20Hz to determine if there is a touch or not. When a touch is detected, NCB3051 shall return to the active mode immediately to acquire the touch information quickly.
- Sleep mode: The chip is setting into power down mode and will consume very little current. It is helpful to prolong the standby time for the portable devices. The sleep mode shall be wake up by INT or nRST signals.

## 3.3 Host Interface

The interface to host consist the following signals:

- I2C slave interface
- Interrupt(INT) from NCB3051 to Host

The details of the I2C slave address are described in section. The interrupt (INT) signal is used for NCB3051 to inform the host when the point data is ready for the host to receive.

### 3.3.1 I2C Slave Interface

NCB3051 supports I2C slave interface with provide two wires, serial data (SDA) and serial clock (SCL), to carry information transfers at up to 1000 kbit/s(Fast mode plus). Data is transferred synchronously to SCL on the SDA line on a byte-by-byte basis. Each data byte is 8 bits long. Each transaction begins with a START (S) and can be terminated by a STOP (P). Please refer the following section for the details.

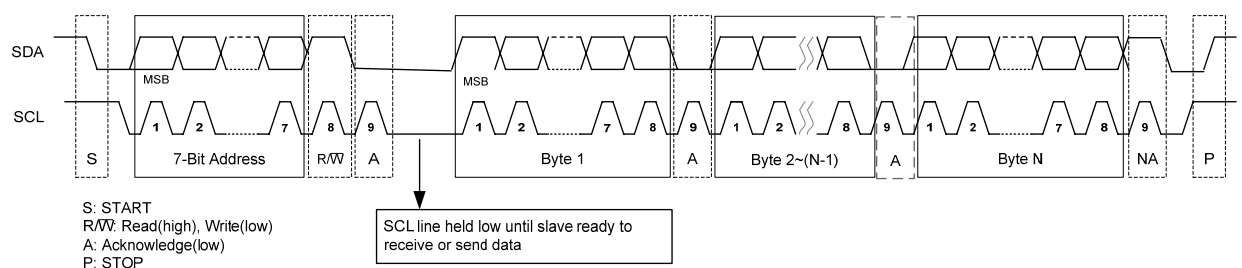
#### 3.3.1.1 Slave Address transfer

The first byte of data transferred by the host is the slave address. The slave address is 7 bits long followed by a R/W bit. NCB3061 will be respond by retuning an acknowledge bit by pulling the SDA low at the 9<sup>th</sup> when the slave address is matching.

#### 3.3.1.2 Data Transfer

Data is transferred on a byte-by-byte basis in the direction specified by the R/W bit sent by the master. Each transferred byte is followed by an acknowledge bit on the 9<sup>th</sup> SCL clock cycle. For Read operation, the master as the receiving device signals a NACK to the slave, the slave will release the SDA line and get into standby for next transaction. For write operation, the slave signals a NACK, the master can generate a STOP command to abort the current transaction

Read



# Write

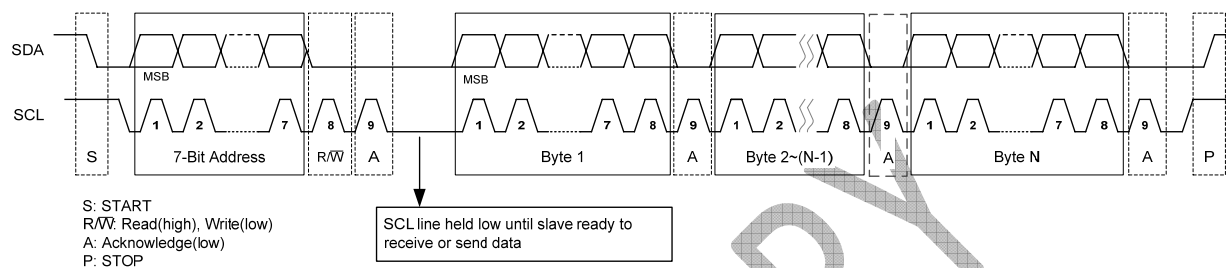


Figure3-2 I2C waveform

## 4 Electrical Characteristic

### 4.1 Absolute Maximum Ratings

Table4-1 absolute maximum ratings

Parameter	Symbol	Value	Unit
Power supply voltage 1 (Notes1)	DVDD	-0.3 ~ +5.5	V
Power supply voltage 2 (Notes1)	VDDA	-0.3 ~ +5.5	V
I/O supply voltage (Notes1,2)	V <sub>IO</sub>	-0.3 ~ IOVCC + 0.3	V
Operating temperature (Notes1)	T <sub>op</sub>	-40 ~ +85	°C
Storage temperature (Notes1)	T <sub>STR</sub>	-55 ~ +125	°C

#### Notes

1. If used beyond the absolute maximum ratings, NCB3051 may be permanently damaged. It is strongly recommended that the device be used within the electrical characteristics in normal operations. If exposed to the condition not within the electrical characteristics, it may affect the reliability of the device.
2. IOVCC is set to DVDD by software configuration

### 4.2 DC Electrical Characteristic

Table4-2 DC electrical characteristic

Parameter	Symbol	Specification				Test Conditions
		MIN.	TYP.	MAX.	UNIT	
Power supply voltage 1	DVDD	2.7	-	5.5	V	
Power supply voltage 2	VDDA	2.7	-	5.5	V	
Power Ground	GND	-0.3	-	-	V	
Operating Current (Normal operation mode)	I <sub>normal</sub>	-	30	-	mA	DVDD=VDD5=3.3V T <sub>op</sub> =25°C Report rate@100Hz
Operating current (Sleep Mode)	I <sub>sleep</sub>	-	15uA	-		DVDD=VDDA=3.3V T <sub>op</sub> =25°C

Input low voltage, GPIO	$V_{IL}$	-0.5	-	0.2DVDD	V	
Input high voltage, GPIO	$V_{IH}$	0.4DVDD	-	DVDD+0.5	V	
Low Voltage Reset	$V_{LVR}$	1.7	2.0	2.3	V	
Source Current	$I_{SR}$	4	6	8	mA	DVDD=2.7V $V_S=2.2V$
Sink Current	$I_{SK}$	7	10	13	mA	DVDD=2.7V $V_S=0.45V$

## 4.3 AC Electrical Characteristic

### 4.3.1 I2C Dynamic Characteristic

Figure4-1 is the waveform of I2C fast mode timing

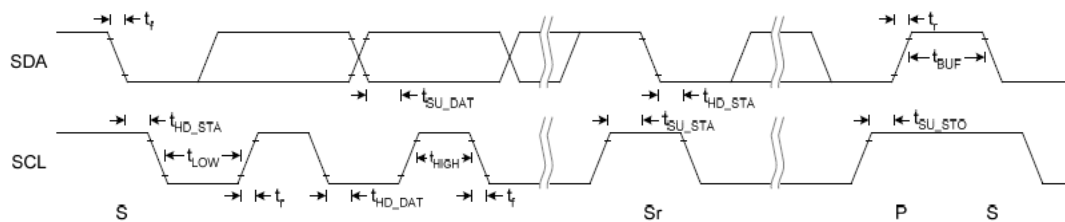


Figure4-1 I2C Waveform

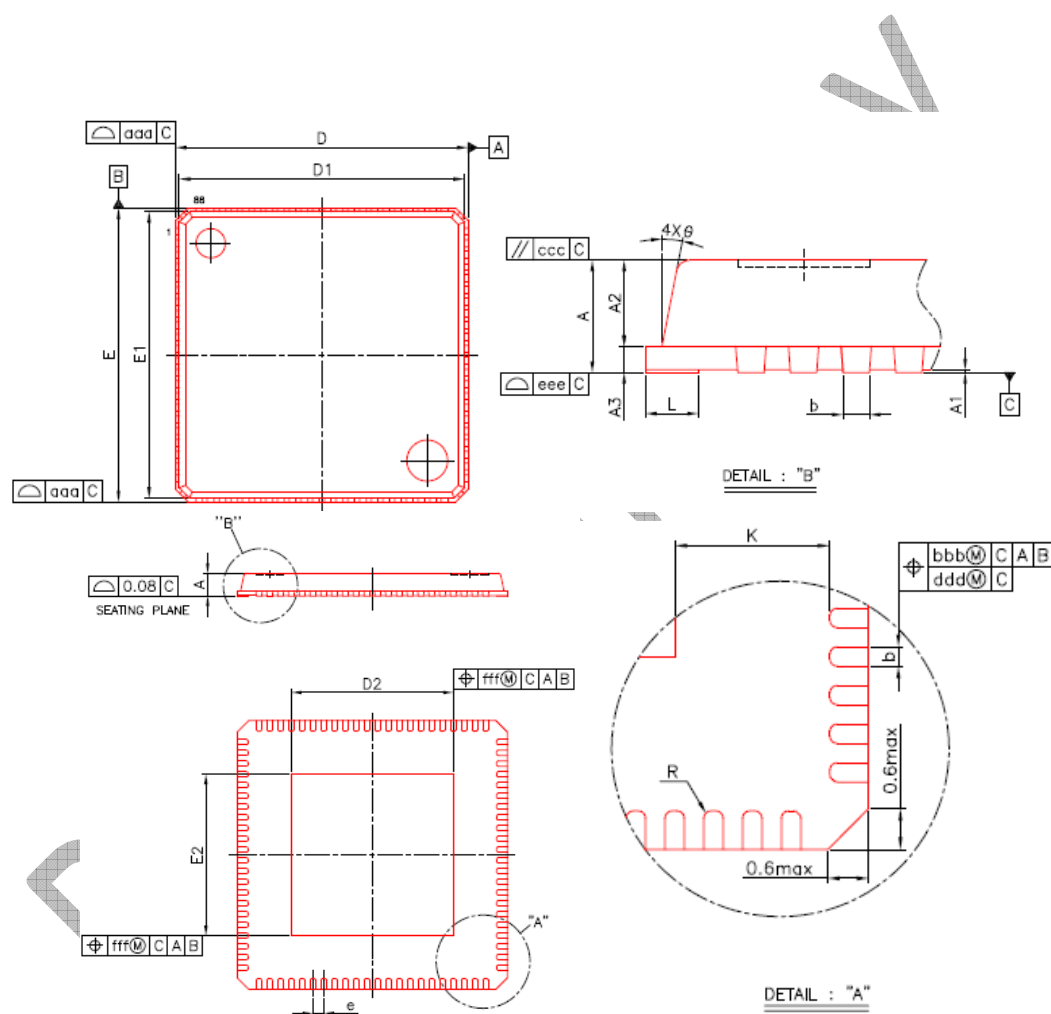
Table is the timing characteristic of I2C fast mode plus

Conditions: DVDD=3.3V, GND=0V,  $T_{OP}=25$

Parameter	Symbol	Specification			
		MIN.	TYP.	MAX.	UNIT
SCL clock frequency	$f_{SCL}$	0	-	1000	kHz
Low period of the SCL clock	$t_{LOW}$	0.5	-	-	us
High period of the SCL clock	$t_{HIGH}$	0.26	-	-	us
Set up time for a repeated START condition	$t_{SU\_STA}$	0.26	-	-	us
Hold time for a repeated START condition. After this period, the first	$t_{HD\_STA}$	0.26	-	-	us

clock pulse is generated					
Data set up time	$t_{SU\_DAT}$	50	-	-	ns
Data hold time	$t_{HD\_DAT}$	0	-	-	us
Signal falling time of SDA and SCL	$t_f$		-	120	ns
Signal rising time of SDA and SCL	$t_r$			120	ns
Data set up time	$t_{SU\_DAT}$	100			ns
Data hold time	$t_{HD\_DAT}$	0		0.9	us
Set up time for STOP condition	$t_{SU\_STO}$	0.26			us
Bus free time between a STOP and START condition	$t_{BUF}$	0.5			us
Capacitive load for each bus line	$C_b$			550	pF

## 5 Package Dimension



Exposed Pad Size					
D2/E2 (mm)			D2/E2 (inch)		
MIN	NOM	MAX	MIN	NOM	MAX
4.15	4.30	4.45	0.163	0.169	0.175

Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.80	0.85	0.90	0.031	0.033	0.035
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2	0.60	0.65	0.70	0.024	0.026	0.028
A3	0.20 REF			0.008 REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D/E	10.00 BSC			0.394 BSC		
D1/E1	9.75 BSC			0.384 BSC		
e	0.40 BSC			0.016 BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020
θ	0°	---	14°	0°	---	14°
R	0.075	---	---	0.003	---	---
K	0.20	---	---	0.008	---	---
aaa	0.10			0.004		
bbb	0.07			0.003		
ccc	0.10			0.004		
ddd	0.05			0.002		
eee	0.08			0.003		
fff	0.10			0.004		

Figure6-1 QFN88 Package Dimension



## 7 Revision

REVISION	DESCRIPTION	PAGE	DATE
0.1	■ First release		2011/05/03

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