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Spec No: 001-48430

Spec Title: CAPSENSE(R) EXPRESS(TM) - NOISE FILTERING METHODS - AN48430

Replaced by: None

CapSense® Express™ – Noise Filtering Methods

Author: Shivendra Singh
Associated Part Family: CY8C201xx
Associated Code Examples: None
Related Application Notes: None

CapSense® noise filtering helps to make capacitive sensing more robust. AN48430 describes the different filtering mechanisms implemented in CapSense Express™ devices.

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1 Introduction

CapSense Express supports a maximum of 10 GPIOs. These GPIOs are configurable as capacitive sensing input, output with LED driving capabilities, interrupt output, wakeup on interrupt input, and other digital I/O functionalities. The CapSense Express device supports I^2C serial communication interface in slave mode.

CapSense filtering removes noise from the measurements, making capacitive sensing more robust. The CapSense Express device implements two filtering methods:

- I^2C Drop The Samples (DTS)
- Averaging

This application note describes the methods of implementing filters depending on the type of noise. The following sections discuss the filtering mechanisms:

- Filtering Methods
- Filtering Configuration Register
- Filtering Register

2 Filtering Methods

CapSense Express devices implement two different filtering methods to reduce noise from different sources: the I^2C DTS filter to discard samples acquired during I^2C communication and the averaging filter to improve CapSense system noise immunity.

2.1 I^2C Drop the Samples

If I^2C communication occurs while a CapSense scan is in progress, it introduces noise in the acquired sample due to interference of I^2C data processing with the control algorithm for the capacitance charge phase.

The I^2C DTS filter removes the noise induced by I^2C communication by selectively discarding CapSense samples affected by I^2C transactions. If an I^2C communication occurs while a CapSense scan is in progress, the acquired sample is discarded and not used for the following processing algorithms.

Although this filter is enabled together with the averaging filter, its effectiveness is evident when the averaging filter is disabled.

2.2 Averaging Filter

The CapSense averaging filter is a low-pass filter (LPF) to suppress spurious high- and low-capacitance measurements, smooth the capacitance measurements over time, and filter the powerline Tnoise (50 Hz and 60 Hz).

This filter averages 2, 4, 8, or 16 CapSense scans (raw counts) for every “sample”. Averaging is implemented by adding 2, 4, 8, or 16 consecutive raw counts and dividing the result by 2, 4, 8, or 16 respectively.

3 Filtering Configuration Register

In the CapSense Express device, the filtering functionality is configured (for CapSense-enabled pins) using the CS Filtering register as shown in Table 1. For details on CapSense Express registers, refer to CY8C201xx Register Reference Guide.

3.1 CapSense Filtering Register: 0x56

Table 1. CapSense Express Filtering Register

Address	Register Name	Access	Description
0x56	CS Filtering	Read/Write	CapSense Filtering

Table 2. CapSense Express Filtering Register Definition

Address	Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
56h	CS Filtering	RstBl	NA	I²C DTS	AvgEn	NA	NA	AvgSamples[1:0]	

Table 3: CapSense Express Filtering Regieter Description

Bit #	Name	Description
[1:0]	AvgSamples[1:0]	These two bits are used to select the number of CapSense samples to average.
[4]	AvgEn	This bit set to '1' enables the averaging filter.
[5]	I²C DTS	This bit set to '1' enables the I²C Drop The Sample filter. I²C communication occurring while a scan is in progress invalidates the resulting sample. Factory default is set to '1'.
[7]	RstBL	This bit set to '1' forces immediate Baseline Initialization for all sensors. This bit is auto reset to '0' when the initialization is complete and helps in recovering from Button Stuck events.

Bit1	Bit0	Hex	Samples to Average
0	0	0x00	2
0	1	0x01	4
1	0	0x10	8
1	1	0x11	16

4 Filtering Register Settings

To enable or disable different filtering options, write appropriate configuration data into the x56 register using the PSoC Designer™ 5.0 software tool, which enables tuning filtering parameters in the GUI-based tuning window or any I²C host controller by initiating appropriate I²C communication protocols. Get a detailed description on I²C communication and protocols from the application note, AN44208 - Capsense Express - I2C Communication Timing Analysis. The following table describes different examples of settings of CapSense Express filtering.

Table 3. CapSense Express Filtering Settings

Register	Value	Comment
0x56	0x20	I²C DTS enabled, Averaging Disabled, RstBL=0
0x56	0x31	I²C DTS enabled, Averaging Enabled, No of samples = 4, RstBL=0
0x56	0xB2	I²C DTS enabled, Averaging Enabled, No of samples = 8, RstBL=1
0x56	0xB3	I²C DTS enabled, Averaging Enabled, No of samples = 16, RstBL=1

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5 Summary

This application note provides information on noise filtering mechanisms implemented in CapSense Express devices. Implementing these methods removes noise from the measurements, making the capacitive sensing more robust.

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6 Document History

Document Title: AN48430 - CapSense® Express™ – Noise Filtering Methods

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Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	2560936	ZSK	09/02/2008	New application note
*A	3393079	SLAN	10/03/2011	Updated template. Updated software version on page 1.
*B	3756195	SLAN	09/29/2012	Updated the link to “CY8C201XX Register Reference Guide” under section “Filtering Configuration Register”. Updated template.
*C	4938230	PRIA	09/28/2015	Fixed hyperlink for AN44208. Updated template.
*D	5092581	PRIA	01/19/2016	Obsoleting the Application Note

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