Ultra Low Power Capacitive Touch Sensor Interface IC

Description

The EM6420 is an ultra low power Touch Sensor Interface IC able to scan sequentially up to 16 capacitive sensors. The device parameters (number of used sensors, sensors scan frequency, sensors sensitivity level, IRQ condition) are configurable either from a host microcontroller through a communication port or through configuration inputs.

Recognised touch inputs will be signaled with an active edge at the IRQ pad and data are ready to be read through the communicaion port by the host MCU. Conditions for the IRQ to get active are configurable : at the end of every scan, at the end of a scan if at least one sensor is active or at the end of a scan if the sensors state has changed.

The EM6420 can also detect the most active sensor in applications where sensors are tightly spaced. It compares relative levels among sensors and selects the sensor with the largest signal strength.

To increase the number of sensors >16, use several EM6420 in parallel.

Depending on the selected supply voltage range, 3 or 4 decoupling capacitors are required for the entire functionality of the EM6420 from -40 to + 85°C.

Features

- Up to 16 analogue sensor inputs
- User selectable communication interfaces : 4-wire SPI, I^2C, 4-bit parallel interface and 8-bit direct output
- User-selectable active edge IRQ output signal
- Active high enable input
- No software development and tuning required
- Development tools and documentations available
- Complete touch module available: IC + electrodes design on various non-conductive substrates

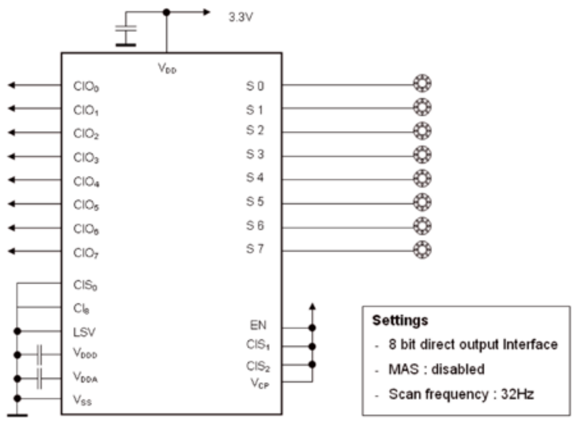
Electrical Characteristics

• Supply voltage	1.2 V to 2.0 V or 2.2 to 3.6 V
• Power consumption Low Power Mode	8.0 µA @ 3.0 V (14.5 µA @1.5 V) for 16 sensors scanned at 8 Hz
• Ultra Low Power Mode	2.0 µA @ 3.0 V (5.0 µA @1.5 V) for 16 sensors scanned at 8 Hz
• Nominal sensor capacitance	3 to 31 pF
• Sensors scan frequency	1 Hz to 128 Hz *frequency depending on number of sensors
• COM clock frequency	up to 400 kHz

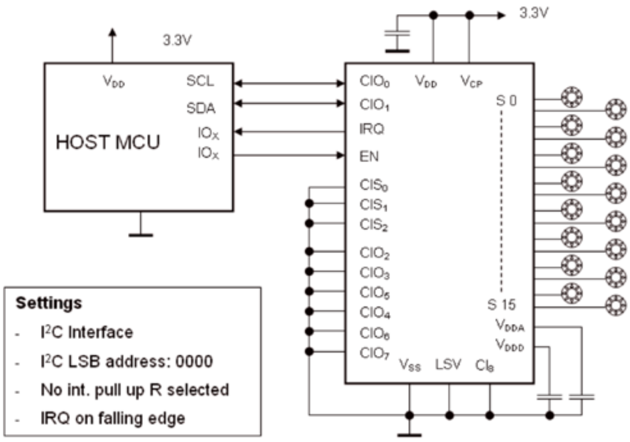
Availability

- Naked die
- SMT package MLF32-36-40

Typical Application in Stand Alone Mode and 8 Sensing Inputs



Typical Application with a Host MCU and 16 Sensing Inputs



Design Considerations

The EM6420 is well suited for battery and mains powered applications where the following features are important :

- Tamper proof applications
- Nice and clean designs
- Touch function to avoid buttons and keys
- Slider functions
- Hygienic issues, cleaning aspects
- Waterproof designs

Applications

- Mobile phones, cordless phones
- PDA, keyboards
- White & brown goods
- Toys
- Lighting - Sliders for dimming

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1. PRELIMINARIES

1.1 REFERENCE

[1] "*The I2C-Bus Specification – Version 2.1*", Philips Semiconductors, January 2000

1.2 CONVENTIONS

The following conventions will be used in this document:

- Signals which are active low have names which start with the prefix "n_". Example: n_rst. Signal names without this prefix are active high.
- When qualifying a signal, the term "asserted" means that the signal is active, while the term "deasserted" or "negated" means that the signal is inactive regardless of whether the active state is represented by a high or low voltage.
- When qualifying a bit within a register, the term "set" or "activated" means that the bit value is a high logic level, while the term "cleared" means that the bit value is a low logic level.
- Signal busses are denoted with the range "**[MSB:LSB]**" where the index of the **M**ost **S**ignificant **B**it (**MSB**) is given first and the index of the **L**east **S**ignificant **B**it (**LSB**) is given last.
- Bit group within a register are denoted $\mathbf{B_{MSB}}$ **...** $\mathbf{B_{LSB}}$ where the index of the **M**ost **S**ignificant **B**it (**MSB**) is given first and the index of the **L**east **S**ignificant **B**it (**LSB**) is given last.
- Hexadecimal numbers are followed by the index "$_H$". Example: $\mathbf{1F5A_H}$.
- Binary numbers are followed by the index "$_B$". Example: $\mathbf{1011_B}$.
- Register names followed by the index "$_H$" refers to the high byte of a 16-bit register.
- Register names followed by the index "$_L$" refers to the low byte of a 16-bit register.

2. GENERAL DESCRIPTION

The **EM6420** is a very low power ASIC that includes a Touch Screen interface able to handle up to 16 capacitive sensors. Several devices can be used in parallel to manage more than 16 sensors. The application parameters (number of used sensors, sensors scan frequency, sensors sensitivity level, IRQ condition …) are fully configurable either from a host microcontroller through a communication port or from several configuration inputs.

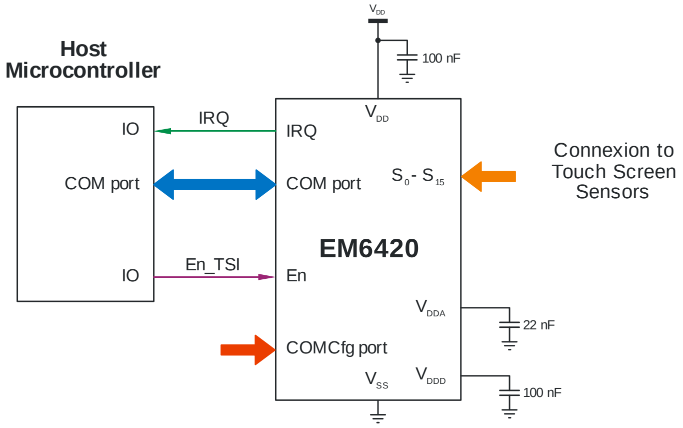


Figure 2-1: Typical Operating Configuration

Depending on the IRQ condition parameter, a user-selectable IRQ active edge can be generated:

- At the end of every scan.
- At the end of a scan if the sensors state has changed.
- At the end of a scan if either the sensors state has changed or at least one sensor is active.

The sensors state can then be read by the host microcontroller through the communication port.

The **EM6420** can also detect the most activated sensor in applications where sensors are tightly spaced by comparing relative levels among sensors and by selecting the one with the largest signal strength.

Supply voltage range can be selected either from 1.2 V to 2.0 V or from 2.2 V to 3.6 V. Depending on selected supply voltage range, 3 or 4 decoupling capacitors are required for overall functionality. No other external component is needed.

The **EM6420** can operate over a wide temperature range, from -40°C to +85°C. It is available in die form or in different SMT packages.
Ultra low current consumptions have been achieved with the **EM6420** starter kit[1], typically[2] :

- 8.0 µA @ 3.0 V (14.5 µA @1.5 V) for 16 sensors scanned at 8 Hz in Low Power Mode
- 2.0 µA @ 3.0 V (5.0 µA @1.5 V) for 16 sensors scanned at 8 Hz in Ultra Low Power Mode
- 5.0 µA @ 3.0 V (9.0 µA @1.5 V) for 8 sensors scanned at 2 Hz in Low Power Mode
- 0.7 µA @ 3.0 V (1.2 µA @1.5 V) for 8 sensors scanned at 2 Hz in Ultra Low Power Mode

[1] Please ask EM Microelectronic-Marin SA for EM6420 starter kit availability

[2] Other values may be obtained depending on electrode design and selected parameters

3. FEATURES

3.1 KEY ELEMENTS

- Ultra low power and ultra low voltage Touch Screen interface
- Up to 16 sensor inputs per device
- Increased number of sensors can be addressed with more devices in parallel
- User selectable power supply range (see below)
- User-selectable active edge IRQ output signal
- User-selectable communication interface (see below)
- Active high enable input
- Maximum 4 external components needed (decoupling capacitors only)
- No software development or tuning required

3.2 POWER SUPPLY

- Low supply voltage range : 1.2 V to 2.0 V
- High supply voltage range : 2.2 V to 3.6 V
- Disabled Mode consumption : $I_{DD\ Disabled}$ < 50 nA
- I_{DD} = 8.0 µA @ 3.0 V (14.5 µA @ 1.5 V) for 16 sensors scanned at 8 Hz in Low Power Mode
- I_{DD} = 2.0 µA @ 3.0 V (5.0 µA @ 1.5 V) for 16 sensors scanned at 8 Hz in Ultra Low Power Mode
- I_{DD} = 5.0 µA @ 3.0 V (9.0 µA @ 1.5 V) for 8 sensors scanned at 2 Hz in Low Power Mode
- I_{DD} = 0.7 µA @ 3.0 V (1.2 µA @ 1.5 V) for 8 sensors scanned at 2 Hz in Ultra Low Power Mode
- Internal voltage regulator for logic supply when used in high supply voltage range
- Internal voltage multiplier for analog supply when used in low supply voltage range
- Internal voltage regulator for analog supply

3.3 INTERFACES

- 4-wire SPI
- I^2C (Standard-Mode or Fast-Mode compatible)
- 4-bit parallel interface
- 8-bit direct output (Standalone Mode)

3.4 DEVELOPMENT TOOLS

- **EM6420** starter kit with its related documentation
- Ultra low power User Interface reference design with **EM6420**-based Touch solution, EM6110 LCD driver and EM6819 host MCU

3.5 TOUCH MODULES BASED ON EM6420 IC

- Capacitive electrodes design capability on various non-conductive substrates (according customer's requirements)"
- Transparent / Invisible electrodes possible
- Application-specific touch modules development: contact EM-Microelectronic HQ

4. BLOCK DIAGRAM

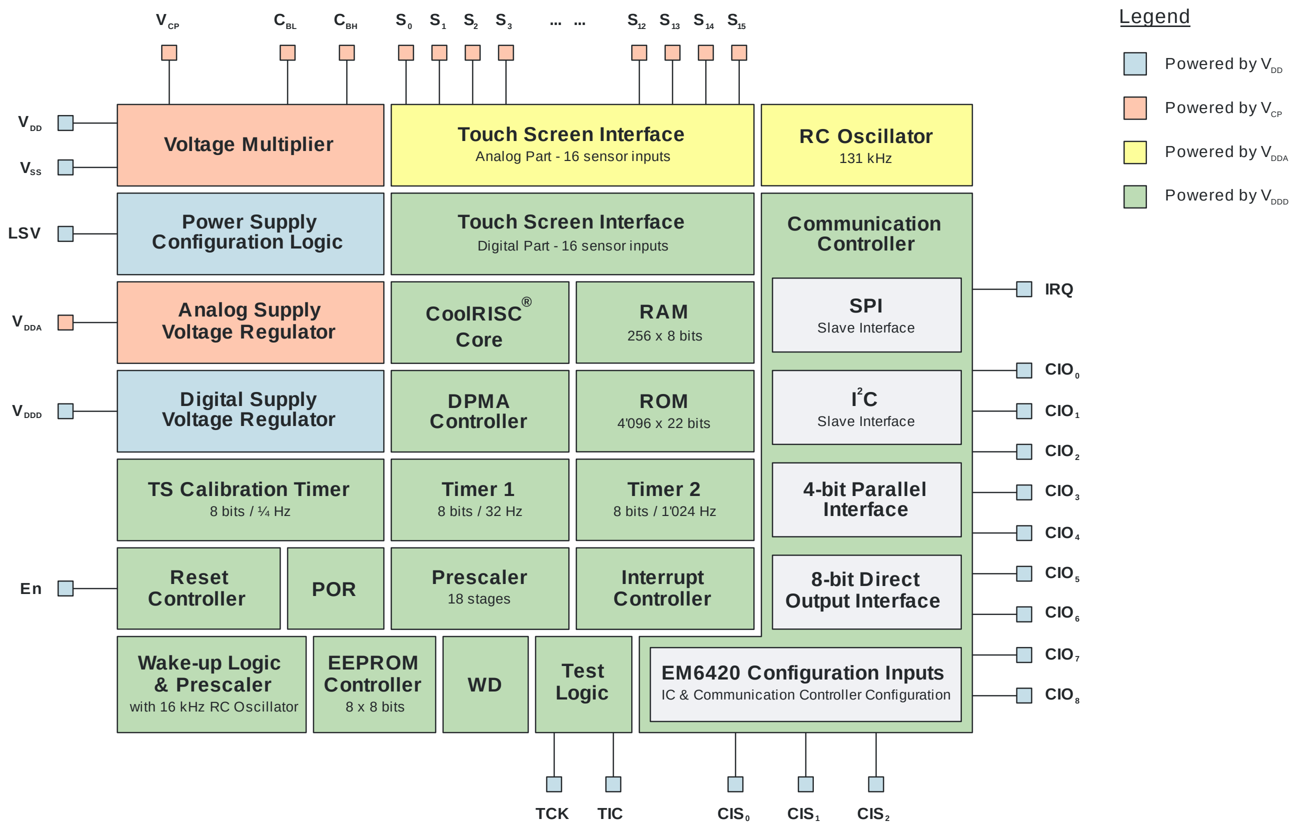


Figure 4-1 : ***EM6420*** *Block Diagram*

5. PAD DESCRIPTION

PAD				
Number	**Name**	**Type**	**Description**	**Note**
1	V_{SS}	Supply	Negative power supply, bulk	Internal reference potential (ground)
2	C_{BL}	Analog	Charge pump **B**ooster **C**apacitor connection	Low voltage side
3	C_{BH}	Analog	Charge pump **B**ooster **C**apacitor connection	High voltage side
4	V_{CP}	Supply	Unregulated **C**harge **P**ump output voltage, capacitor connection	
5	V_{DDA}	Supply	Regulated **A**nalog supply voltage, capacitor connection	
6	S_{15}	Analog	Touch Screen **S**ensor **15** connection	Pull-down when not selected – See Note 3
7	S_{11}	Analog	Touch Screen **S**ensor **11** connection	Pull-down when not selected – See Note 3
8	S_{14}	Analog	Touch Screen **S**ensor **14** connection	Pull-down when not selected – See Note 3
9	S_{10}	Analog	Touch Screen **S**ensor **10** connection	Pull-down when not selected – See Note 3
10	S_{7}	Analog	Touch Screen **S**ensor **7** connection	Pull-down when not selected – See Note 3

Table 5-1 : ***EM6420*** *pad description*

PAD				
Number	**Name**	**Type**	**Description**	**Note**
11	**S_6**	Analog	Touch Screen **S**ensor **6** connection	Pull-down when not selected – See Note 3
12	**S_5**	Analog	Touch Screen **S**ensor **5** connection	Pull-down when not selected – See Note 3
13	**S_4**	Analog	Touch Screen **S**ensor **4** connection	Pull-down when not selected – See Note 3
14	**S_9**	Analog	Touch Screen **S**ensor **9** connection	Pull-down when not selected – See Note 3
15	**S_{13}**	Analog	Touch Screen **S**ensor **13** connection	Pull-down when not selected – See Note 3
16	**S_3**	Analog	Touch Screen **S**ensor **3** connection	Pull-down when not selected – See Note 3
17	**S_{12}**	Analog	Touch Screen **S**ensor **12** connection	Pull-down when not selected – See Note 3
18	**S_2**	Analog	Touch Screen **S**ensor **2** connection	Pull-down when not selected – See Note 3
19	**S_8**	Analog	Touch Screen **S**ensor **8** connection	Pull-down when not selected – See Note 3
20	**S_1**	Analog	Touch Screen **S**ensor **1** connection	Pull-down when not selected – See Note 3
21	**S_0**	Analog	Touch Screen **S**ensor **0** connection	Pull-down when not selected
22	**TIC**	Input	Factory – Reserved **IC T**est input	Pull-down – See Note 1
23	**TCK**	Input	Factory – Reserved IC **T**est **C**loc**K** input	Pull-down – See Note 1
24	**LSV**	Input	**L**ow **S**upply **V**oltage selection input	
25	**IRQ**	Output	**I**nterrupt **R**equest **O**utput	Push-pull or open-drain with internal pull-up resistor
26	**CI_8**	Input	**C**ommunication Controller **I**nput **8**	
27	**CIO_7**	Bidir	**C**ommunication Controller **IO 7**	See Note 2
28	**CIO_6**	Bidir	**C**ommunication Controller **IO 6**	See Note 2
29	**CIO_5**	Bidir	**C**ommunication Controller **IO 5**	See Note 2
30	**CIO_4**	Bidir	**C**ommunication Controller **IO 4**	See Note 2
31	**En**	Input	IC **En**able input	
32	**V_{DD}**	Supply	Positive power supply	
33	**CIO_3**	Bidir	**C**ommunication Controller **IO 3**	See Note 2
34	**CIO_2**	Bidir	**C**ommunication Controller **IO 2**	See Note 2
35	**CIO_1**	Bidir	**C**ommunication Controller **IO 1**	See Note 2
36	**CIO_0**	Bidir	**C**ommunication Controller **IO 0**	See Note 2
37	**CIS_2**	Input	**C**ommunication **I**nterface **S**elector input **2**	
38	**CIS_1**	Input	**C**ommunication **I**nterface **S**elector input **1**	
39	**CIS_0**	Input	**C**ommunication **I**nterface **S**elector input **0**	
40	**V_{DDD}**	Supply	Regulated **D**igital supply voltage, capacitor connection	
41	**V_{DD}**	Supply	Positive power supply	

Note 1 : Connect this pad to V_{SS} for better ESD protection in customer application

Note 2 : Depending on selected communication interface, pad type may be either Input, Output or Bidirectional

Note 3 : This pin must be left unconnected when not used

*Table 5-2 : **EM6420** pad description (cont'd)*

6. ELECTRICAL SPECIFICATIONS

6.1 ABSOLUTE MAXIMUM RATINGS

Parameter	Conditions	Symbol	Min	Max	Units
Storage Temperature		T_{Store}	-40	125	°C
Supply Voltage	V_{SS} = 0 V	V_{DD}	-0.2	4.6	V
Voltage on any pin		V_{MAX}	V_{SS} – 0.2	V_{DD} + 0.2	V

Stresses above these listed maximum ratings may cause permanent damage to the device. Exposure beyond specified electrical characteristics may affect device reliability or cause malfunction.

6.2 HANDLING PROCEDURES

This device has built-in protection against high static voltages or electric fields; however, anti-static precautions should be taken as for any other CMOS integrated circuit. Unless otherwise specified, proper operation can only occur when all terminal voltages are kept within the supply voltage range.

6.3 SUPPLY VOLTAGE CONFIGURATIONS

The **EM6420** is supplied by a single external power supply between V_{DD} and V_{SS} (Ground). A voltage multiplier and two built-in voltage regulators provide supply voltages V_{DDD} for the internal logic and V_{DDA} for the analog Touch Screen blocks as well as for the system clock RC oscillator. These two regulator outputs are connected to the $\mathbf{V_{DDD}}$ and $\mathbf{V_{DDA}}$ pads respectively, through internal resistors R_{VDDD} and R_{VDDA}. Together with external capacitors C_{VDDD} and C_{VDDA}, these internal resistors implement a low pass filter function to protect the internal circuit against parasitic over and under voltages. When used, the voltage multiplier, clocked by the wake-up RC oscillator, needs an external booster capacitor C_B (typ. 47 nF) to double the input voltage and an external buffer capacitor C_{VCP} to smooth the newly generated voltage V_{CP}. Recommended values for the external capacitors C_{VDDD}, C_{VDDA} and C_{VCP} are 100 nF, 22 nF and 100 nF.

The power supply configuration depends on the selected supply voltage range (**LSV** input state). When the **LSV** input is connected to V_{DD}, the low supply voltage range is selected. The voltage regulator V_{DDD} is disabled (output tri-stated) to avoid an additional dropout voltage between V_{DD} and V_{DDD} supply voltages. In that case, the internal logic is supplied directly by V_{DD}. The voltage multiplier is enabled and the generated voltage V_{CP} supplies the voltage regulator V_{DDA}, the Touch Screen sensor pads as well as several power pads. When the **LSV** input is connected to V_{SS}, the high supply voltage range is selected. The internal logic is supplied by the voltage regulator V_{DDD} to reduce overall power consumption. The voltage multiplier is disabled (output tri-stated) and the voltage regulator V_{DDA} is supplied directly by V_{DD}.

Depending on the selected supply voltage range, 3 or 4 decoupling capacitors are required for the entire functionality of the EM6420 from -40 to + 85°C. Refer to the schematics below for proper mode of operation.

In high supply voltage range (**LSV** is deasserted), connect:

- a 100nF decoupling capacitor to V_{DDD}
- a 100nF decoupling capacitor to V_{DD}
- a 22nF decoupling capacitor to V_{DDA}

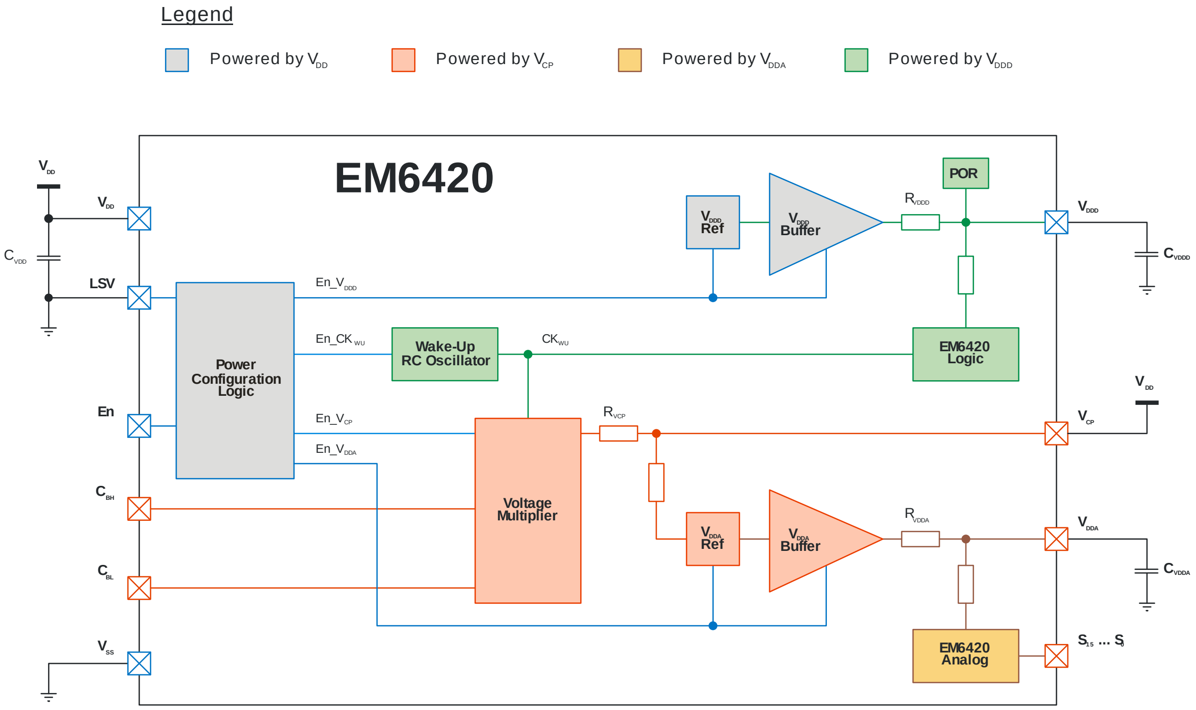


Figure 6-1: EM6420 power supply configuration when the high voltage supply range is selected

In low supply voltage range (**LSV** is asserted), connect:

- a 47nF capacitor to pins C_{BH} and C_{BL}
- a 100nF decoupling capacitor to V_{CP}
- a 100nF decoupling capacitor to V_{DD}
- a 22nF decoupling capacitor to V_{DDA}

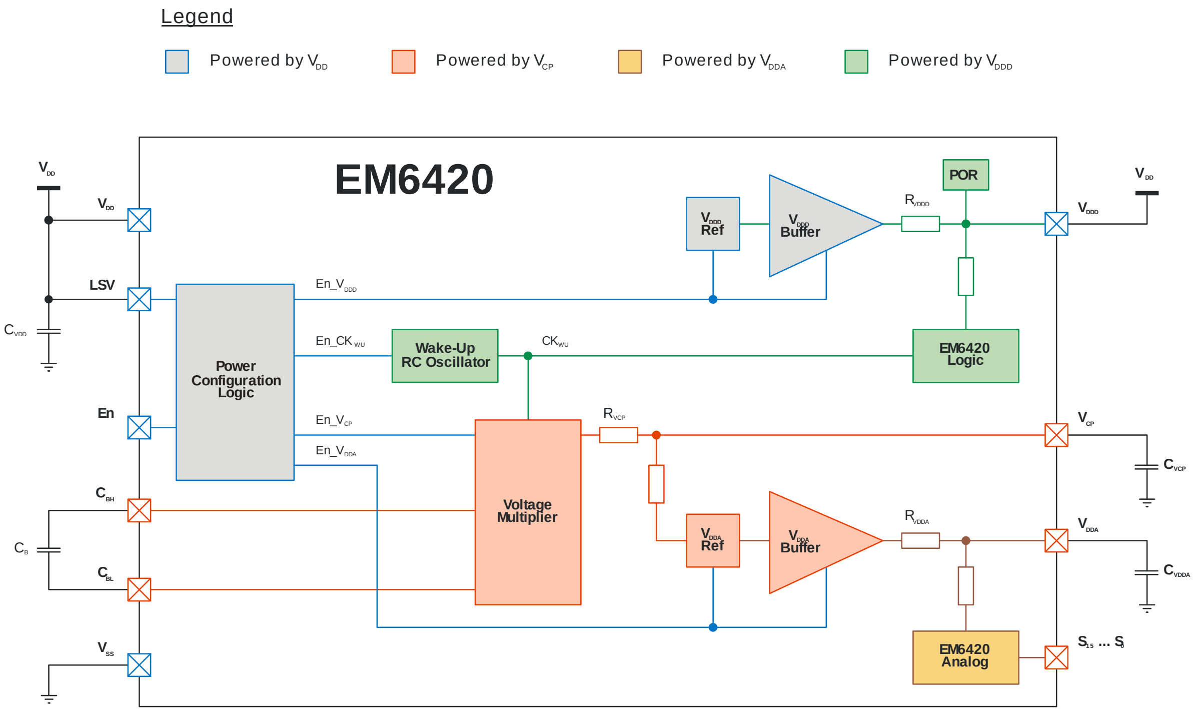


Figure 6-2: EM6420 power supply configuration when the low voltage supply range is selected

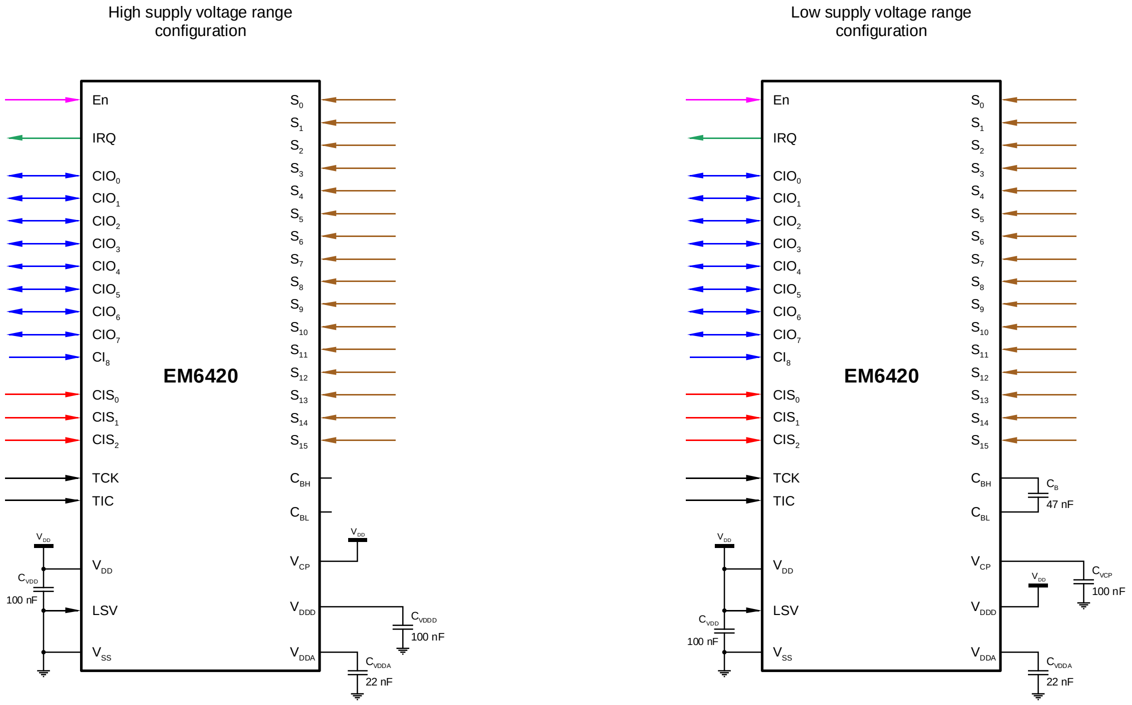


Figure 6-3 : ***EM6420*** *simplified schematic of both supply voltage configurations*

6.4 STANDARD OPERATING CONDITIONS

The **EM6420** can be used in two different modes according to customer application requirements: Low Power Mode or Ultra Low Power Mode (see § 8.3.3).

In Low Power Mode, the **EM6420** device remains always in Active Mode, i.e. during the scans of the sensors and also between them. The Touch Screen interface settings are internally chosen in order to minimize the current consumption. Furthermore, the communication between the host microcontroller and the **EM6420** is more efficient than in Ultra low Power Mode. The **EM6420** is indeed always active and so it takes less time to reply to a received command.

In Ultra Low Power Mode, the **EM6420** device remains in Active Mode only during the scans of the sensors and goes in Sleep Mode between them. The Touch Screen interface settings are internally chosen in order to scan as fast as possible the sensors, thus shortening as much as possible the time the **EM6420** device remains in Active Mode. Furthermore, receiving a command while in Sleep Mode may slow down the communication between the host microcontroller and the **EM6420**, as it has first to return in Active Mode before preparing and sending the reply. But when this mode is selected, it reduces the **EM6420** power consumption with full functionality to the minimum (see typical values above).

If the Touch Screen interface has to be switched off for a long time, it is strongly recommended to put the **EM6420** in Disable Mode by putting the **En** input to V_{SS} instead of simply sending a ***stopTS*** command (see § 8.3.2). In this case, the current consumption is reduced to a few nA, but the **EM6420** loses the application parameters and the host microcontroller must send them again next time the **En** input is set to V_{DD}.

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Operating temperature		T_{Op}	-40		85	°C
Low supply voltage range		V_{DDL}	1.2		2.0	V
High supply voltage range		V_{DDH}	2.2		3.6	V
Reference terminal		V_{SS}		0		V
Regulated voltage V_{DDD} capacitor		C_{VDDD}	100		470	nF
Regulated voltage V_{DDA} capacitor		C_{VDDA}		22		nF
Unregulated voltage V_{CP} buffer capacitor		C_{VCP}		100		nF
Voltage multiplier booster capacitor		C_B		47		nF

6.5 DC CHARACTERISTICS – POWER SUPPLY

Conditions unless otherwise specified : V_{DD} = 3.0 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Supply voltage	T = -40 to +85°C	V_{DD}	2.2	3.0	3.6	V
Disable mode current consumption[3]	**En** input connected to V_{SS}	I_{DD_Dis}		2	10	nA
Sleep mode current consumption		I_{DD_Slp}		470	580	nA
Active mode current consumption	Touch Screen OFF	I_{DD_RUN}		7.5	9.5	µA

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Supply voltage	T = -40 to +85°C	V_{DD}	1.2	1.5	2.0	V
Disable mode current consumption[4]	**En** input connected to V_{SS}	I_{DD_Dis}		2	10	nA
Sleep mode current consumption		I_{DD_Slp}		380	530	nA
Active mode current consumption	Touch Screen OFF	I_{DD_RUN}		12.0	16.5	µA

6.6 POR

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
High threshold voltage		V_{IH_POR}	0.75	0.90	1.10	V
Threshold voltage hysteresis		V_{Hys_POR}	50		110	mV

[3] This value is guaranteed by design

[4] This value is guaranteed by design

6.7 TOUCH SCREEN INTERFACE

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Reference capacitor	**TS_RCap** = 00_H	C_R		0.5		pF
	TS_RCap = $3F_H$			31.5		pF
Reference capacitor increment	Δ**TS_RCap** = 1	ΔC_R		0.5		pF
Pad $\mathbf{S_x}$ input current	Pull-down activated, analog switch turned OFF V_{IN} = 0.3 V	I_{IN_SPdON}	100	180	260	µA

6.8 INPUT PADS CIS_X, CI_8 AND LSV

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level input voltage		V_{IL_CIS}	V_{SS}		0.3 • V_{DD}	V
High level input voltage		V_{IH_CIS}	0.7 • V_{DD}		V_{DD}	V
Static input current	V_{IN} = V_{SS} … V_{DD}	I_{In_CIS}	-100		100	nA

6.9 INPUT PAD EN

Conditions unless otherwise specified : V_{DD} = 3.0 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level input voltage		V_{IL_En}	V_{SS}		0.7	V
High level input voltage		V_{IH_En}	2.2		V_{DD}	V
Schmitt trigger hysteresis		V_{Hys_En}		0.8		V
Static input current	V_{IN} = V_{SS} … V_{DD}	I_{In_En}	-100		100	nA
Min filtered glitches width		t_{FGl_En}			10	µs
Valid reset pulse width (**En** = V_{SS})		t_{En}	50			µs

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level input voltage		V_{IL_En}	V_{SS}		0.4	V
High level input voltage		V_{IH_En}	1.1		V_{DD}	V
Schmitt trigger hysteresis		V_{Hys_En}		0.2		V
Static input current	V_{IN} = V_{SS} … V_{DD}	I_{In_En}	-100		100	nA
Min filtered glitches width		t_{FGl_En}			10	µs
Valid reset pulse width (**En** = V_{SS})		t_{En}	50			µs

6.10 OUTPUT PAD IRQ

Conditions unless otherwise specified : V_{DD} = 3.0 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_IRQ}	3.0			mA
High level output current	Push-pull configuration $V_{OUT} = V_{DD} - 0.3$ V	I_{OH_IRQP}			-3.0	mA
	Open drain with internal pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_IRQQ}	-140		-75	µA
Internal pull-up resistance		R_{PU_IRQ}		30		kΩ

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_IRQ}	1.6			mA
High level output current	Push-pull configuration $V_{OUT} = V_{DD} - 0.3$ V	I_{OH_IRQP}			-1.6	mA
	Open drain with internal pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_IRQQ}	-75		-35	µA
Internal pull-up resistance		R_{PU_IRQ}		30		kΩ

6.11 BIDIRECTIONAL PADS CIO_2 … CIO_7

Conditions unless otherwise specified : V_{DD} = 3.0 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_CIO}	3.0			mA
High level output current	$V_{OUT} = V_{DD} - 0.3$ V	I_{OH_CIO}			-3	mA
Low level input voltage		V_{IL_CIO}	V_{SS}		$0.3 \cdot V_{DD}$	V
High level input voltage		V_{IH_CIO}	$0.7 \cdot V_{DD}$		V_{DD}	V
Static input current	$V_{IN} = V_{SS} \dots V_{DD}$	I_{IN_CIO}	-100		100	nA

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_CIO}	1.6			mA
High level output current	$V_{OUT} = V_{DD} - 0.3$ V	I_{OH_CIO}			-1.6	mA
Low level input voltage		V_{IL_CIO}	V_{SS}		$0.3 \cdot V_{DD}$	V
High level input voltage		V_{IH_CIO}	$0.7 \cdot V_{DD}$		V_{DD}	V
Static input current	$V_{IN} = V_{SS} \dots V_{DD}$	I_{IN_CIO}	-100		100	nA

6.12 BIDIRECTIONAL PADS CIO0 AND CIO1

Conditions unless otherwise specified : V_{DD} = 3.0 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_I2C}	3.0			mA
High level output current	Push-pull configuration $V_{OUT} = V_{DD} – 0.3$ V	I_{OH_I2CP}			-3.0	mA
	Open drain with internal weak pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_I2CWR}	-120		-50	µA
	Open drain with internal strong pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_I2CSR}	-200		-110	µA
Internal weak pull-up resistance		R_{I2C_W}		40		kΩ
Internal strong pull-up resistance		R_{I2C_S}		20		kΩ
Low level input voltage		V_{IL_I2C}	V_{SS}		$0.3 \cdot V_{DD}$	V
High level input voltage		V_{IH_I2C}	$0.7 \cdot V_{DD}$		V_{DD}	V
Static input current	Open drain with no internal pull-up configuration $V_{IN} = V_{SS} … V_{DD}$	I_{IN_I2C}	-100		100	nA
Schmitt trigger hysteresis		V_{Hys_I2C}	$0.05 \cdot V_{DD}$			V

Conditions unless otherwise specified : V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Low level output current	V_{OUT} = 0.3 V	I_{OL_I2C}	1.6			mA
High level output current	Push-pull configuration $V_{OUT} = V_{DD} – 0.3$ V	I_{OH_I2CP}			-1.6	mA
	Open drain with internal weak pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_I2CWR}	-60		-25	µA
	Open drain with internal strong pull-up configuration $V_{OUT} = V_{SS}$	I_{OH_I2CSR}	-100		-55	µA
Internal weak pull-up resistance		R_{I2C_W}		40		kΩ
Internal strong pull-up resistance		R_{I2C_S}		20		kΩ
Low level input voltage		V_{IL_I2C}	V_{SS}		$0.3 \cdot V_{DD}$	V
High level input voltage		V_{IH_I2C}	$0.7 \cdot V_{DD}$		V_{DD}	V
Static input current	Open drain with no internal pull-up configuration $V_{IN} = V_{SS} … V_{DD}$	I_{IN_I2C}	-100		100	nA
Schmitt trigger hysteresis		V_{Hys_I2C}	$0.1 \cdot V_{DD}$			V

7. TIMING SPECIFICATIONS

7.1 STANDARD OPERATING CONDITIONS

Parameter	Symbol	Min	Typ.	Max	Units
Operating Temperature	T_{Op}	-40		85	°C
Low Supply Voltage Range	V_{DDL}	1.2	1.5	2.0	V
High Supply Voltage Range	V_{DDH}	2.2	3.0	3.6	V
Reference terminal	V_{SS}		0		V

7.2 COMMUNICATION INTERFACE

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Communication interface start-up time	8-bit Direct Output Interface selected	t_{CI_St}			70	ms
	SPI, I2C or Parallel Interface selected				10	ms
IRQ start-up pulse width		t_{IRQ_StPW}	100		150	µs

7.3 8-BIT DIRECT OUTPUT INTERFACE

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
IRQ pulse width		t_{IRQ_PW}	100		150	µs

7.4 SLAVE I2C INTERFACE

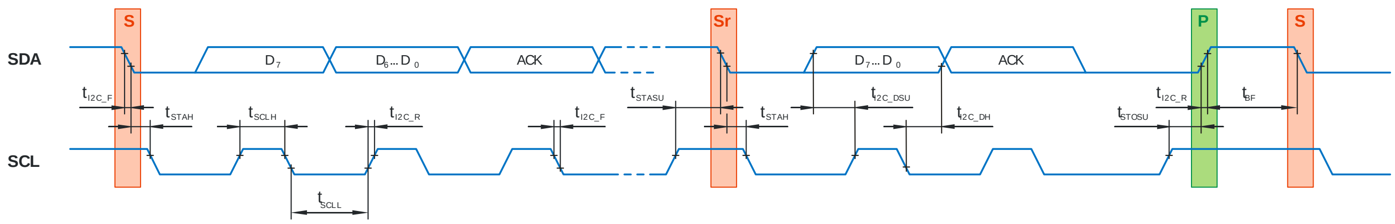


Figure 7-1: I2C interface timings

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
SCL clock frequency		f_{SCL}	0		400	kHz
Hold time (repeated) START condition.		t_{STAH}	0.6			µs
Low period of the **SCL** clock		t_{SCLL}	1.3			µs
High period of the **SCL** clock		t_{SCLH}	0.6			µs

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Setup time for a repeated START condition		t_{STASU}	0.6			µs
Data hold time		t_{I2C_DH}	0		0.9	µs
Data setup time		t_{I2C_DSU}	100			ns
Rise time of both **SDA** and **SCL** signals		t_{I2C_R}	20 + 0.1·C_b		300	ns
Fall time of both **SDA** and **SCL** signals		t_{I2C_F}	20 + 0.1·C_b		300	ns
Setup time for a STOP condition		t_{STOSU}	0.6			µs
Bus free time between a STOP and a START condition		t_{BF}	1.3			µs
Capacitive load for each bus line	With internal pull-up resistors	C_b			200	pF
	With external pull-up resistors	C_b			400	pF

7.5 SLAVE SPI INTERFACE

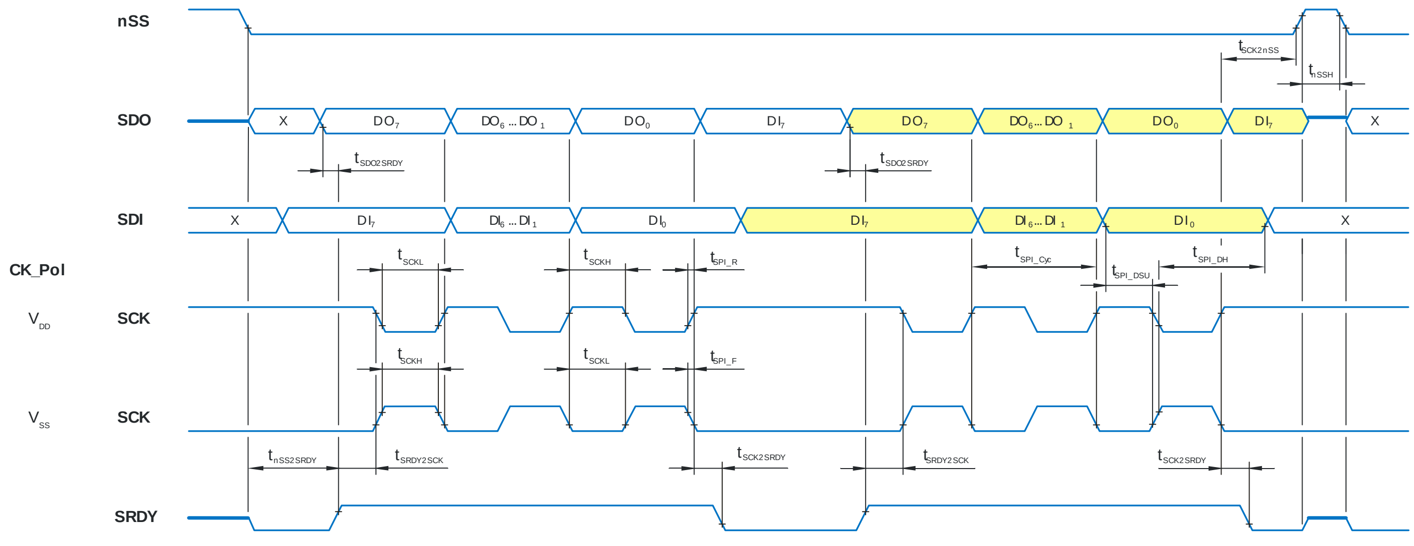


*Figure 7-2 : SPI Interface timings when **CK_Pha** input is set to V_{SS}.*

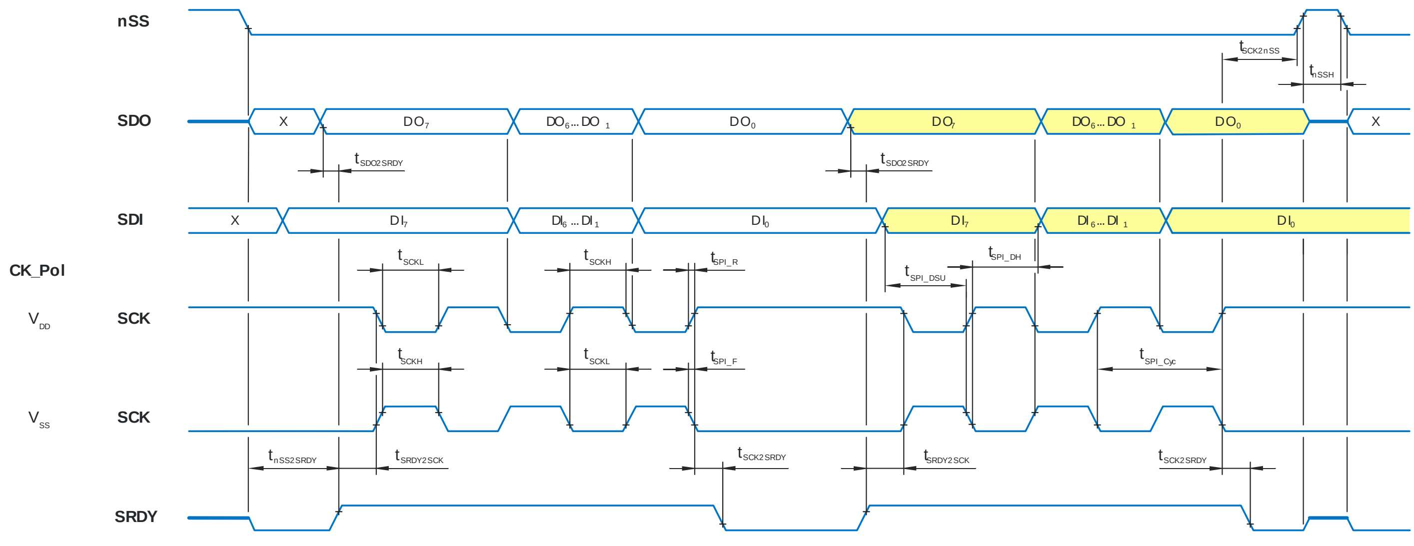


*Figure 7-3 : SPI Interface timings when **CK_Pha** input is set to V_{DD}.*

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Operating frequency		f_{SPI_Op}			400	kHz
Cycle time		t_{SPI_Cyc}	2.5			µs
Rise time of inputs **SCK**, **SDI** and **nSS**		t_{SPI_R}			250	ns
Fall time of inputs **SCK**, **SDI** and **nSS**		t_{SPI_F}			250	ns
Delay from **nSS** low to **SRDY** high		$t_{nSS2SRDY}$			200	ns
Low period of the **SCK** clock		t_{SCKL}	1			µs
High period of the **SCK** clock		t_{SCKH}	1			µs
Data setup time		t_{SPI_DSU}	200			ns
Data hold time		t_{SPI_DH}	200			ns
Delay from valid data to **SRDY** high		$t_{SDO2SRDY}$			200	ns
Delay from **SRDY** high to first **SCK** edge		$t_{SRDY2SCK}$	200			ns
Delay from last **SCK** edge to **SRDY** low		$t_{SCK2SRDY}$			200	ns
Delay from last **SCK** edge to **nSS** high		$t_{SCK2nSS}$			200	ns
nSS high time (Bus free time between communication frames)		t_{nSSH}	2			µs

7.6 SLAVE 4-BIT PARALLEL INTERFACE

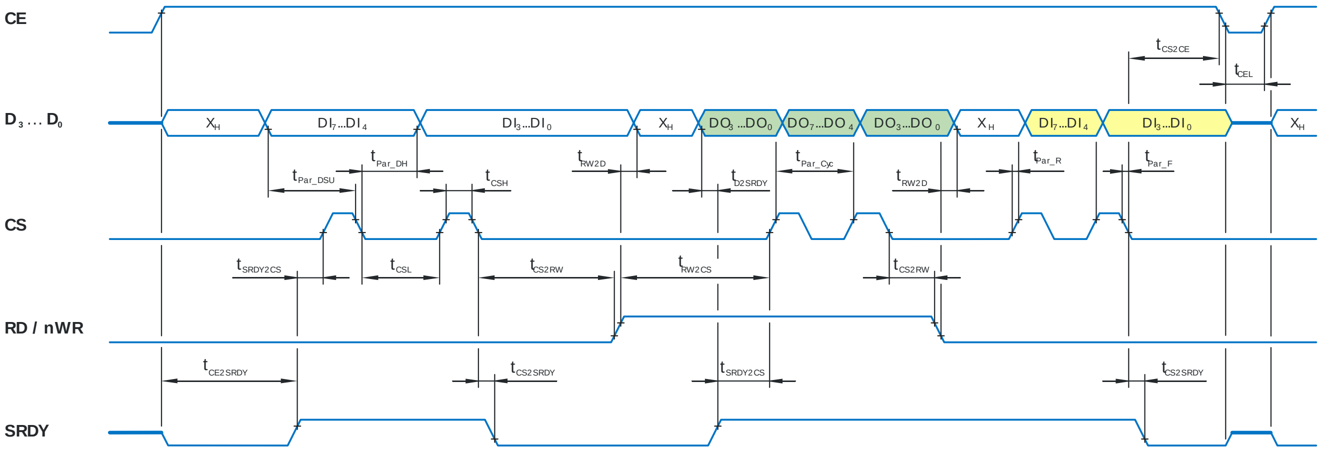


Figure 7-4 : Parallel Interface timings

Conditions unless otherwise specified : V_{DD} = 3.0 V or V_{DD} = 1.5 V, T = 25°C

Parameter	Conditions	Symbol	Min	Typ.	Max	Units
Operating frequency		f_{Par_Op}			400	kHz
Cycle time		t_{Par_Cyc}	2.5			µs
Rise time of inputs **CE**, **CS**, **RD / nWR** and **D$_X$**		t_{Par_R}			250	ns
Fall time of inputs **CE**, **CS**, **RD / nWR** and **D$_X$**		t_{Par_F}			250	ns
Delay from **CE** high to **SRDY** high		$t_{CE2SRDY}$			200	ns
Time interval between **CS** strobes		t_{CSL}	1			µs
CS strobe width		t_{CSH}	1			µs
Data setup time		t_{Par_DSU}	200			ns
Data hold time		t_{Par_DH}	200			ns
Delay from valid data to **SRDY** high		t_{D2SRDY}			200	ns
Delay from **SRDY** high to **CS** strobe		$t_{SRDY2CS}$	200			ns
Delay from **CS** strobe to **SRDY** low		$t_{CS2SRDY}$			200	ns
Delay from **RD / nWR** low to valid data		t_{RW2D}			200	ns
Delay from **RD / nWR** high to **CS** strobe		t_{RW2CS}	200			ns
Delay from **CS** strobe to **RD / nWR** low		t_{CS2RW}	200			ns
Delay from **CS** strobe to **CE** low		t_{CS2CE}	200			ns
CE low time (Bus free time between communication frames)		t_{CEL}	2			µs

8. EM6420 TO HOST CONTROLLER COMMUNICATION

8.1 INTRODUCTION

The **EM6420** can communicate with a host processor through several communication interfaces, mainly to receive application parameters, to signal sensors activity or to send **EM6420** status / error flags. Only one communication interface can be active at a time, as they share the same **EM6420** IO pads **CIO_7 … CIO_0** and input pad **CI_8**. During a communication, the host processor is always considered as the master device and the **EM6420** as the slave one. Thus, the **EM6420** may never initiate a communication. However, by asserting its output pad **IRQ**, the **EM6420** can signal to the host processor that a predefined condition or an error occurred and that a communication may be initiated, normally by a ***getStatus*** command.

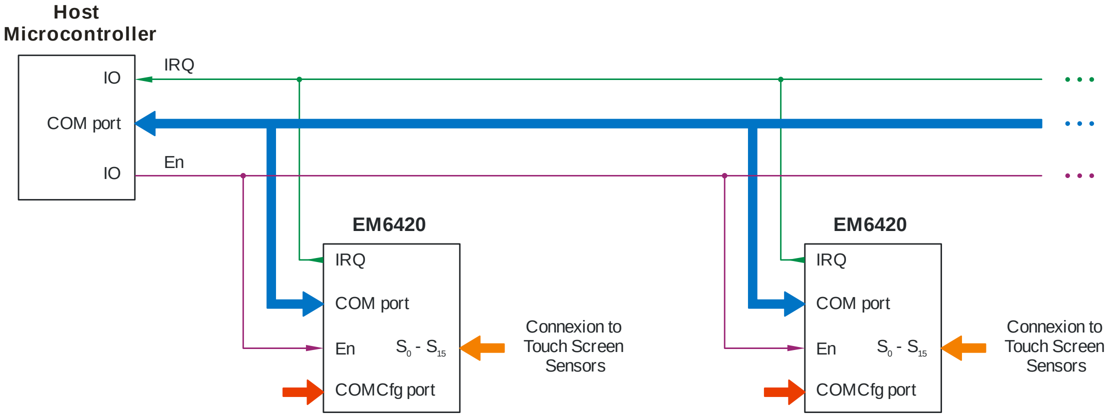


*Figure 8-1 : Multi **EM6420** configuration*

In applications where several **EM6420** are used, the open-drain with internal pull-up resistor configuration must be selected for **IRQ** output pads, to allow connecting all these output pads to a unique host IRQ input (see *Figure 8-1*).

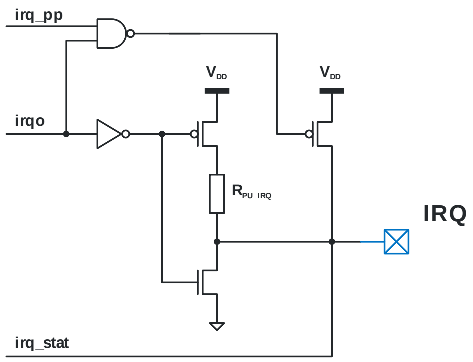


*Figure 8-2 : Configuration of **EM6420 IRQ** output pad*

In this case, all **IRQ** output pads should be asserted by default (wired-OR), and each **EM6420** can signal to the host processor that a communication may be initiated by deasserting its output pad **IRQ**.

8.2 EM6420 COMMUNICATION INTERFACES

Active **EM6420** communication interface is selected by input pads **CIS_2 … CIS_0** state, according to the Table 8-1.

CIS_2	CIS_1	CIS_0	Active Communication Interface
0	0	0	Slave I^2C Interface
0	0	1	Slave 4-bit Parallel Interface
0	1	X	Slave SPI Interface
1	X	X	8-bit Direct Output Interface

Table 8-1 : Communication interface selection

As input pads **CIS_2 … CIS_0** do not include pull resistors, they must be connected either to **V_{SS}** or **V_{DD}** in customer application. Selecting a communication interface will directly define the functionality of communication input pad **CI_8** and IO pads **CIO_7 … CIO_0**, thus configuring IO pads either as input, output or bidirectional pad.

8.2.1 Slave I2C Interface

When slave I^2C interface is selected, communication pads **CI_8** and **CIO_7 … CIO_0** are configured for specific I^2C functions or define I^2C interface options, according to the Table 8-2:

PAD			
Name	**Alternate name**	**Type**	**Specific function or defined option for slave I^2C interface**
CIO_0	**SCL**	Bidir	I^2C **S**erial **Cl**ock
CIO_1	**SDA**	Bidir	I^2C **S**erial **Da**ta
CIO_2	**EN_IWPU**	Input	**En**able **I**nternal **W**eak **P**ull-**U**p resistors
CIO_3	**EN_ISPU**	Input	**En**able **I**nternal **S**trong **P**ull-**U**p resistors
CIO_7 … CIO_4	**A_3 ... A_0**	Input	Low 4-bit I^2C **A**ddress. Default high 3-bits I^2C address are 100_B
CI_8	**IRQ_Pol**	Input	**IRQ Pol**arity

*Table 8-2 : Defined I^2C options and specific functions for communication pads **CI_8** and **CIO_7 … CIO_0** when slave I^2C interface is selected*

This I^2C interface fulfills the I^2C specification (see [1] "*The I2C-Bus Specification – Version 2.1*", Philips Semiconductors, January 2000) with the following restrictions:

- Only Standard-mode and Fast-mode are supported. Thus, the maximum clock frequency is 400 kHz.
- Only standard 7-bit addressing is supported. The default values of the higher three bits are 100_B[5] while the lower 4 bits are defined by **A_3…A_0** input pads.
- General Calls are ignored.
- Each I^2C bidir pad has a weak and a strong internal pull-up resistor. They can be enabled by connecting the **En_IWPU** and / or **EN_ISPU** input pads to V_{DD}. However, these internal pull-up resistors have been designed to minimize power consumption. As such, they can only drive capacitive bus loads up to 200 pF, even when both pull-up resistors are simultaneously enabled. For higher capacitive bus loads, external I^2C pull-up resistors must be added.

[5] Please contact EM Microelectronic-Marin SA for setting other values to the three higher address bits

The **IRQ_Pol** input defines the polarity of the **IRQ** output:

- The positive IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{DD}, and a rising edge is generated when the **EM6420** asserts its **IRQ** output.
- The negative IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{SS}, and a falling edge is generated when the **EM6420** asserts its **IRQ** output.

8.2.2 Slave SPI Interface

When slave SPI interface is selected, communication pads **CI_8** and **CIO_7 … CIO_0** are configured for specific SPI functions or define SPI interface options, according to the Table 8-3:

PAD			
Name	**Alternate name**	**Type**	**Specific function or defined option for slave SPI interface**
CIO_0	**SCK**	Input	SPI **S**erial **C**loc**K**
CIO_1	**SDI**	Input	SPI **S**erial **D**ata **I**nput
CIO_2	**SDO**	Output	SPI **S**erial **D**ata **O**utput
CIO_3	**nSS**	Input	SPI **S**lave **S**elect (active low)
CIO_4	**SRDY**	Output	SPI **S**lave **R**ea**DY** (see below)
CIO_5	**CK_Pol**	Input	SPI **C**loc**K** **Pol**arity (see below)
CIO_6	**CK_Pha**	Input	SPI **C**loc**K** **Pha**se (see below)
CIO_7	**MSB_First**	Input	SPI data are sent **MSB First** (see below)
CI_8	**IRQ_Pol**	Input	**IRQ Pol**arity (see below)

*Table 8-3 : Defined SPI options and specific functions for communication pads **CI_8** and **CIO_7 … CIO_0** when slave SPI interface is selected*

This 4-wire SPI interface allows full-duplex, synchronous, serial communication between the host and the **EM6420**. The clock signal **SCK** generated by the host synchronizes data transmission.

The **nSS** input is the control signal used to enable the **EM6420** SPI interface. When set to V_{DD}, the **SDO** and the **SRDY** outputs are tri-stated, thus allowing another **EM6420** to take control of these lines in applications where several devices are used (see Figure 8-3).

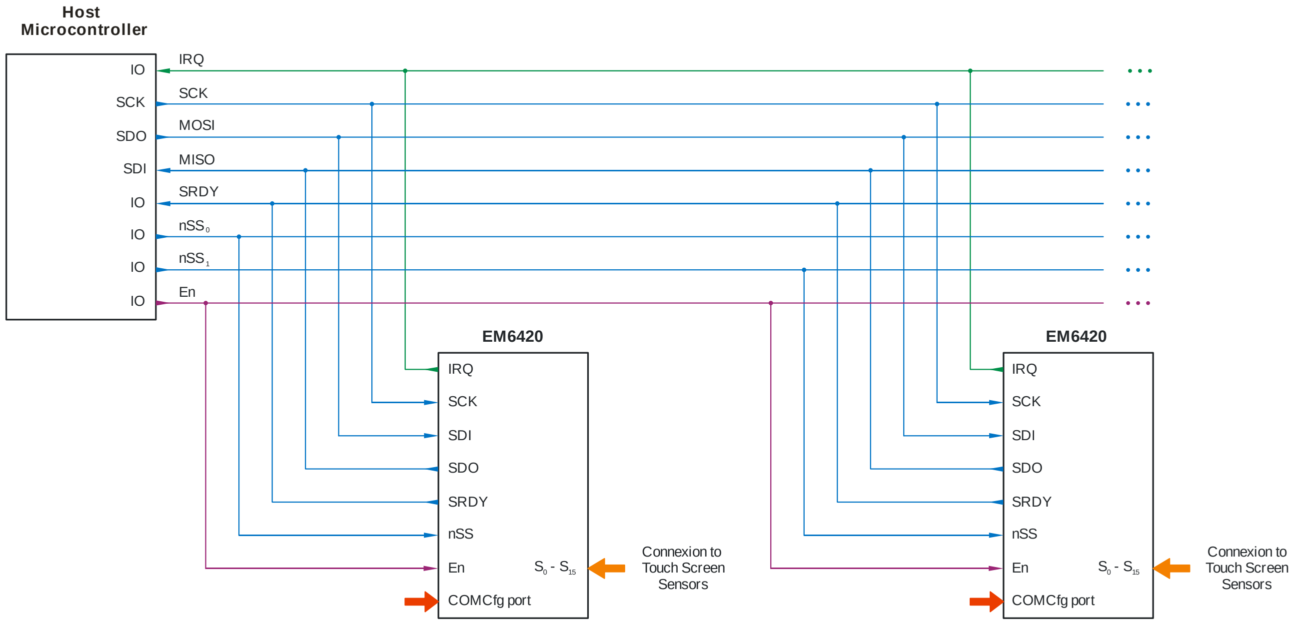


*Figure 8-3: Multi **EM6420** configuration using the SPI interface*

To accommodate the different serial communication requirements of hosts, the **EM6420** is able to control the timing relationship between the serial clock **SCK** and the transmitted data on **SDO** output.

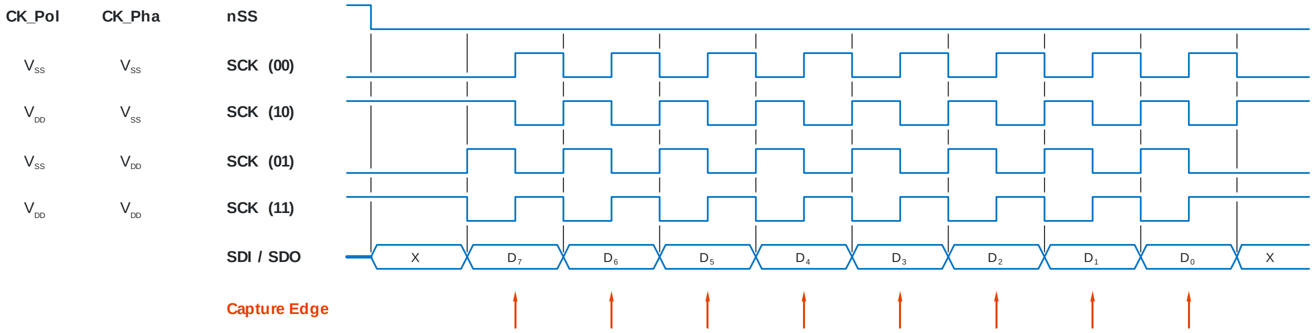


Figure 8-4: Timing relationship between the serial clock SCK and the transmitted data

The **CK_Pol** input indicates to the **EM6420** the polarity of the **SCK** clock signal between transmissions:

- When set to V_{SS}, the **SCK** clock signal is set to V_{SS} between transmissions.
- When set to V_{DD}, the **SCK** clock signal is set to V_{DD} between transmissions.

The **CK_Pha** input defines which clock edge latches the data:

- When set to V_{SS}, the data on **SDI** input is latched at the first **SCK** clock edge. Data on **SDI** input and **SDO** output must change at the second **SCK** clock edge.
- When set to V_{DD}, the data on **SDI** input is latched at the second **SCK** clock edge. Data on **SDI** input and **SDO** output must change at the first **SCK** clock edge.

The **SRDY** output indicates to the host that the **EM6420** is ready to send and receive a data byte. The host must always check that **SRDY** is set to V_{DD} before generating the eight clocks needed to transfer a data byte. Data byte is sent MSB first when the **MSB_First** input is set to V_{DD} and LSB first otherwise.

The **IRQ_Pol** input defines the polarity of the **IRQ** output:

- The positive IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{DD}, and a rising edge is generated when the **EM6420** asserts its **IRQ** output.
- The negative IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{SS}, and a falling edge is generated when the **EM6420** asserts its **IRQ** output.

8.2.3 Slave 4-bit Parallel Interface

When slave 4-bit parallel interface is selected, communication pads **CI_8** and **CIO_7 … CIO_0** are configured for specific 4-bit parallel functions and define **IRQ** output pad polarity, according to the Table 8-4:

PAD			
Name	**Alternate name**	**Type**	**Specific function for slave 4-bit parallel interface**
CIO_3 … CIO_0	**D_3 … D_0**	Bidir	4-bit **D**ata bus
CIO_4	**CE**	Input	**C**hip **E**nable control signal
CIO_5	**RD / nWR**	Input	**R**ea**D** / **n**ot **WR**ite control signal
CIO_6	**CS**	Input	**C**hip **S**elect control signal
CIO_7	**SRDY**	Output	**S**lave **R**ea**DY**
CI_8	**IRQ_Pol**	Input	**IRQ Pol**arity

*Table 8-4 : Defined **IRQ** polarity and specific functions for communication pads **CI_8** and **CIO_7 … CIO_0** when slave 4-bit parallel interface is selected*

This parallel interface allows fast bidirectional and synchronous communication between the host and the **EM6420**.

The **CE** input is the control signal used to enable the **EM6420** parallel interface. When set to V_{SS}, the data lines **D_3 ... D_0** as well as the **SRDY** output are tri-stated, thus allowing another **EM6420** to take control of these lines in applications where several devices are used.

When the **CE** input is set to V_{DD}, the **EM6420** drives its **SRDY** output and also the data lines **D_3** … **D_0** if the **RD / nWR** input is set to V_{DD} too. The data lines **D_3** … **D_0** are driven by the host when the **RD / nWR** control signal is set to V_{SS}.

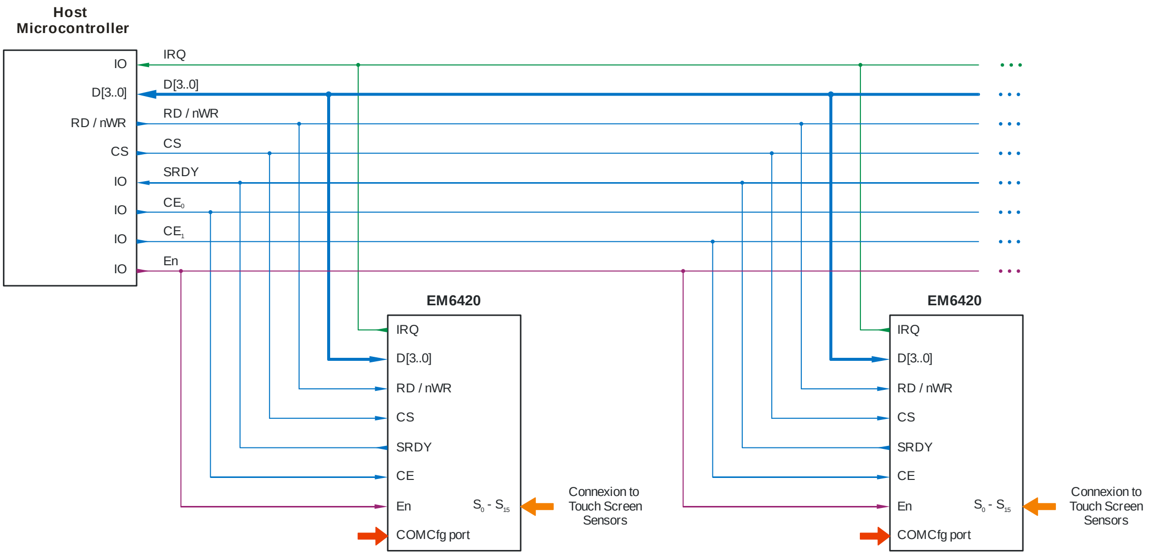


Figure 8-5: Multi EM6420 configuration using the 4-bit parallel interface

The **CS** input is the control signal used to effectively read or write a data nibble on the data bus. Data lines **D_3** … **D_0** can only change at the **CS** rising edge, and they are sampled at the **CS** falling edge.
The **SRDY** output indicates to the host that the **EM6420** is ready to send or receive a data byte. The host must always check that **SRDY** is set to V_{DD} before generating the two **CS** strobes needed to transfer a data byte. Data byte is sent high nibble first.

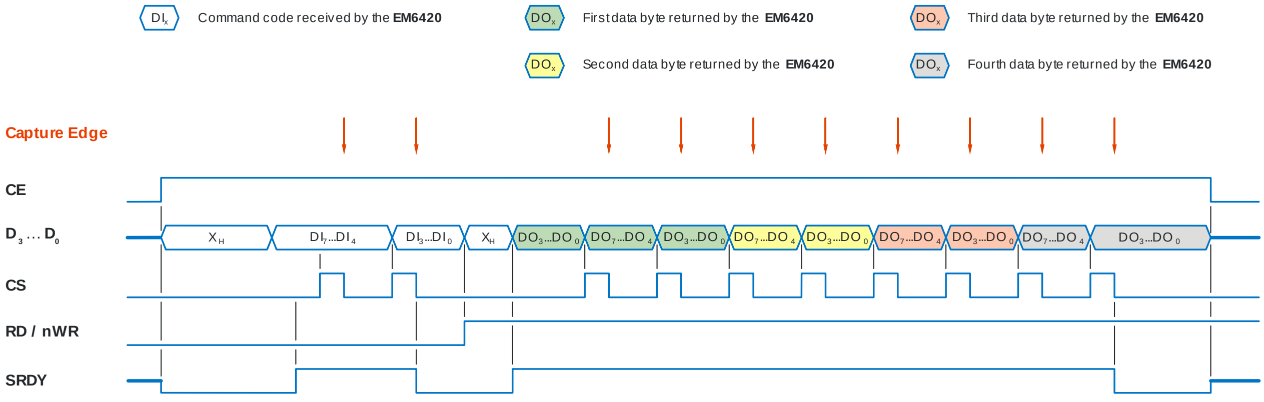


Figure 8-6: Typical data transfer using the parallel 4-bit interface.

The **IRQ_Pol** input defines the polarity of the **IRQ** output:

- The positive IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{DD}, and a rising edge is generated when the **EM6420** asserts its **IRQ** output.
- The negative IRQ polarity is selected when the **IRQ_Pol** input is connected to V_{SS}, and a falling edge is generated when the **EM6420** asserts its **IRQ** output.

8.2.4 8-bit Direct Output Interface

When 8-bit direct output interface is selected, communication pads **CI_8** and **CIO_7 … CIO_0** are configured for specific 8-bit direct output functions and define Touch Screen IRQ condition, according to the Table 8-5:

PAD			
Name	**Alternate name**	**Type**	**Specific function for 8-bit direct output interface**
CIO_7 … CIO_0	**$SStO_7$ … $SStO_0$**	Output	**S**ensors **Stat**us **O**utput port
CI_8	**MAS**	Input	Touch Screen **M**ost **A**ctivated **S**ensor feature

*Table 8-5 : Touch Screen feature and specific functions for communication pads **CI_8** and **CIO_7 … CIO_0** when 8-bit direct output interface is selected*

In this configuration, the **EM6420** can only provide sensors status on an 8-bit output port. As no application parameters can be received from the host processor, the **EM6420** defines itself the number of sensors to be scanned (up to 8 sensors) while the Touch Screen scan frequency is defined from configuration inputs **CIS_0** and **CIS_1**, according to Table 8-6. Therefore, the **EM6420** may also be used in a standalone configuration, i.e. without any host processor connection.

CIS_1	CIS_0	Touch Screen scan frequency
0	0	2 Hz
0	1	8 Hz
1	0	32 Hz
1	1	128 Hz

Table 8-6 : Touch Screen scan frequency when 8-bit Direct Output interface is selected (Standalone configuration)

When 8-bit direct output interface is selected, the Touch Screen interface is always ON. Activating a sensor will directly asserts its corresponding bit on output port **$SStO_7$ … $SStO_0$**. When input pad **MAS** is connected to V_{DD}, only the bit corresponding to the most activated sensor is asserted, even if other sensors are also active. By default, the output port polarity is positive[6], i.e. the **$SStO_x$** outputs are asserted when they are set to V_{DD}.

A pulse of at least 100 µs is generated on the **IRQ** output every time a Touch Screen IRQ condition occurred. By default, the pulse polarity is negative and the open-drain with internal pull-up resistor configuration is selected by embedded software for the **IRQ** output pad[7].

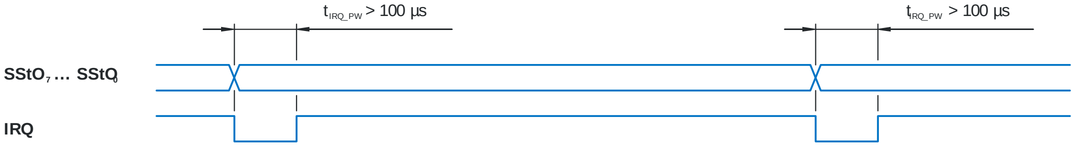


Figure 8-7: Default IRQ output pad timing when 8-bit direct output is selected

[6] Please contact EM Microelectronic-Marin SA to change the output port polarity from positive to negative, in order to have the **$SStO_x$** outputs set to V_{SS} when they are asserted

[7] Please contact EM Microelectronic-Marin SA to change the IRQ polarity from negative to positive and to select the push-pull instead of the open-drain configuration for the **IRQ** output pad

8.2.5 *Communication interface initialization.*

At start-up, the **EM6420** can determine which communication interface is active. It then sets the required communication options according to the communication pads **CI$_8$** and **CIO$_7$ … CIO$_0$** state. Finally, the **EM6420 IRQ** output pad is activated and special code 18$_H$ is returned in the next ***getStatus*** command, thus signaling to the host controller that it is ready to accept communication frames. See Table 8-16 on page 39 for a complete list of the possible special codes.

When the positive IRQ polarity is used, the push-pull configuration is selected by the embedded software for the **IRQ** output pad and the timings shown in Figure 8-8 are generated at startup.

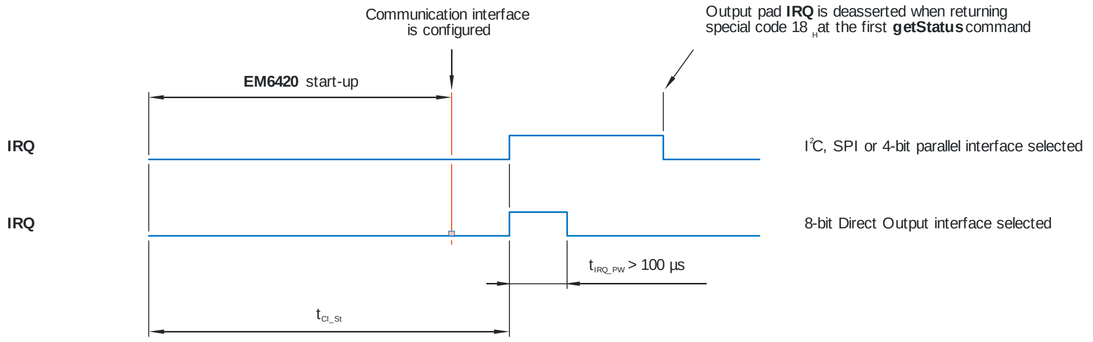


*Figure 8-8 : **IRQ** output startup timings when positive **IRQ** polarity is selected by embedded software*

When the negative IRQ polarity is used, the open-drain with internal pull-up resistor configuration is selected by the embedded software for the **IRQ** output pad and the timings shown in Figure 8-9 are generated at startup.

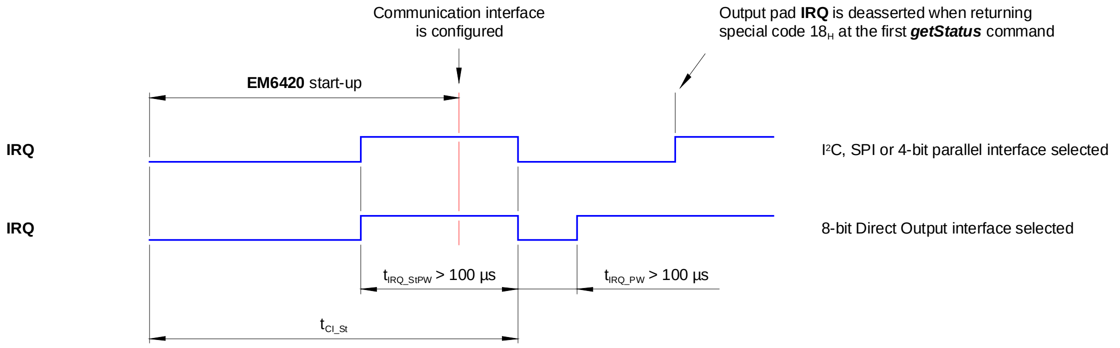


*Figure 8-9 : **IRQ** output pad start-up timings when negative **IRQ** polarity is selected*

8.3 EM6420 COMMANDS

Communication commands interpreted by the **EM6420** can be grouped into 3 command sets:

- The first command set includes all single byte commands, as described in Table 8-7. These commands are mainly used to send a new parameter value to the **EM6420**.

Command name	Command description
startTS	Start the Touch Screen interface
stopTS	Stop the Touch Screen interface
setTSMode	Select the Touch Screen running features
selectBaseSettings	Select the base settings as the current settings
selectAltSettings	Select the alternate settings as the current settings
setBaseScanFreq	Set the Touch Screen base scan frequency
setAltScanFreq	Set the Touch Screen alternate scan frequency
setBaseHiSensNb	Set the base highest sensor number to be scanned
setAltHiSensNb	Set the alternate highest sensor number to be scanned
setBaseIRQCond	Set the base IRQ condition
setAltIRQCond	Set the alternate IRQ condition
next	Request the next data byte within a multiple data byte read sequence (SPI interface only)
end	End a multiple data byte read sequence (SPI interface only)

*Table 8-7 : **EM6420** single byte command set*

- The second command set includes two-byte commands, as described in the following table. These commands are used to get any parameter value from the **EM6420** or to send a more than 4-bit parameter value to the **EM6420**.

Command name	Command description
setThreshold	Set Touch Screen threshold
getAppSettings	Get current application settings

*Table 8-8 : **EM6420** two-byte command set*

- The third command set includes multiple byte commands, as described in the following table. These commands are used to get multiple parameters from or to send multiple parameters to the **EM6420**, thus reducing communication traffic and overall system consumption.

Command name	Command description
getVersion	Get **EM6420** HW and SW version
getStatus	Get **EM6420** status

*Table 8-9 : **EM6420** multiple bytes command set*

8.3.1 *Command startTS*

This command starts the **EM6420** Touch Screen interface.

	7							0	
1	0	0	0	1	0	1	0	0	14_H

*Figure 8-10 : **startTS** command format*

At power-up, the Touch Screen interface is stopped. Some settings must be defined before the Touch Screen is started, and cannot be changed later on. Therefore, the commands ***setTSMode***, ***setBaseScanFreq***, ***setBaseHiSensNb***, ***setBaseIRQCond*** and ***setThreshold***, if used, must be sent before the ***startTS*** command. Attempting to send one of these commands while the Touch Screen interface is running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

The Touch Screen base settings are checked when the Touch Screen interface is started. If they are invalid, the **EM6420** asserts its **IRQ** output and returns error code 02_H.

During the Touch Screen startup, the **EM6420** checks the presence of each sensor and establishes a sensor map. If the total number of sensors wasn't specified before the ***startTS*** command (with the ***setBaseHiSensNb*** command), the device scans all sixteen sensors and determines the number of sensors by itself. To be valid, the sensor map must have at least sensor 0 connected and there must be no lack between the first and the last used sensor. If the highest sensor number was specified, the following sensors will never be scanned. If the **EM6420** detects a problem with the sensor map, it asserts its **IRQ** output and returns error code 01_H.

If the alternate settings are already selected before the ***startTS*** command is used, that is if the command ***selectAltSettings*** was sent before the ***startTS*** command, the **EM6420** will automatically apply the alternate settings immediately after the Touch Screen startup. However, initialization of the sensors is always performed according to the base settings. Sending the ***startTS*** command while the Touch Screen interface is already running will restart it according to the base settings for initialization, and then it will use the previous selected settings.

Sensors that are already activated during the Touch Screen startup procedure will not be detected until they are released and the **EM6420** has had enough time to initialize them properly.

8.3.2 *Command stopTS*

This command stops the **EM6420** Touch Screen interface.

	7							0	
1	0	0	0	1	0	1	0	1	15_H

*Figure 8-11 : **stopTS** command format*

This command has no effect if the Touch Screen interface is already stopped. Stopping the Touch Screen interface allows the host to change the base settings with the commands ***setTSMode***, ***setBaseScanFreq***, ***setBaseHiSensNb***, ***setBaseIRQCond*** and ***setThreshold***. However, if some sensors are activated during the next startup procedure (initiated by the ***startTS*** command), they will not be detected by the **EM6420** until they are released and the **EM6420** has had enough time to initialize them properly.

8.3.3 *Command setTSMode*

This command sets the **EM6420** Touch Screen running features.

	7					0			
1	0	0	1	1	0	TSM	30_H	#	TSM

*Figure 8-12 : **setTSMode** command format*

Table 8-10 gives the mapping between the **TSM** bits and the selected Touch Screen running features.

Bit	Behavior if bit is set	Behavior if bit is cleared
0	**EM6420** works in Ultra Low Power mode	**EM6420** works in Low Power mode
1	Each sensor sensitivity is continuously optimized, taking into account actual room temperature and supply voltage	Each sensor sensitivity is optimized only when the Touch Screen interface is started
2	Each sensor has its own activation threshold which is continuously adapted to sensor sensitivity	All sensors have the same activation threshold which is a fixed value

*Table 8-10 : Mapping between the **TSM** bits and the Touch Screen running features*

The Touch Screen running features must be defined before starting the Touch Screen interface. By default, the **TSM** bits values are 111_B when 8-bit direct output interface is selected and 110_B when any other communication interface is selected[8].
Attempting to modify the Touch Screen running features while the Touch Screen interface is running will cause the **EM6420** to assert its **IRQ** output and return the error code 06_H.

8.3.4 Command selectBaseSettings

This command selects the basic settings as the Touch Screen current settings.

	7							0	
1	0	1	1	1	0	1	0	0	74_H

*Figure 8-13 : **selectBaseSettings** command format*

The Touch Screen base settings can be defined by ***setBaseScanFreq***, ***setBaseHiSensNb*** and ***setBaseIRQCond*** commands. If used, these commands must be sent before the Touch Screen interface is started. If they aren't used, default values are supplied for the base settings. At power-up, the base settings (as opposed to the alternate settings) are selected, so that this command is only needed after a ***selectAltSettings*** command, in order to switch back to the base settings.

The Touch Screen base settings are checked when the Touch Screen interface is started. If they are invalid, the **EM6420** asserts its **IRQ** output and returns error code 02_H. Attempting to change the base settings while the Touch Screen interface is running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

It is possible to switch from the alternate settings to the base settings at any time, even when the Touch Screen interface is running. In that case, the base settings are applied immediately. This command has no effect if the base settings are already selected.

8.3.5 Command selectAltSettings

This command selects the alternate settings as the Touch Screen current settings.

	7							0	
1	0	1	1	1	0	1	0	1	75_H

*Figure 8-14 : **selectAltSettings** command format*

The Touch Screen alternate settings are defined by ***setAltScanFreq***, ***setAltHiSensNb*** and ***setAltIRQCond*** commands. They can be modified when the Touch Screen interface is stopped as well as when it's running even if some other alternate settings are currently active.. However, the new alternate settings will not take effect immediately after one of

[8] Please contact EM Microelectronic-Marin SA to change the default values of **TSM** bits 1 and 2

these three commands. Instead, if the Touch Screen interface is running, the new alternate settings will be applied at the next occurrence of a ***setAltSettings*** command. If the Touch Screen interface is stopped and the alternate settings are already selected, they will be applied directly after the next ***startTS*** command.

Each alternate parameter that has never been explicitly set through the appropriate command, when applied, will be substituted by the corresponding base settings. Therefore, toggling between base and alternate settings without having ever sent any of the three ***setAlt...*** commands won't have any effect.

The validity of the new alternate settings is checked when they are applied, that is either after a ***selectAltSettings*** or a ***startTS*** command. If they are invalid, the **EM6420** asserts its **IRQ** output and returns error code 03_H.

8.3.6 Command setBaseScanFreq

This command sets the basic scan frequency of Touch Screen sensors.

1	0	1	0	1	0	SF			50_H # SF
	7							0	

Figure 8-15 : ***setBaseScanFreq*** *command format*

Table 8-11 lists valid values for parameter **SF**. Note that a 64 Hz or 128 Hz scan frequency can only be used with a reduced number of sensors, i.e. 8 at 64 Hz and 4 at 128 Hz.

SF	Touch Screen scan frequency	SF	Touch Screen scan frequency
000_B	1 Hz	100_B	16 Hz
001_B	2 Hz	101_B	32 Hz
010_B	4 Hz	110_B	64 Hz
011_B	8 Hz	111_B	128 Hz

Table 8-11 : Selection of Touch Screen scan frequency

The ***setBaseScanFreq*** command, if used, must be sent before the Touch Screen interface is started. If the ***setBaseScanFreq*** command isn't used, the base scan frequency is 8 Hz by default.

Attempting to modify the base scan frequency while the Touch Screen interface is running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

8.3.7 Command setAltScanFreq

This command sets the alternate scan frequency of Touch Screen sensors.

1	1	0	0	1	0	ASF			90_H # ASF
	7							0	

Figure 8-16 : ***setAltScanFreq*** *command format*

Table 8-12 lists valid values for parameter **ASF**. Note that a 64 Hz or 128 Hz scan frequency can only be used with a reduced number of sensors, i.e. 8 at 64 Hz and 4 at 128 Hz. Moreover, the alternate scan frequency cannot be greater than the base scan frequency. The **EM6420** will assert its **IRQ** output and return error code 03_H if these conditions are not met when the alternate settings are applied.

ASF	Touch Screen scan frequency
000_B	1 Hz
001_B	2 Hz
010_B	4 Hz
011_B	8 Hz

ASF	Touch Screen scan frequency
100_B	16 Hz
101_B	32 Hz
110_B	64 Hz
111_B	128 Hz

Table 8-12 : Selection of alternate Touch Screen scan frequency

The alternate scan frequency can be modified at any time, even if some other Touch Screen alternate settings are already selected. However, the new alternate scan frequency will be taken into account only next time a ***setAltSettings*** command is issued. By default, if the ***setAltScanFreq*** command has never been sent, the alternate scan frequency is the same as the base scan frequency (no change in scan frequency when switching from base to alternate settings).

8.3.8 Command setBaseHiSensNb

This command sets the highest sensor number to be scanned when base settings are selected. Sensors are numbered from 0 to 15.

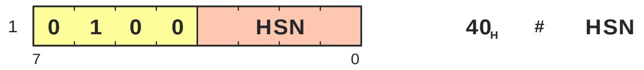


Figure 8-17 : ***setBaseHiSensNb*** *command format*

Valid values for parameter **HSN** range from 0 to 15, allowing the host to select from one to sixteen sensors.

The base highest sensor number can only be defined before the Touch Screen interface is started. Attempting to modify the base highest sensor number while the Touch Screen interface is already running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

If the base highest sensor number hasn't been defined when the Touch Screen interface is started, the **EM6420** will determine the number of connected sensors by itself. Otherwise, if the number of sensors has been defined, it will check that these sensors are effectively connected. An error in the sensor map (due to inappropriate settings or to sensors failure) will cause the **EM6420** to assert its **IRQ** output and generate error 01_H at the next ***startTS*** command.

8.3.9 Command setAltHiSensNb

This command sets the alternate highest sensor number to be scanned.

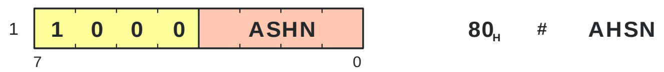


Figure 8-18 : ***setAltHiSensNb*** *command format*

Valid values for parameter **AHSN** range from 0 to 15, allowing the host to select from one up to sixteen sensors. The alternate highest sensor number must not be greater than the highest sensor number selected in the base settings.

The alternate highest sensor number can be modified at any time, even if some other alternate settings are currently being used. However, the new alternate highest sensor number will be taken into account only next time a ***setAltSettings*** command is issued. By default, if the ***setAltHiSensNb*** command has never been sent, the alternate sensor number is the same as the base sensor number (no change in number of sensors when switching from base to alternate settings).

8.3.10 *Command setBaseIRQCond*

This command sets the basic Touch Screen IRQ condition.

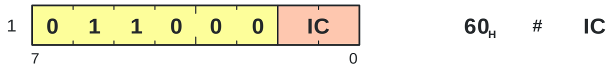


*Figure 8-19 : **setBaseIRQCond** command format*

Table 8-13 gives the mapping between **IC** parameter values and the selected Touch Screen IRQ condition.

IC	Touch Screen IRQ condition
00_B	**EM6420** output pad **IRQ** is asserted at the end of each sensors scan
01_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when at least one sensor state has changed
10_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when either at least one sensor is active or at least one sensor state has changed
11_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when the most activated sensor has changed

*Table 8-13 : Selection of **EM6420** IRQ condition*

The Touch Screen IRQ condition defines under which circumstances the **EM6420** will assert its **IRQ** output to signal events happening on the Touch Screen. The **IRQ** output remains asserted until the new Touch Screen state is returned in response to a ***getStatus*** command.

The base Touch Screen IRQ condition should be defined before starting the Touch Screen interface. Two separate default values exist when 8-bit direct output interface is selected: the default value is 11_B when **MAS** input is asserted and 01_B when **MAS** input is deasserted or when any other communication interface is selected[9].

Attempting to modify the base IRQ condition while the Touch Screen interface is running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

8.3.11 *Command setAltIRQCond*

This command set the alternate Touch Screen IRQ condition.

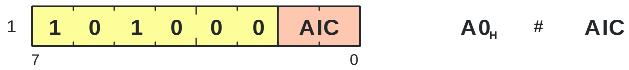


*Figure 8-20 : **setAltIRQCond** command format*

Table 8-14 gives the mapping between **AIC** parameter values and the selected Touch Screen IRQ condition.

When alternate settings are selected, the alternate Touch Screen IRQ condition defines under which circumstances the **EM6420** will assert its **IRQ** output to signal events happening on the Touch Screen. The **IRQ** output remains asserted until the new Touch Screen state is returned in response to a ***getStatus*** command.

The alternate Touch Screen IRQ condition can be modified at any time, even if some other alternate settings are currently being used. However, the new alternate IRQ condition will be taken into account only next time a ***setAltSettings*** command is issued. By default, if the ***setAltIRQCond*** command has never been sent, the alternate IRQ condition is the same as the base IRQ condition (no change in IRQ generation mode when switching from base to alternate settings).

[9] Please contact EM Microelectronic-Marin SA to change the default Touch Screen IRQ condition values

AIC	Touch Screen IRQ condition
00_B	**EM6420** output pad **IRQ** is asserted at the end of each sensors scan
01_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when at least one sensor state has changed
10_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when either at least one sensor is active or at least one sensor state has changed
11_B	**EM6420** output pad **IRQ** is asserted at the end of a sensors scan, when the most activated sensor has changed

*Table 8-14 : Selection of **EM6420** alternate IRQ condition*

When alternate settings are selected, the alternate Touch Screen IRQ condition defines under which circumstances the **EM6420** will assert its **IRQ** output to signal events happening on the Touch Screen. The **IRQ** output remains asserted until the new Touch Screen state is returned in response to a ***getStatus*** command.

The alternate Touch Screen IRQ condition can be modified at any time, even if some other alternate settings are currently being used. However, the new alternate IRQ condition will be taken into account only next time a ***setAltSettings*** command is issued. By default, if the ***setAltIRQCond*** command has never been sent, the alternate IRQ condition is the same as the base IRQ condition (no change in IRQ generation mode when switching from base to alternate settings).

8.3.12 Command next (SPI protocol only)

This is a dummy command that has to be sent while fetching all the bytes of a response, but the last one (see § 8.3.13 and also § 9.2). This command will request the next output byte to be prepared on the **EM6420**, thus indicating that the transfer isn't finished. The ***next*** command may not be used when the communication bus is idle and no response is expected. If the **EM6420** receives a ***next*** command in such circumstances, it will assert its **IRQ** output and return error code 05_H.

1	7							0	
	1	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**$C3_H$**

*Figure 8-21 : **next** command format*

This command can only be used when SPI communication interface is selected, and will cause the **EM6420** to assert its **IRQ** output and return error code 05_H if used with any other communication protocol.

8.3.13 Command end

This is a dummy command that has to be sent in order to fetch the last desired byte of a response and close the transfer. It indicates the end of a SPI communication frame and lets the **EM6420** stop sending data (see § 9.2)

1	7							0	
	1	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**CA_H**

*Figure 8-22 : **end** command format*

It is not necessary to send an ***end*** for each intermediate command when several commands are chained. The following command code can be sent directly in place of the ***end*** code. That way, the last response byte to the previous command will be retrieved during the transfer of the following command code, and the reception of a new command will automatically close the previous one on the **EM6420** side.

The ***end*** command may not be used when the communication bus is idle and no response is expected. If the **EM6420** receives an ***end*** command in such circumstances, it will assert its **IRQ** output and return error code 05_H. Moreover, this command can only be used in SPI mode, and will cause the **EM6420** to assert its **IRQ** output and return error code 05_H if used with any other communication protocol.

8.3.14 *Command setThreshold*

This command sets the initial sensor activation threshold.

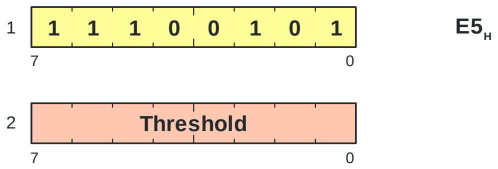


*Figure 8-23 : **setThreshold** command format*

Threshold values must be in the range from 3 to 200. Invalid values will cause the **EM6420** to assert its **IRQ** output and return error code 04_H. The default threshold value is 6[10].

The threshold value can only be defined before the Touch Screen interface is started. Attempting to modify that value while the Touch Screen interface is already running will cause the **EM6420** to assert its **IRQ** output and return error code 06_H.

8.3.15 *Command getAppSettings*

This command gets the current application settings, i.e. the current Touch Screen scan frequency and the current highest scanned sensor number.

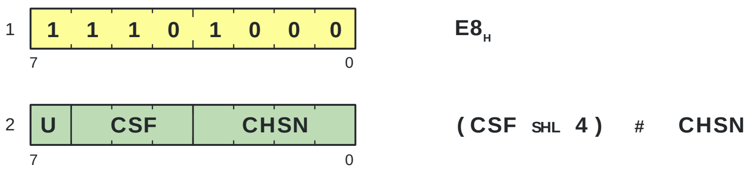


*Figure 8-24 : **getAppSettings** command format*

Valid values for parameter **CHSN** range from 0 to 15, thus indicating a number of scanned sensors comprised between 1 and 16. Note that the current sensor number could also be unknown, if it hasn't been specified by the host processor and the Touch Screen has not been started yet. In that case, the flag **U** is set, and **CHSN** contains the highest possible sensor number, depending on the scan frequency, i.e.15 at scan frequencies up to 32 Hz, 7 at 64 Hz and 3 at 128 Hz.

Table 8-15 lists valid values for parameter **CSF**. Note that a 64 Hz or 128 Hz scan frequency can only be obtained with a reduced number of sensors, i.e. 8 at 64 Hz and 4 at 128 Hz.

CSF	Touch Screen scan frequency	CSF	Touch Screen scan frequency
000_B	1 Hz	100_B	16 Hz
001_B	2 Hz	101_B	32 Hz
010_B	4 Hz	110_B	64 Hz
011_B	8 Hz	111_B	128 Hz

Table 8-15 : Current Touch Screen scan frequency

8.3.16 *Command getVersion*

This command gets the hardware as well as the software version of the **EM6420**.

[10] Please contact EM Microelectronic-Marin SA to change the default threshold value

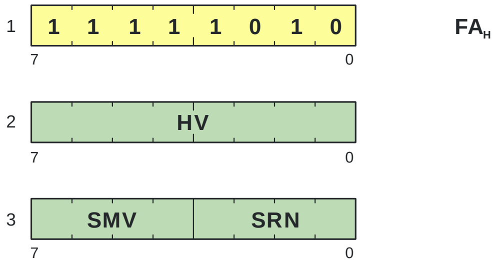


*Figure 8-25 : **getVersion** command format*

The hardware version is a single 8 bits value. The software version is composed of two nibbles: the **SMV** nibble is the software major version and the **SRN** nibble is the software revision number.

8.3.17 Command getStatus

This command gets the **EM6420** status and deasserts the **IRQ** output pad, if asserted. If the **IRQ** was not asserted, the ***getStatus*** will return null bytes.

NB: For better performance, do not send ***getStatus*** requests while no **IRQ** is asserted. In particular, do not try to read the Touch Screen status by sending this command repeatedly, as it will only slow down the **EM6420** and increase its power consumption.

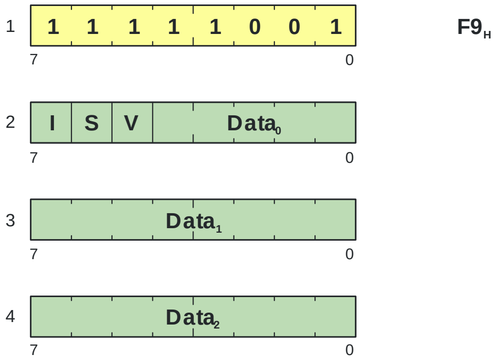


*Figure 8-26 : **getStatus** command format*

Flag **I** (**I**nterrupt) is set if the **EM6420 IRQ** output was asserted when a ***getStatus*** command was received. In a multi **EM6420** configuration (all **IRQ** output pads connected to a unique host IRQ input) this flag allows the host to determine which **EM6420** device has asserted the IRQ line.

When flag **I** is set, flag **S** (**S**pecial) defines which kind of information is returned to the host processor:

When flag **S** is cleared, a Touch Screen IRQ condition occurred. In this case, parameter **Data$_0$** indicates the number of the most activated sensor, parameter **Data$_1$** gives the state of sensors 0 to 7 and parameter **Data$_2$** gives the state of sensors 8 to 15, as shown in Figure 8-27.

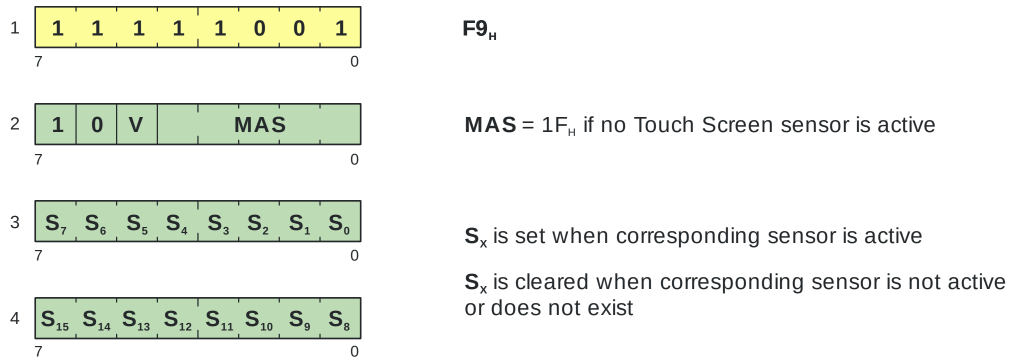


*Figure 8-27 : **getStatus** command format when flag **I** is set and flag **S** is cleared*

When command parameter **S** is set, the **EM6420** returns device status information, mainly error codes, but also the READY status after device startup. In this case, parameter **Data$_0$** gives a special code which valid values are listed in Table 8-16. For some special codes, parameters **Data$_1$** and **Data$_2$** may contain more information as shown in Figure 8-28. For special codes that do not provide complementary information, these parameters are null.

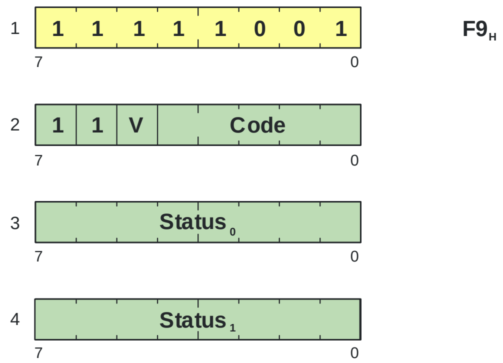


*Figure 8-28 : **getStatus** command format when flags **I** and **S** are set*

The flag **V** (o**V**errun) indicates that the host has missed one or more significant status messages. This happens when the host takes too much time to react to an **IRQ**, and the **EM6420** wants to signal another event while the **IRQ** line is still active. In this case, the previous important message is deleted, and the host won't be able to retrieve it anymore. It will only have an indication, through the overflow bit, that at least one message was lost. In case of an overrun, the retrieved message is the most recent message containing the **S** flag. If none of them contains the **S** flag, it is the most recent Touch Screen message.

Code	Special code description
01_H	At least one Touch Screen sensor is not correctly connected to the **EM6420** device. Command parameters **Status$_0$** and **Status$_1$** show which sensors seem to be connected. 1: 1 1 1 1 1 0 0 1 (bit 7 … bit 0) — **F9$_H$** 2: 1 1 V 0 0 0 0 1 (bit 7 … bit 0) 3: S_7 S_6 S_5 S_4 S_3 S_2 S_1 S_0 (bit 7 … bit 0) 4: S_{15} S_{14} S_{13} S_{12} S_{11} S_{10} S_9 S_8 (bit 7 … bit 0) S_x is cleared when corresponding sensor seems to be defect S_x is set when corresponding sensor seems to be connected
02_H	Base settings are invalid. These settings are checked when the Touch Screen interface is started
03_H	Alternate settings are invalid. These settings are checked once selected as current settings or when the Touch Screen interface is started, if alternate settings are already selected at this moment
04_H	Bad initial sensor activation threshold
05_H	Unexpected command received
06_H	Parameter modification not allowed. Command parameter **Status$_0$** returns the command code
07_H	Reserved for debug purposes
08_H	Major overflow occurred. Command parameters **Status$_0$** and **Status$_1$** show which sensor has generated the major overflow. Normally, only one bit is set 1: 1 1 1 1 1 0 0 1 (bit 7 … bit 0) — **F9$_H$** 2: 1 1 V 0 1 0 0 0 (bit 7 … bit 0) 3: S_7 S_6 S_5 S_4 S_3 S_2 S_1 S_0 (bit 7 … bit 0) 4: S_{15} S_{14} S_{13} S_{12} S_{11} S_{10} S_9 S_8 (bit 7 … bit 0) S_x is cleared when corresponding sensor is working properly S_x is set when corresponding sensor has generated a major overflow
$0F_H$	Unknown command received. Command parameter **Status$_0$** returns the command code
10_H	Reserved for debug purposes
11_H	Reserved for debug purposes
18_H	**EM6420** is READY to accept communication frames

Table 8-16 : ***EM6420*** *special codes description*

9. EM6420 COMMUNICATION FRAMES

All **EM6420** commands may be sent by the host using one of the two following communication frames:
A Write-Only (WO) communication frame is used to send commands that do not return any values to the host.

- A Write-Read (WR) communication frame is used to send commands that return one or more values to the host.
- Depending of the selected communication interface, these two communication frames may slightly differ, as explained in details hereafter.

9.1 SLAVE I²C COMMUNICATION FRAME

Each I²C communication frame must begin with a START condition followed by an I²C header and must end with a STOP condition.

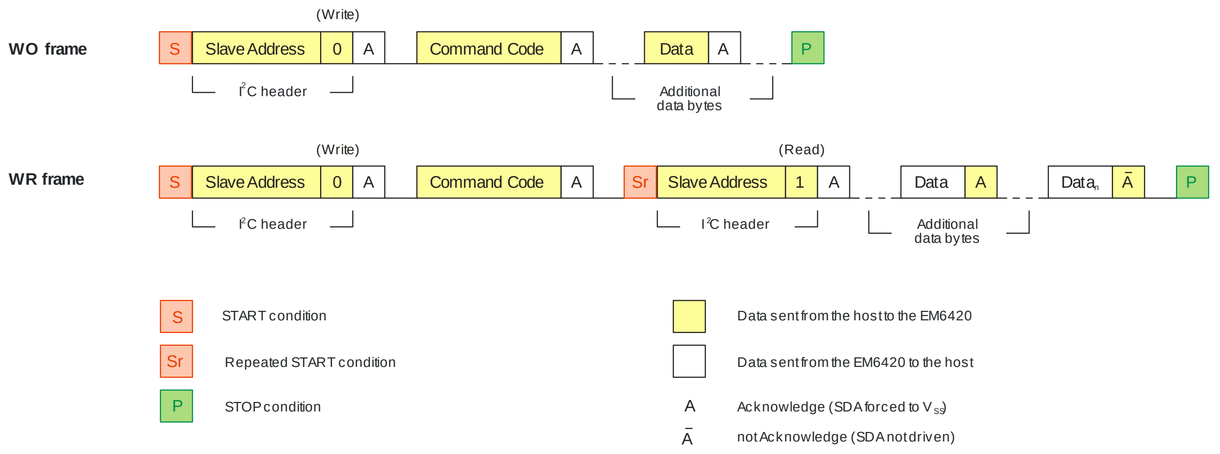


Figure 9-1: I2C WO and WR communication frames

When several commands are sent to the same EM6420 device, the STOP condition is not necessarily be generated between the concatenated communication frames.

9.2 SLAVE SPI COMMUNICATION FRAME

As the SPI is a full duplex interface, WO and WR communication frames looks quite the same. However, the host should ignore the values returned by the **EM6420** in a WO communication frame.

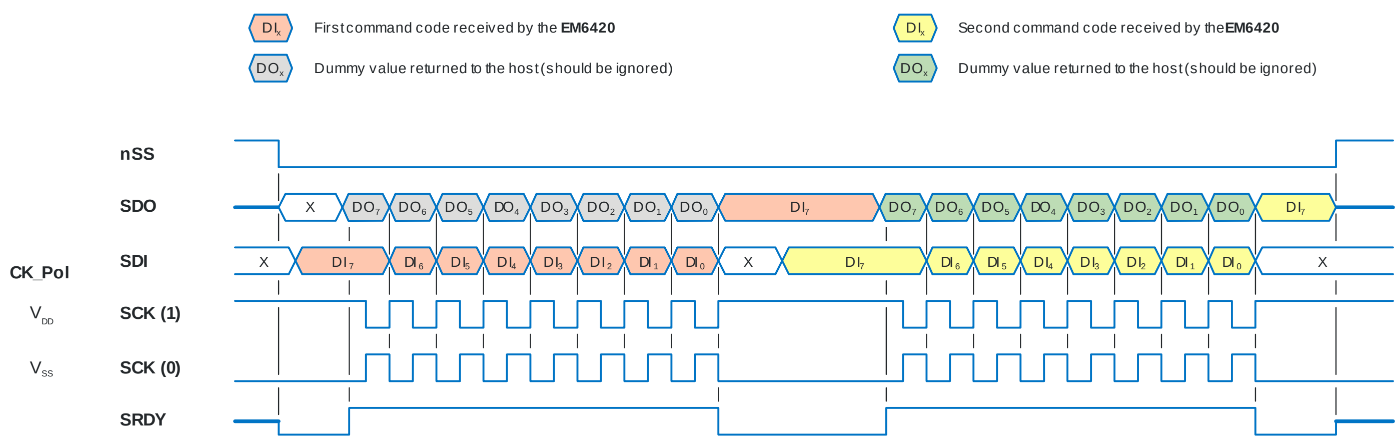


Figure 9-2: SPI WO communication frames when CK_Pha input is set to VSS

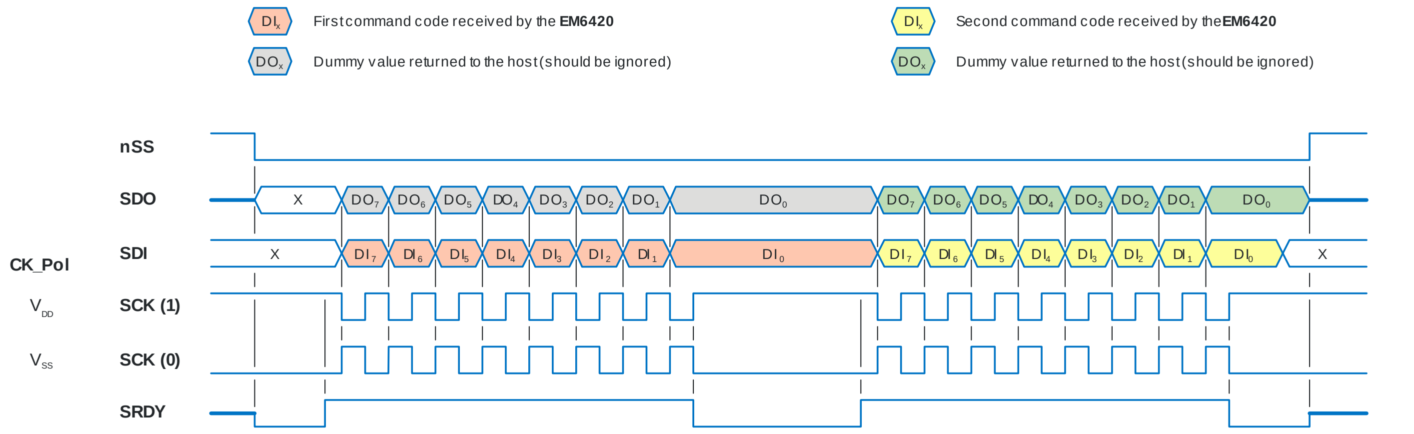


Figure 9-3: SPI WO communication frames when CK_Pha input is set to VDD

In a WR communication frame, the **EM6420** return the requested values as long as it receives a ***next*** command code. Receiving any other command code will terminate the current command and immediately start the new one.

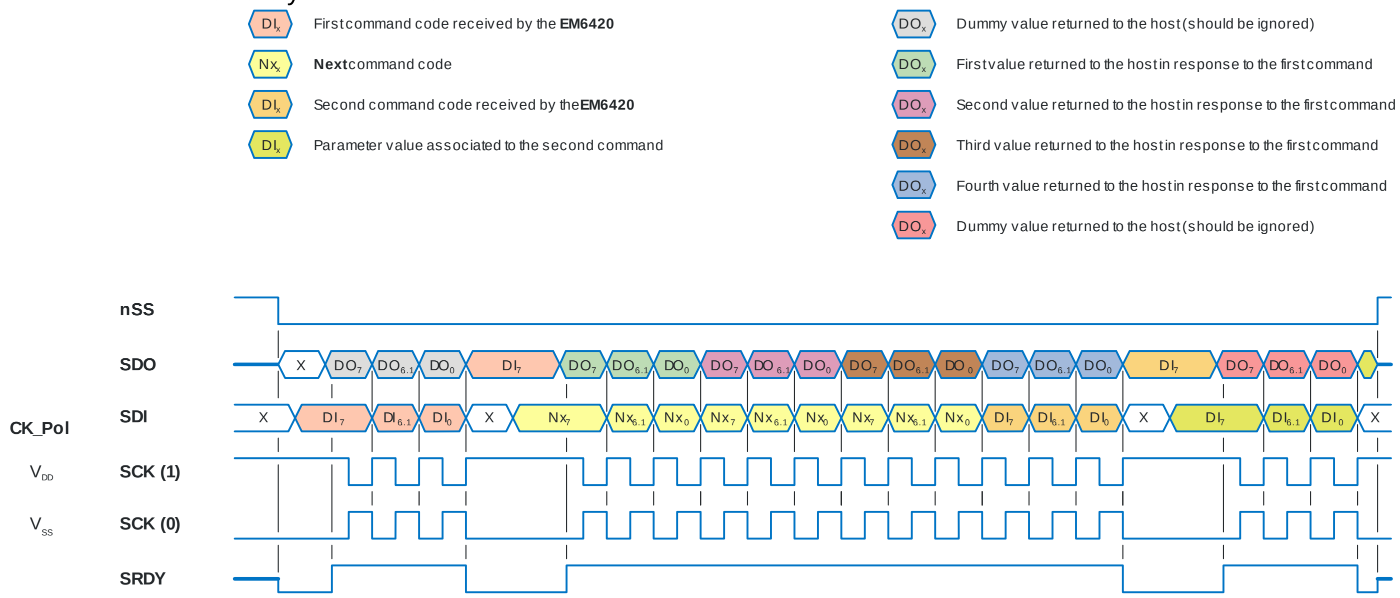


Figure 9-4: SPI WR followed by a WO communication frame when CK_Pha input is set to VSS

The **nSS** input of the **EM6420** does not need to be deasserted between two communication frames.

9.3 SLAVE 4-BIT PARALLEL COMMUNICATION FRAME

The **CE** input of the **EM6420** does not need to be deasserted between two communication frames.

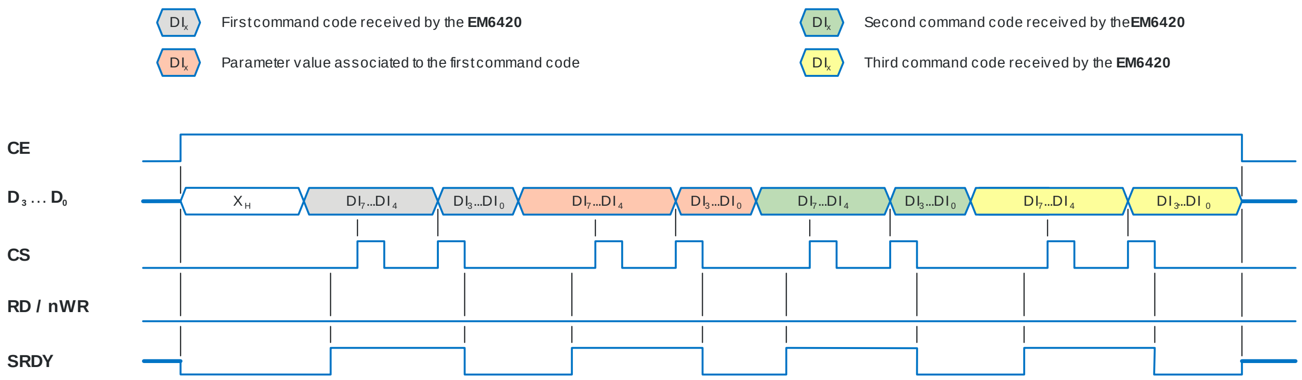


Figure 9-5 : Multiple 4-bit parallel WO communication frames

The falling edge of the **RD / nWR** input defines the end of a WR communication frame, and therefore the end of the current command.

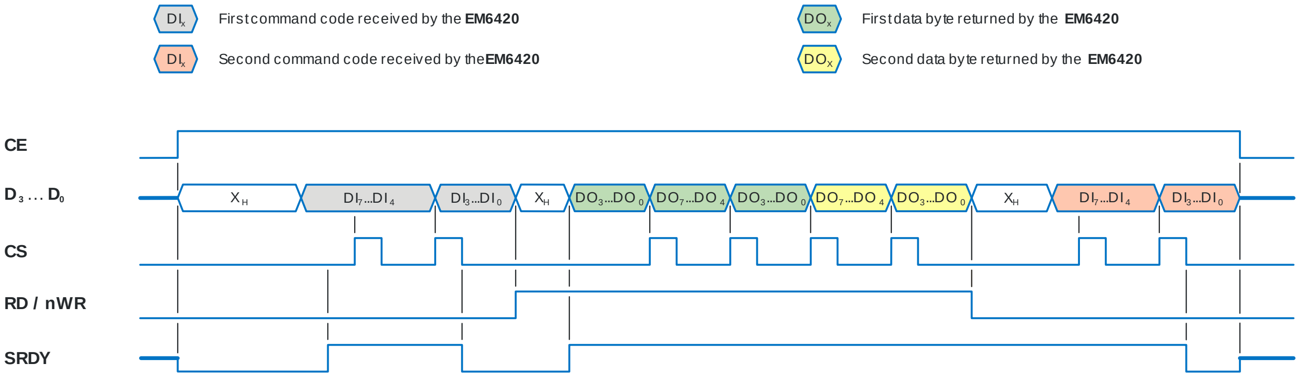
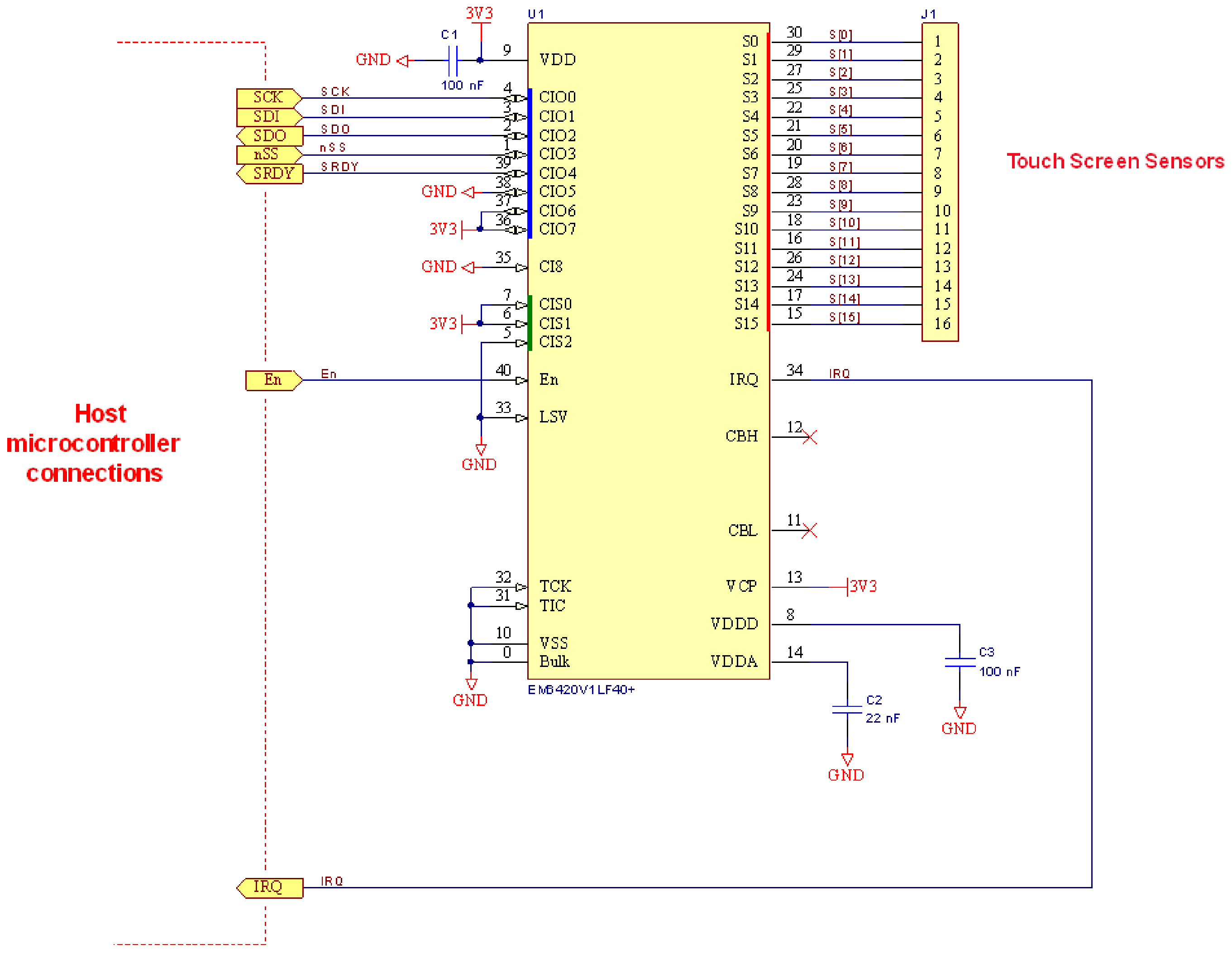


Figure 9-6: 4-bit parallel WR followed by a WO communication frame

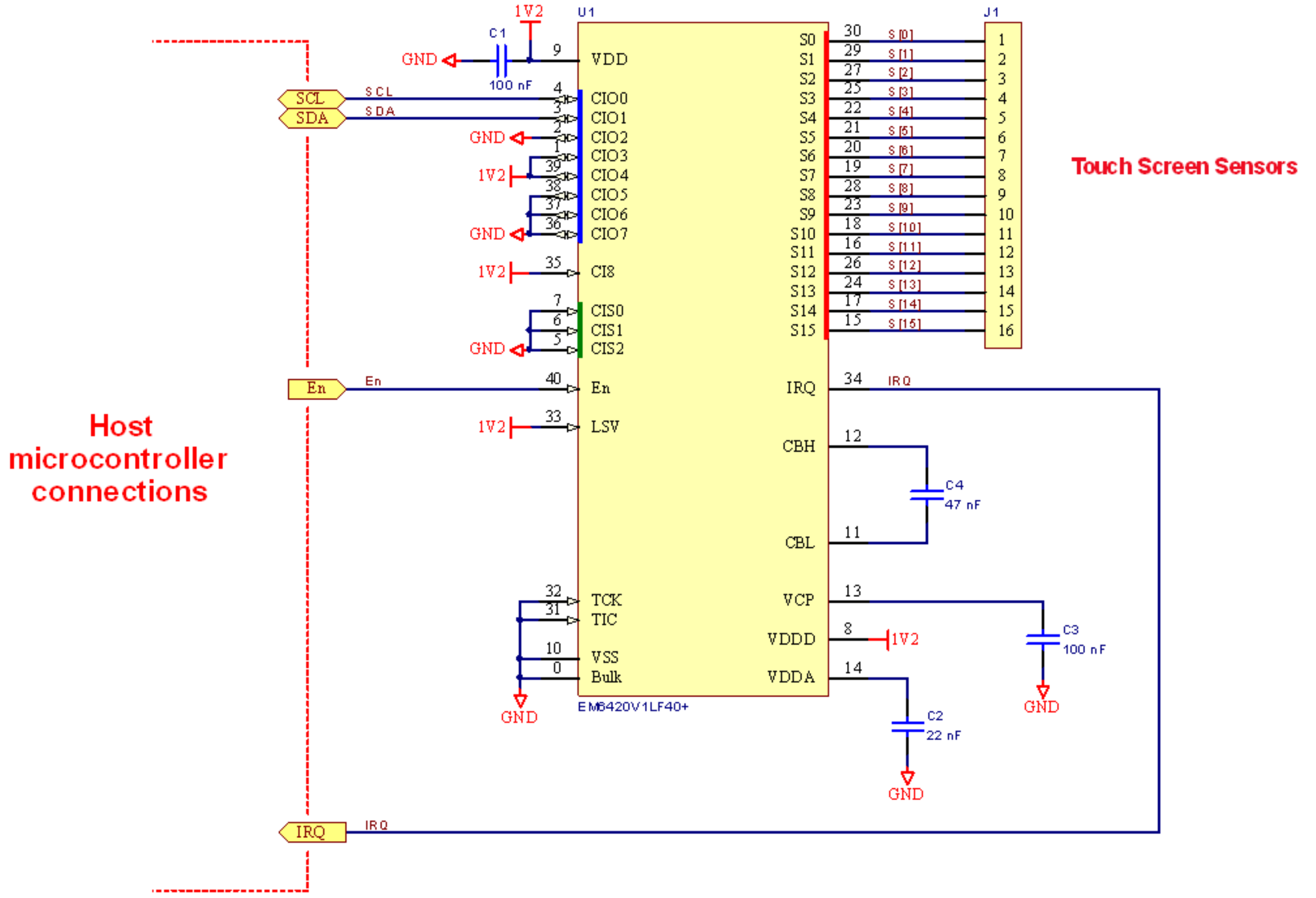
10. TYPICAL APPLICATIONS



SPI interface settings :

- **SCK** clock is set to V_{SS} between transmissions (**CK_Pol** [**CIO$_5$**] input connected to V_{SS})
- Data on **SDI** input is latched at the second **SCK** clock edge (**CK_Pha** [**CIO$_6$**] input connected to V_{DD})
- Data bytes are sent MSB first (**MSB_First** [**CIO$_7$**] input connected to V_{DD})
- Negative IRQ polarity is selected (**IRQ_Pol** [**CI$_8$**] input connected to V_{SS})

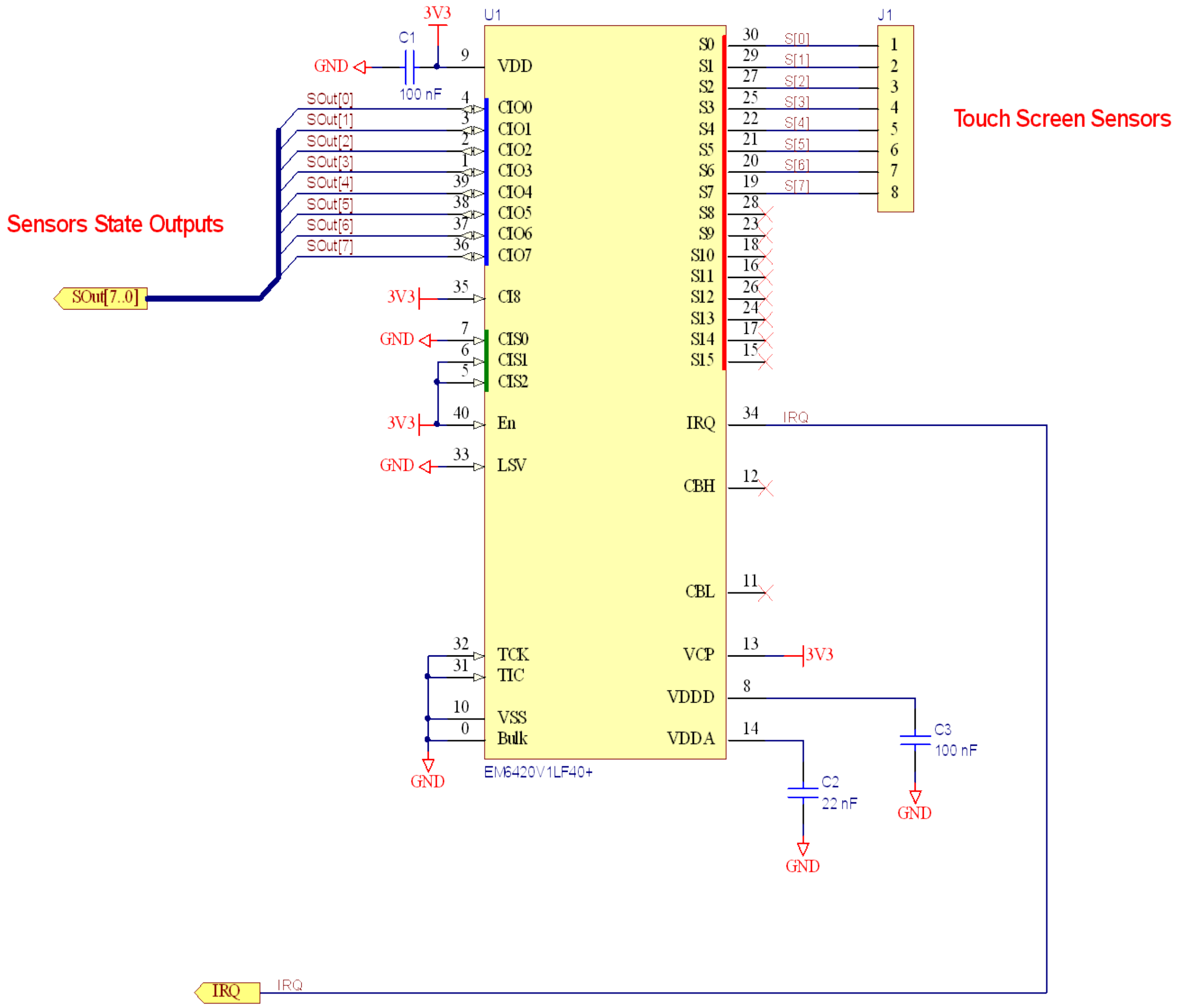
*Figure 10-1: **EM6420** typical application powered by a 3.3 V supply voltage and using the SPI communication interface*



<u>I2C interface settings :</u>

- Internal strong pull-up resistors are enabled on bidir pads **SDA** and **SCL** (**En_IWPU** [**CIO**$_2$] input connected to V_{SS} and **En_ISPU** [**CIO**$_3$] input connected to V_{DD})
- 7-bit I2C address is set to 41_H (**A**$_3$ ... **A**$_1$ [**CIO**$_7$ ... **CIO**$_5$] inputs connected to V_{SS} and **A**$_0$ [**CIO**$_4$] input connected to V_{DD})
- Positive IRQ polarity is selected (**IRQ_Pol** [**CI**$_8$] input connected to V_{DD})

Figure 10-2: EM6420 typical application powered by a 1.2 V supply voltage and using the I2C communication interface



Standalone settings :

- Scan frequency = 32 Hz (**CIS$_0$** input connected to V_{SS} and **CIS$_1$** input connected to V_{DD})
- Most Activated Feature selected (**MAS [CI$_8$]** input connected to V_{DD})
- IRQ generated each time the Most Activated Sensor has changed

*Figure 10-3: **EM6420** typical standalone application powered by a 3.3 V supply voltage*

For better ESD protection in customer application, it is strongly recommended to connect the bulk of the **EM6420** to V_{SS}.

11. PAD LOCATION DIAGRAM

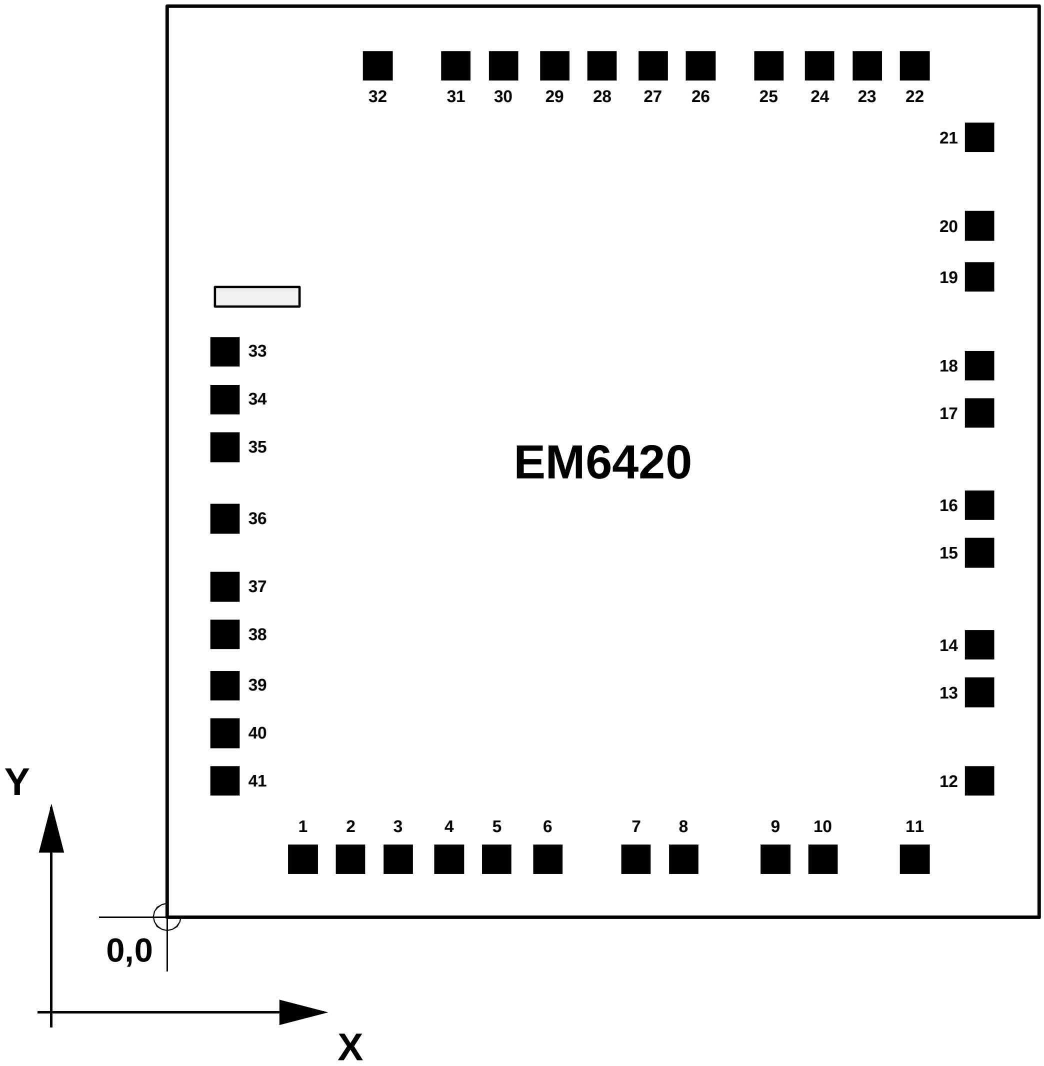


*Figure 11-1 : **EM6420** pad location diagram*

Chip dimensions		
Die size :	X = 2'130 µm ± 100 µm	(83.86 mils ± 3.94 mils)
	Y = 2'224 µm ± 100 µm	(87.56 mils ± 3.94 mils)
Die thickness :	279.4 µm ± 25.4 µm	(10 mils ± 1 mils)

Table 11-1: EM6420 chip dimensions

Pad Number	Pad Name	X [µm]	Y [µm]	Pad Number	Pad Name	X [µm]	Y [µm]
1	V_{SS}	312.000	143.625	22	TIC	1'818.000	2'080.375
2	C_{BL}	432.000	143.625	23	TCK	1'698.000	2'080.375
3	C_{BH}	552.000	143.625	24	LSV	1'578.000	2'080.375
4	V_{CP}	672.000	143.625	25	IRQ	1'458.000	2'080.375
5	V_{DDA}	792.000	143.625	26	CI_8	1'290.000	2'080.375
6	S_{15}	912.000	143.625	27	CIO_7	1'170.000	2'080.375
7	S_{11}	1'132.000	143.625	28	CIO_6	1'050.000	2'080.375
8	S_{14}	1'252.000	143.625	29	CIO_5	930.000	2'080.375
9	S_{10}	1'472.000	143.625	30	CIO_4	810.000	2'080.375
10	S_7	1'592.000	143.625	31	En	690.000	2'080.375
11	S_6	1'812.000	143.625	32	V_{DD}	500.000	2'080.375
12	S_5	1'986.375	312.000	33	CIO_3	143.625	1'368.000
13	S_4	1'986.375	532.000	34	CIO_2	143.625	1'248.000
14	S_9	1'986.375	652.000	35	CIO_1	143.625	1'128.000
15	S_{13}	1'986.375	872.000	36	CIO_0	143.625	960.000
16	S_3	1'986.375	992.000	37	CIS_2	143.625	792.000
17	S_{12}	1'986.375	1'212.000	38	CIS_1	143.625	672.000
18	S_2	1'986.375	1'332.000	39	CIS_0	143.625	552.000
19	S_8	1'986.375	1'552.000	40	V_{DDD}	143.625	432.000
20	S_1	1'986.375	1'672.000	41	V_{DD}	143.625	312.000
21	S_0	1'986.375	1'892.000				
X, Y coordinates refers to the center of the pads. The origin (0, 0) is the bottom left corner of the circuit scribe line.							

*Table 11-2 : **EM6420** pads coordinates*

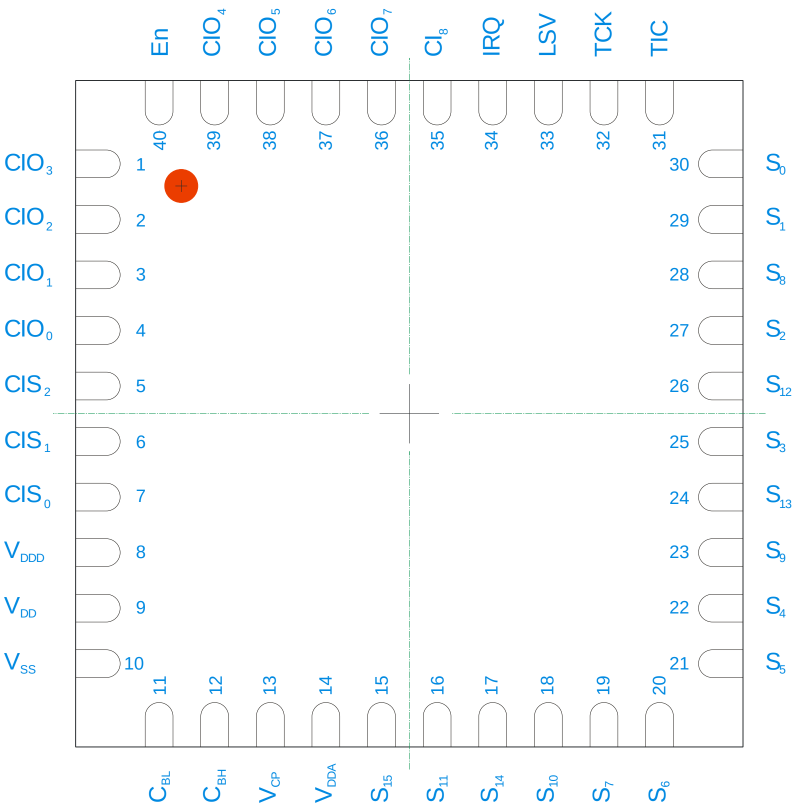
Standard die version	
Pads opening	72 µm x 72 µm
Minimum pad pitch :	120 µm

Gold bump version	
Bump size :	68 µm x 68 µm ± 5 µm
Bump height :	17.5 µm ± 3 µm
Bump height co-planarity	< 2 µm within die
	< 4 µm within wafer
Bump roughness	< 2 µm
Bump hardness :	30 – 90 HV (soft bump)
Minimum bump space	52 µm edge to edge
Shear force :	> 7.2 mg / $µm^2$
PI thickness	No PI layer

*Table 11-3 : **EM6420** pads and gold bumps additional information*

12. PACKAGE INFORMATION

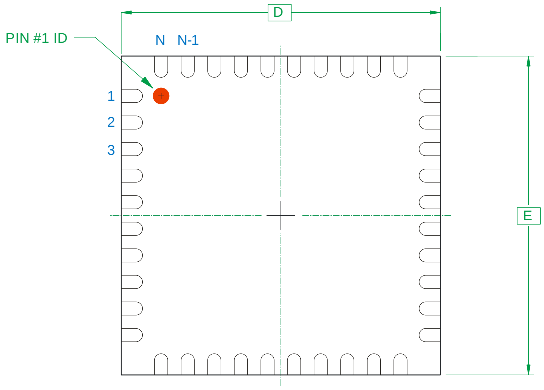
12.1 SAWN 40-PIN MICRO LEAD FRAME 2 – 6 X 6 MM BODY



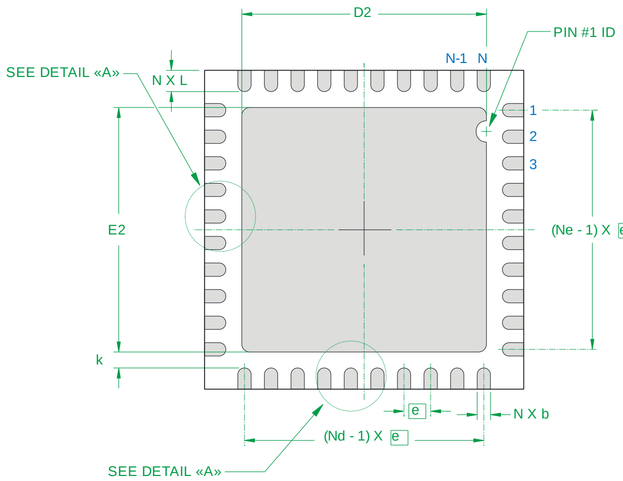
The exposed pad of the package is connected to the bulk of the device

Figure 12-1 : 40-pin Micro Lead Frame 2 Pin Assignment (TOP view)

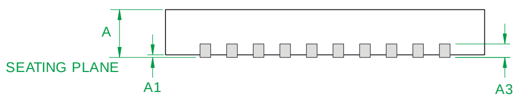
The exposed pad of the package is connected to the bulk of the device



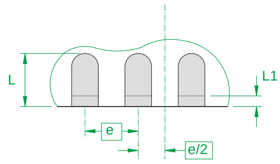
TOP VIEW



BOTTOM VIEW



SIDE VIEW



DETAIL «A»

Symbol	Dimensions		
	Min	Nom	Max
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3	0.20 REF		
D	6.00 BSC		
D2	4.00	4.10	4.20
E	6.00 BSC		
E2	4.00	4.10	4.20

Symbol	Dimensions		
	Min	Nom	Max
N [11]	40		
Nd [12]	10		
Ne [13]	10		
e	0.50 BSC		
L	0.35	0.40	0.45
L1	0.00		0.15
b	0.18	0.25	0.30

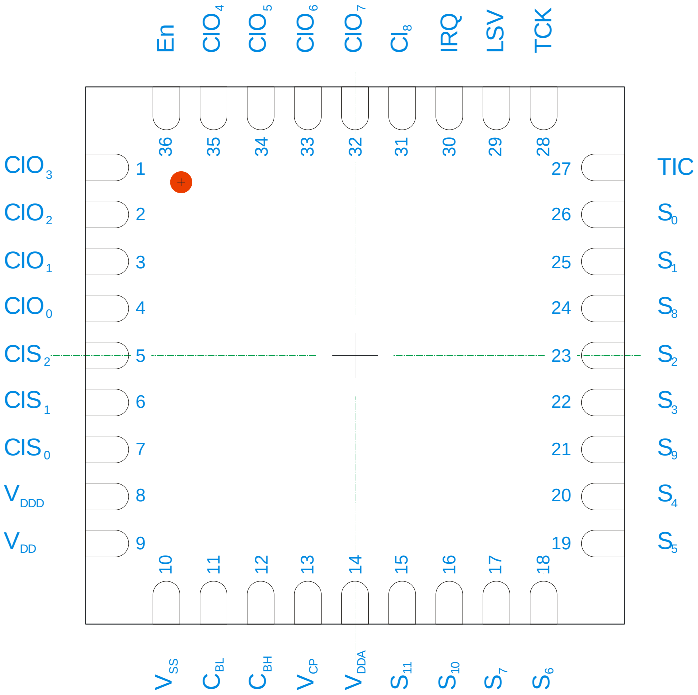
All dimensions are in mm

[11] N is the number of terminals

[12] Nd is the number of terminals in X-direction

[13] Ne is the number of terminals in Y-direction

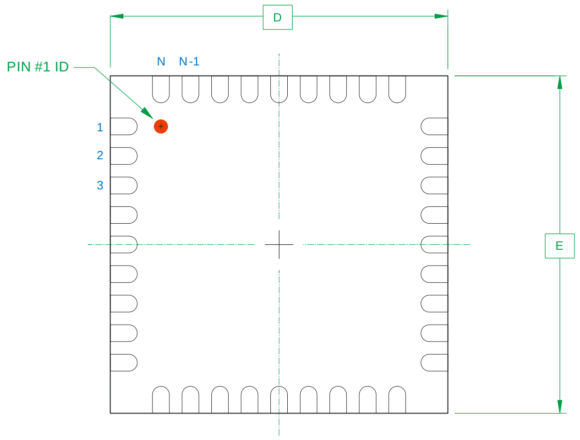
12.2 SAWN 36-PIN MICRO LEAD FRAME 2 – 5 X 5 MM BODY



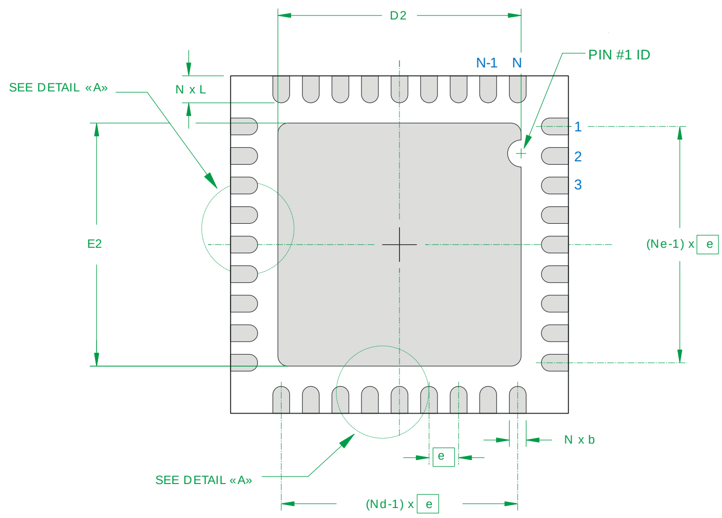
The exposed pad of the package is connected to the bulk of the device

Figure 12-2 : 36-pin Micro Lead Frame 2 Pin Assignment (Top View)

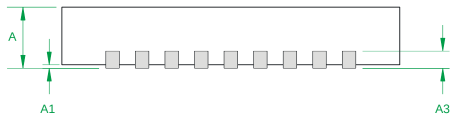
The exposed pad of the package is connected to the bulk of the device



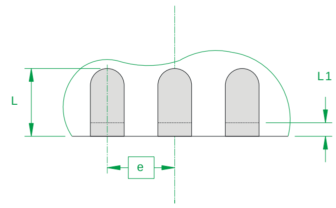
TOP VIEW



BOTTOM VIEW



SIDE VIEW



DETAIL «A»

Symbol	Dimensions		
	Min	Nom	Max
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3	0.20 REF		
D	5.00 BSC		
D2	3.50	3.60	3.70
E	5.00 BSC		
E2	3.50	3.60	3.70

All dimensions are in mm

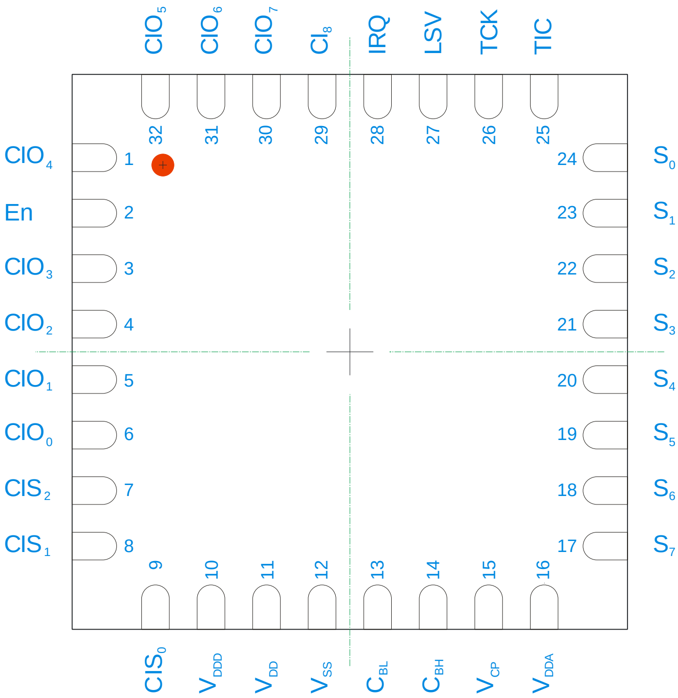
Symbol	Dimensions		
	Min	Nom	Max
N [14]	36		
Nd [15]	9		
Ne [16]	9		
e	0.40 BSC		
L	0.35	0.40	0.45
L1	0.00		0.15
b	0.15	0.20	0.25

[14] N is the number of terminals

[15] Nd is the number of terminals in X-direction

[16] Ne is the number of terminals in Y-direction

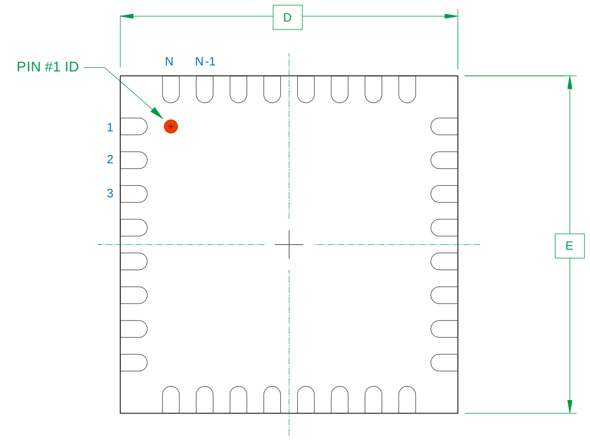
12.3 SAWN 32-PIN MICRO LEAD FRAME 2 – 5 X 5 MM BODY



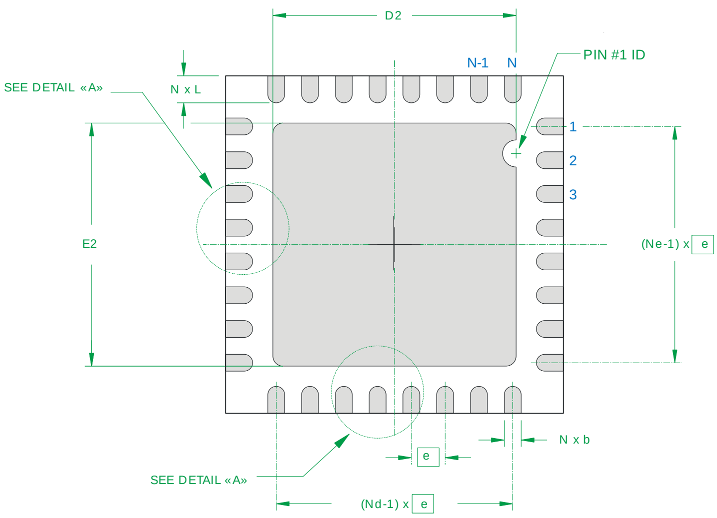
The exposed pad of the package is connected to the bulk of the device

Figure 12-3 : 32-pin Micro Lead Frame 2 Pin Assignment (Top View)

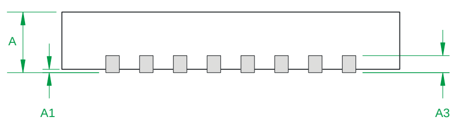
The exposed pad of the package is connected to the bulk of the device



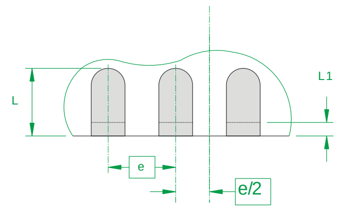
TOP VIEW



BOTTOM VIEW



SIDE VIEW



DETAIL «A»

Symbol	Dimensions		
	Min	Nom	Max
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A3	0.20 REF		
D	5.00 BSC		
D2	3.50	3.60	3.70
E	5.00 BSC		
E2	3.50	3.60	3.70

All dimensions are in mm

Symbol	Dimensions		
	Min	Nom	Max
N [17]	32		
Nd [18]	8		
Ne [19]	8		
e	0.50 BSC		
L	0.35	0.40	0.45
L1	0.00		0.15
b	0.18	0.25	0.30

[17] N is the number of terminals

[18] Nd is the number of terminals in X-direction

[19] Ne is the number of terminals in Y-direction

13. ORDERING INFORMATION

Part number	Delivery Form
EM6420V3WS10	Sawn wafer, 10 mils thickness
EM6420V3WS10E	Sawn wafer with gold bumps, 10 mils thickness
EM6420V3LF40D+	40-pin sawn Micro Lead Frame 2 (40-pin MLF2), Tray
EM6420V3XXXX+	For other options please contact the EM Microelectronic-Marin SA sales representative.
EM6420V4WS10	Sawn wafer, 10 mils thickness

Part number	Hardware version	Software version	I^2C Multi Chip mode	Minimum scan frequency
EM6420V3WS10 EM6420V3WS10E EM6420V3LF40D+ EM6420V3XXXX+	3	1-6	Supported	1 Hz
EM6420V4WS10	3	2-0	Supported	1 Hz