
SPC58x - Configurable PAD - Keeper feature

Introduction

This document describes the Pad-Keeper feature and configuration applied to the SPC58x family devices.

The devices are listed in [Table 1](#).

Table 1. Devices list

Reference	Part number
SPC582Bx	SPC582B50x, SPC582B54x, SPC582B60x
SPC584Bx	SPC584B60x, SPC584B64x, SPC584B70x
SPC584Cx, SPC58ECx	SPC584C70x, SPC584C74x, SPC584C80x, SPC58EC70x, SPC58EC74x, SPC58EC80x
SPC584Gx, SPC58EGx, SPC58NGx	SPC584G80x, SPC584G84x, SPC58EG80x, SPC58EG84x, SPC58NG80x, SPC58NG84x
SPC58EHx, SPC58NHx	SPC58EH84x, SPC58EH90x, SPC58EH92x, SPC58NH84x, SPC58NH90x, SPC58NH92x

1 Overview

The Low Power Pads and Pad-Keeper features are the only ones active during STANDBY mode.

1.1 Low Power Pads

Low Power pads are the only ones active during STANDBY.

They can belong to the following types:

- Wakeup (WKUP) pads

The ones that can wake-up the device from STANDBY through WKPU module (i.e: PA[0])

Figure 1. WKUP pad

Port	Function	Module	Description	Direction
PA[0]	INT22	WakeUp	WakeUp External Interrupt 22	pi

- SSWU pads

The ones that are configured by SSWU Module:

- OPC

These pads can be configured at the desired level during STANDBY (i.e PB[8])

Figure 2. SSWU pad - OPC

Port	Function	Module	Description	Direction
PB[8]	OPC2	SSWU	SSWU Output Pad Control 2	o

- PDC

These pads can wakeup the device from STANDBY basing on their level (i.e. PA[1])

Figure 3. SSWU pad - PDC

Port	Function	Module	Description	Direction
PA[1]	PDC19	SSWU	SSWU Digital Comparator 19	pi

- JTAG Test Data Output (TDO) pad

It is used for debug entry/exit across low-power modes (i.e. PA[9])

Figure 4. TDO pad

Port	Function	Module	Description	Direction
PA[9]	TDO	JTAG	JTAG Test Data Output	o

For those LP pads, I/O electrical characteristics can be configured in running mode through SIUL2_MSCR_IOn registers, but they are fixed in STANDBY with the following configuration:

Table 2. I/O configuration

Input Level Selection (ILS)	Running Mode	STANDBY Mode
SPC582Bx	Configurable	TTL
SPC584Bx	Configurable	CMOS
SPC584Cx/SPC58ECx	Configurable	CMOS
SPC584Gx/SPC58EGx	Configurable	TTL
SPC58EHx/SPC58NHx	Configurable	CMOS

Note: Logic level is configurable in running mode while it is not-configurable in STANDBY for LP (low power) pads, so if a LP pad is used to wakeup from STANDBY, it should be configured in running mode coherently with STANDBY configuration, reported in Table 2, in order to prevent device wrong behavior in STANDBY.

1.2 Pad-Keeper feature

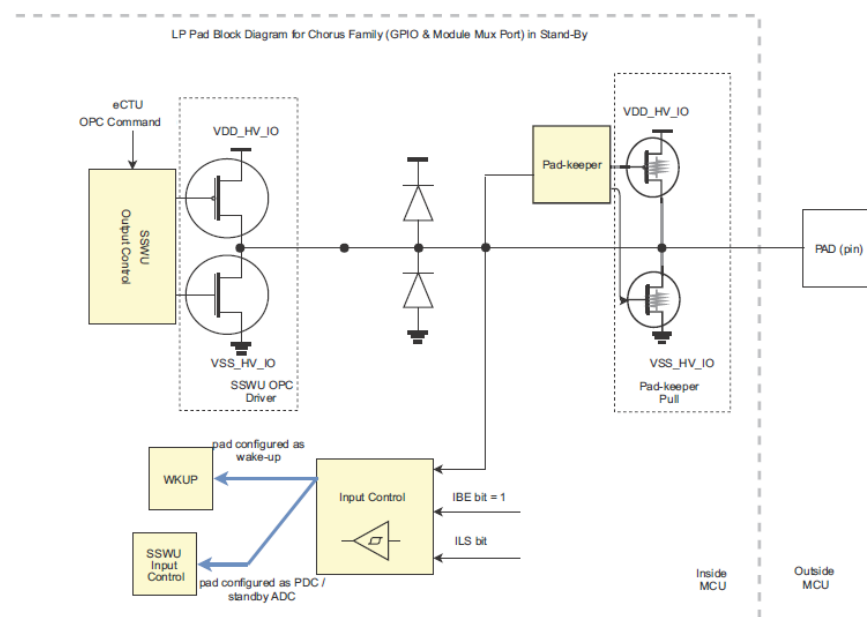
When the device enters in STANDBY mode, the Pad-Keeper feature is activated for all LP pads by default. It means that:

- Input Buffer enabled.
- If the pad voltage level is above the pad-keeper high threshold (PK_h), a weak pull-up resistor is automatically enabled.
- if the pad voltage level is below the pad-keeper low threshold (PK_l), a weak pull-down resistor is automatically enabled.

where:

- $PK_h = (VDD_HV_IO_MAIN / 2) + 20 \%$
- $PK_l = (VDD_HV_IO_MAIN / 2) - 20 \%$
- weak pull-up/down are the same as the ones configurable through SIUL2_MSCR_IO register in running mode, and their values (RWPU/RWPD) are showed in the device datasheet

Figure 5. LP Pads with Pad-Keeper



2 Pad-Keeper configurability

2.1 Purpose of modification

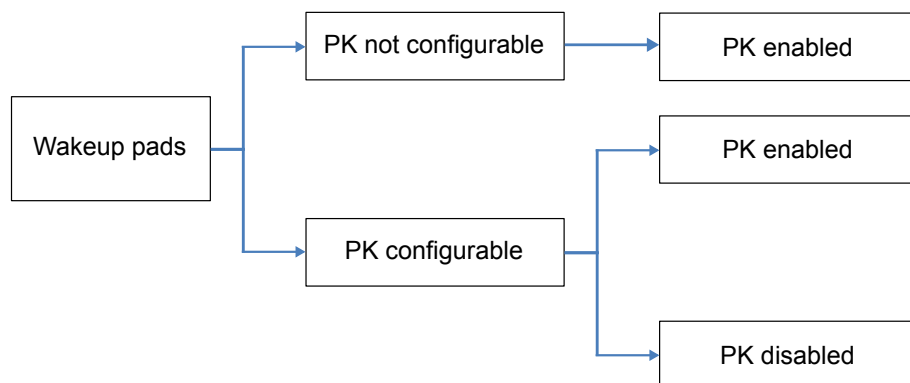
As PK (Pad-Keeper), applying the internal pull (up/down), modifies the impedance of the input, some application signals need extra external components to cope with the PK.

For such reason, PK feature has been made configurable by software (only) on the following devices:

- SPC584Bx cut1.2
PK can be disabled on the following 6 WKUP pads: PC1, PD5, PA2, PA11, PE10, PF3.
- SPC584Cx, SPC58ECx cut2.0
PK can be disabled on all WKUP pads.
- SPC58EHx, SPC58NHx cut2.0
PK can be disabled on all WKUP pads.

For the Non-WKUP pads (OPCs/PDCs/TDO), PK feature cannot be configured and it will be enabled immediately at STANDBY Mode entry.

Figure 6. PK configuration



2.2 PK configuration by software

On the specific devices where the PK can be disabled, it can be done through the WKPU.WIPUER register.

So, WIPUER register changes its behavior according to the following cases:

- PK not configurable
This register is used to enable a pull (up/down) on the corresponding pads, or-ed with SIUL control (please refer to wakeup pads behavior).
- PK configurable
The pad pull control via WIPUER is lost. Only the SIUL one can be used. In such case:
 - WIPUER[X] = 0 (default) → PK enabled
 - WIPUER[X] = 1 → PK disabled, pad in HiZ during STANDBY

Table 3. WIPUER setup vs PAD value

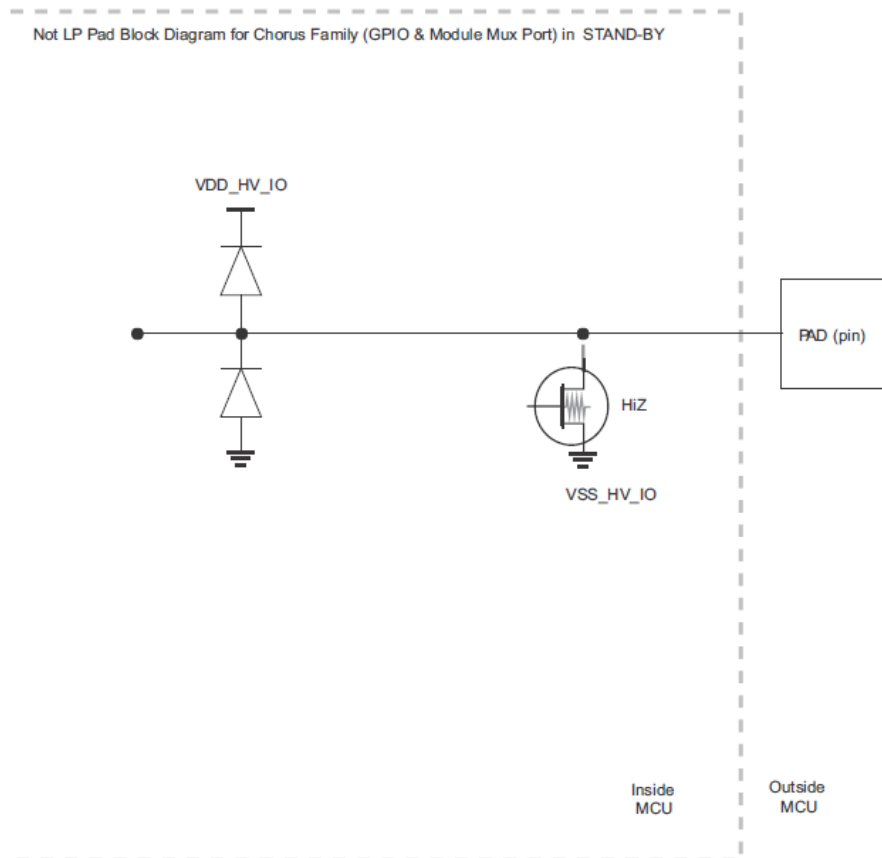
PAD[x]/WIPUER[x]	PAD value	I/O internal doc
1	Z	Padkeeper disabled
0	X	Padkeeper enabled (default)

2.3 WKUP pads behavior – PK disabled

In case of PK disabled by sw, when the device enters in STANDBY mode, behavior of WKUP pads is:

- Input Buffer Enable always on
- the pull-up and pull-down are disabled for the LP pads
- LP pads will be in HiZ

Figure 7. WKUP pads with Pad-Keeper disabled



2.4 Pull behavior of WKUP pads

The following tables show the behavior of the pull applied on WKUP pads over RUN and STANDBY Mode in case of PK disabled and enabled.

Consider that PUE and PUS are internal signals with the following meaning:

- PUE = pull enabled
- PUS = pull strength (PU → 1, PD → 0)

and their relations with SIUL2 register are:

- PUE = SIUL2.WPUE xor SIUL2.WPDE
- PUS = SIUL2.WPUE

Table 4. Pull behavior – PK not configurable

Operating Mode	Pull Enable (1=on/0=off)	Pull Strength (1=PU/0=PD)	Resulting Pull Configuration
Configuration	PUE = Siul.PUE Wkpu.WIPUER	PUS = Siul.PUS	
RUN	Siul.PUE = any, Wkpu.WIPUER = 1	Siul.PUS = 1	Pull-up active
	Siul.PUE = 1, Wkpu.WIPUER = any	Siul.PUS = 1	Pull-up active
	Siul.PUE = any, Wkpu.WIPUER = 1	Siul.PUS = 0	Pull-down active
	Siul.PUE = 1, Wkpu.WIPUER = any	Siul.PUS = 0	Pull-down active
	Siul.PUE = 0, Wkpu.WIPUER = 0	Siul.PUS = any	HiZ (depends on external Pull)
SBY-ENTRY TRANSIENT ⁽¹⁾	Siul.PUE = 0 (ip off, fixed) Wkpu.WIPUER = 1	Siul.PUS = 0 (ip off, fixed)	Pull-down active
	Siul.PUE = 0 (ip off, fixed) Wkpu.WIPUER = 0	Siul.PUS = 0 (ip off, fixed)	HiZ (depends on external Pull)
DURING SBY	Siul.PUE = 0 (ip off, fixed)	Siul.PUS = 0 (ip off, fixed)	Depends on Pad-Keeper latched values (PU or PD)
	Wkpu.WIPUER = any		

1. The Transient mentioned here is the one explained in the errata: "Pad Keeper functionality not immediately enabled on Low Power pads when entering in Stand-by" (Please, refer to Section 2.5 PK behavior during STANDBY transient)

Table 5. Pull behavior – PK configurable

Operating Mode	Pull Enable (1=on/0=off)	Pull Strength (1=PU/0=PD)	Resulting Pull Configuration
Configuration	PUE = Siul.PUE	PUS = Siul.PUS	
RUN	Siul.PUE = 1	Siul.PUS = 1	Pull-up active
	Siul.PUE = 1	Siul.PUS = 0	Pull-down active
	Siul.PUE = 0	Siul.PUS = any	HiZ (depends on external Pull)
SBY-ENTRY TRANSIENT ⁽¹⁾	Siul.PUE = 0 (ip off, fixed)	Siul.PUS = 0 (ip off, fixed)	HiZ (depends on external Pull)
DURING SBY	Siul.PUE = 0 (ip off, fixed)	Siul.PUS = 0 (ip off, fixed) Pad.PUS = 1 ⁽²⁾ if Wkpu.WIPUER = 0 (default)	Pad-Keeper enabled (PU or PD)
	Siul.PUE = 0 (ip off, fixed)	Siul.PUS = 0 (ip off, fixed) Wkpu.WIPUER=1 (prog)	Pad-Keeper disabled (HiZ)

1. The Transient mentioned here is the one explained in the errata: "Pad Keeper functionality not immediately enabled on Low Power pads when entering in Stand-by" (Please, refer to Section 2.5 PK behavior during STANDBY transient)
2. set by hw to keep the default configuration as PK enabled

2.5 PK behavior during STANDBY transient

As reported in the Pull behavior tables, Pad-Keeper functionality is not immediately enabled on Low Power pads when entering in STANDBY.

This would cause that, in the time-frame before the activation of the Pad-Keeper, if the LP pads, configured to wakeup from STANDBY mode, get discharged, STANDBY mode can be immediately exited.

This behavior is managed by an erratum whose wording (description and workaround) is different for each of the following group of devices:

- PK not configurable
 - SPC582Bx cut2.1
 - SPC584Bx cut1.1
 - SPC584Cx/SPC58ECx cut1.1
 - SPC584Gx/SPC58EGx cut2.1
 - SPC58EHx/SPC58NHxcut1.0
- PK partially configurable (only on specific WKUP pads)
 - SPC584Bx cut1.2
- PK configurable (on all WKUP pads)
 - SPC584Cx/SPC58ECx cut2.0
 - SPC58EHx/SPC58NHxcut2.0

2.5.1 Pad-Keeper erratum – devices with PK not configurable

Table 6. PK erratum – devices with PK not configurable (PS3022)

Errata	Description
Errata Title	STANDBY: Pad-Keeper functionality not immediately enabled on Low Power pads when entering in STANDBY Mode.
Errata Description	<p>During stand-by entry, the Pad-Keeper is not immediately activated on Low power pads. The Low power (LP) pads output status, in this time-frame before the activation of the Pad-Keeper, depends on the status of WKPU.WIPUER register:</p> <ul style="list-style-type: none"> • If WKPU.WIPUER=0, Low Power pads are in High-Z. • If WKPU.WIPUER=1, Low Power pads are in Pull-Down. <p>In case the pad configured to wake-up from STANDBY Mode (both on rising and falling edge) is getting discharged during this, STANDBY Mode can be immediately exited.</p> <p>The time from entering in STANDBY Mode to Pad-Keeper activation depends on RC1M regulator and RC1M oscillator status before STANDBY Mode entry. After Pad-Keeper activation, the pad pull configuration (pull-up or pull-down), is controlled by the Pad-Keeper.</p> <p>Please contact ST representative for details.</p>
Errata Workaround	<p>On Used/Bonded LP pads, add an external pull on pad configured to wake-up from STANDBY Mode in order to avoid false wake-up event. WKPU.WIPUER must be set to 0, to avoid contention with external pull components.</p> <p>On Unused/Unbonded LP pads, enable internal pull-down (SIUL2.MSCR_IO [x].WPDE = 1) and WKPU.WIPUER has to be set to 1 so to force pad level during transition in STANDBY Mode and avoid extra-consumption during STANDBY transition.</p>

2.5.2 Pad-Keeper erratum – devices with PK partially configurable

Table 7. PK erratum – devices with PK partially configurable (DAN-0048729)

Errata	Description
Errata Title	STANDBY: Pad-Keeper functionality not immediately enabled on Low Power pads when entering in STANDBY Mode.
Errata Description	<p>In case of pad-keeper enabled, this feature of LP pads is not immediately activated during stand-by mode entry.</p> <p>In time-frame before the activation of the pad-keeper, the LP INTx pads configured to wakeup from STANDBY mode (both on rising and falling edge) could getting discharged and STANDBY mode can be immediately exited.</p> <p>During this time-frame the status of LP INTx pins that can disable the padkeeper feature via SW is in High-Z therefore depending by external pull, while for all other LP INTx pads the status depends via SW by value of WKPU.WIPUER[INTx] bit:</p> <ul style="list-style-type: none"> • If WKPU.WIPUER = 0, LP INTx pads are in High-Z. • If WKPU.WIPUER = 1, LP INTx pads in Pull-Down . <p>After Pad-Keeper activation, the pad pull configuration (pull-up or pull-down), is controlled by the Pad-Keeper. Please contact ST representative for details.</p>
Errata Workaround	<p>For the LP pins that cannot disable the pad-keeper:</p> <ul style="list-style-type: none"> • on Used/Bonded LP pads, add an external pull on pad configured to wake-up from STANDBY Mode in order to avoid false wake-up event. WKPU.WIPUER must be set to 0, to avoid contention with external pull components. • on Unused/Unbonded LP pads, enable internal pull-down (SIUL2.MSCR_IO [x].WPDE = 1) and WKPU.WIPUER has to be set to 1 so to force pad level during transition in STANDBY Mode and avoid extra-consumption during STANDBY transition. <p>For the LP pins that can disable the pad-keeper and configured to wakeup from STANDBY mode, an external pull must be added.</p>

2.5.3 Pad-Keeper erratum – devices with PK configurable

Table 8. PK erratum – devices with PK configurable (DAN-0051761, DAN-0049801)

Errata	Description
Errata Title	STANDBY: Pad-Keeper functionality not immediately enabled on Low Power pads when entering in STANDBY Mode.
Errata Description	<p>In case of pad-keeper enabled, this feature of LP pads is not immediately activated during stand-by mode entry.</p> <p>In time-frame before the activation of the pad-keeper, the LP INTx pads configured to wakeup from STANDBY mode (both on rising and falling edge) could get discharged and STANDBY mode can be immediately exited.</p> <p>During this time-frame the status of LP INTx pins is in High-Z therefore depending on external pull. Please contact ST representative for details.</p>
Errata Workaround	In case that leakage on the LP pad is such that the wake up by STANDBY Mode can happen, an external pull must be added on pad.

2.5.4 Pad-Keeper erratum vs devices/cuts
Table 9. PK erratum vs devices/cuts

Device	cut	PK not configurable	PK partially configurable	PK configurable
SPC582Bx	2.1	PS3022	-	-
SPC584Bx	1.1	PS3022	-	-
	1.2	-	DAN-0048729	-
SPC584Cx/SPC58ECx	1.1	PS3022	-	-
	2	-	-	DAN-0051761
SPC584Gx/SPC58EGx	2.1	PS3022	-	-
SPC58EHx/SPC58NHx	1	PS3022	-	-
	2	-	-	DAN-0049801

Appendix A Other information

A.1 Reference documents

Table 10. Reference documents

Doc Name	ID	Title
DS11597	029210	32-bit Power Architecture® microcontroller for automotive ASIL-B applications
DS11620	029264	32-bit Power Architecture® microcontroller for automotive ASIL-B applications
DS11701	029439	32-bit Power Architecture® microcontroller for automotive ASIL-B applications
DS11758	029572	32-bit Power Architecture® microcontroller for automotive ASIL-B applications
DS12304	031027	32-bit Power Architecture® microcontroller for automotive ASIL-B applications

Revision history

Table 11. Document revision history

Date	Version	Changes
16-Apr-2020	1	Initial release.

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