

# V850E/Dx3 - DJ3/DL3

32-bit Single-Chip Microcontroller

μPD70F3421

μPD70F3422

μPD70F3423

μPD70F3424

μPD70F3425

μPD70F3426A

μPD70F3427

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## General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

### 1. Handling of unused Pins

Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

### 2. Processing at power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

### 3. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

### 4. Clock signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

### 5. Differences between products

Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

- The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

# Chapter 1 Overview

The V850E/Dx3 - DJ3/DL3 is a product in Renesas Electronics V850 family of single-chip microcontrollers designed for Automotive applications.

## 1.1 General

The V850E/Dx3 - DJ3/DL3 single-chip microcontroller is a member of Renesas Electronics V850 32-bit RISC family, which match the performance gains attainable with RISC-based controllers to the needs of embedded control applications. The V850 CPU offers easy pipeline handling and programming, resulting in compact code size comparable to 16-bit CISC CPUs.

The V850E/Dx3 - DJ3/DL3 provides an excellent combination of general purpose peripheral functions, like serial communication interfaces (UART, clocked SI), Timers and measurement inputs (A/D converter), with dedicated CAN network support. Control and driver for 6 stepper motors are included.

The device offers power-saving modes to manage the power consumption effectively under varying conditions.

Thus equipped, the V850E/Dx3 - DJ3/DL3 is ideally suited for automotive applications, like dashboard or body. It is also an excellent choice for other applications where a combination of sophisticated peripheral functions and CAN network support is required.

This specification covers the following devices of the family:

| Family Code | Product Code               | Internal Flash | Internal RAM | LCD Control      | Other Peripherals          |
|-------------|----------------------------|----------------|--------------|------------------|----------------------------|
| DL3         | μPD70F3427GD(A)-LML-QS-AX  | 1024 KB        | 60 KB        | LCD I/F          | Full set<br>+ ext. Mem I/F |
| DJ3         | μPD70F3426AGJ(A)-GAE-QS-AX | 2048 KB        | 84 KB        | LCD I/F          | Full set                   |
| DJ3         | μPD70F3425GJ(A)-GAE-QS-AX  | 1024 KB        | 32 KB        | LCD I/F          | Full set                   |
| DJ3         | μPD70F3424GJ(A)-GAE-QS-AX  | 512 KB         | 24 KB        | LCD I/F          | Full set                   |
| DJ3         | μPD70F3423GJ(A)-GAE-QS-AX  | 512 KB         | 20 KB        | LCD I/F, LCD C/D | Reduced set                |
| DJ3         | μPD70F3422GJ(A)-GAE-QS-AX  | 384 KB         | 20 KB        | LCD I/F, LCD C/D | Reduced set                |
| DJ3         | μPD70F3421GJ(A)-GAE-QS-AX  | 256 KB         | 12 KB        | LCD I/F, LCD C/D | Reduced set                |

The following table gives a more detailed overview of the different derivatives and their major features.

| Series name       |                   | V850E/DL3    |                   |             |        |            |        | V850E/DJ3  |                    |            |       |            |       |             |  |  |  |  |
|-------------------|-------------------|--------------|-------------------|-------------|--------|------------|--------|------------|--------------------|------------|-------|------------|-------|-------------|--|--|--|--|
| Part Number       |                   | uDP70F3427   |                   | uDP70F3426A |        | uDP70F3425 |        | uDP70F3424 |                    | uDP70F3423 |       | uDP70F3422 |       | uPD70F3421  |  |  |  |  |
| Technology        |                   | MF2 (Flash)  |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Internal memory   | Flash             | 1 MB         | 2 MB <sup>a</sup> | 1 MB        | 512 KB | 384 KB     | 256 KB | 60 KB      | 84 KB <sup>b</sup> | 32 KB      | 20 KB | 20 KB      | 12 KB |             |  |  |  |  |
|                   | RAM               |              |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| DMA               |                   | 4 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Operating Clock   | Main (Internal)   | 64 MHz typ.  |                   |             |        |            |        |            |                    |            |       |            |       | 32 MHz typ. |  |  |  |  |
|                   | Ring-OSC          | 240 kHz typ. |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | Subclock          | 32 kHz typ.  |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| I/O ports         |                   | 101          |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Input ports       |                   | 16           |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| A/D converter     |                   | 16 ch        |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Timers            | TMY               | 1 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | TMZ               | 10 ch        |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | TMP               | 4 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | TMG               | 3 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | WDT               | provided     |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | Watch             | provided     |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | Watch calibration | provided     |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Serial interfaces | AFCAN             | 3 ch         | 2 ch              |             |        |            |        |            |                    |            |       |            |       | 3 ch        |  |  |  |  |
|                   | UARTA             | 2 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Serial interfaces | CSIB              | 3 ch         |                   |             |        |            |        |            |                    |            |       |            |       | 2 ch        |  |  |  |  |
|                   | IIC               | 2 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
| Interrupts        | External          | 8            |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | Internal          | 95           |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |
|                   | NMI               | 2 ch         |                   |             |        |            |        |            |                    |            |       |            |       |             |  |  |  |  |



| Series name                |  | V850E/DL3   |             |            |            | V850E/DJ3   |            |            |  |
|----------------------------|--|---|-------------|------------|------------|-------------|------------|------------|--|
| Part Number                |  | uDP70F3427  | uDP70F3426A | uDP70F3425 | uDP70F3424 | uDP70F3423  | uDP70F3422 | uPD70F3421 |  |
| Other functions            |  | 8ch (DBTRAP)  |             |            |            |             |            |            |  |
| ROM correction             |  | Provided  |             |            |            |             |            |            |  |
| POC                        |  | Provided  |             |            |            |             |            |            |  |
| Voltage comparator         |  | 2 ch  |             |            |            |             |            |            |  |
| Clock supervision          |  | Provided  |             |            |            |             |            |            |  |
| Sound generator            |  | 1 ch  |             |            |            |             |            |            |  |
| Stepper motor C/D          |  | 6 ch  |             |            |            |             |            |            |  |
| LCD C/D                    |  | none  |             |            |            |             |            |            |  |
| LCD I/F                    |  | Provided  |             |            |            |             |            |            |  |
| Auxiliary frequency output |  | Provided  |             |            |            |             |            |            |  |
| On-Chip debug              |  | Provided  |             |            |            |             |            |            |  |
| External Mem I/F           |  | Provided  |             |            |            |             |            |            |  |
| Operating voltage          |  | 3.2v to 5.5V for core functions, ADC and StepperMotor C/D, 3.0V to 5.5V for all other I/O<br>Full operation in range from 4.0V to 5.5V due to POC function (8.2 on page 87) |             |            |            |             |            |            |  |
| Package                    |  | 208-pin QFP   |             |            |            | 144-pin QFP |            |            |  |

a) For the DJ3 derivative  $\mu$ PD70F3426A, the upper 1MB of the flash memory is connected to the internal system bus (VSB). In case of performing consecutive accesses to that part of the flash-memory, a 32-bit data access requires two cycles.

In case a random access is applied to that part of the flash-memory, this access requires four cycles.

b) For the DJ3 derivative  $\mu$ PD70F3426A, the upper 24kB of the internal RAM is connected to the internal system bus (VSB). In case of performing consecutive accesses to that part of the internal RAM, a 32-bit data access requires two cycles.

In case a random access is applied to that part of the internal RAM area that access requires two cycles.

# Chapter 2 Pinout Information

## 2.1 Pin configuration μPD70F3427

- μPD70F3427GD

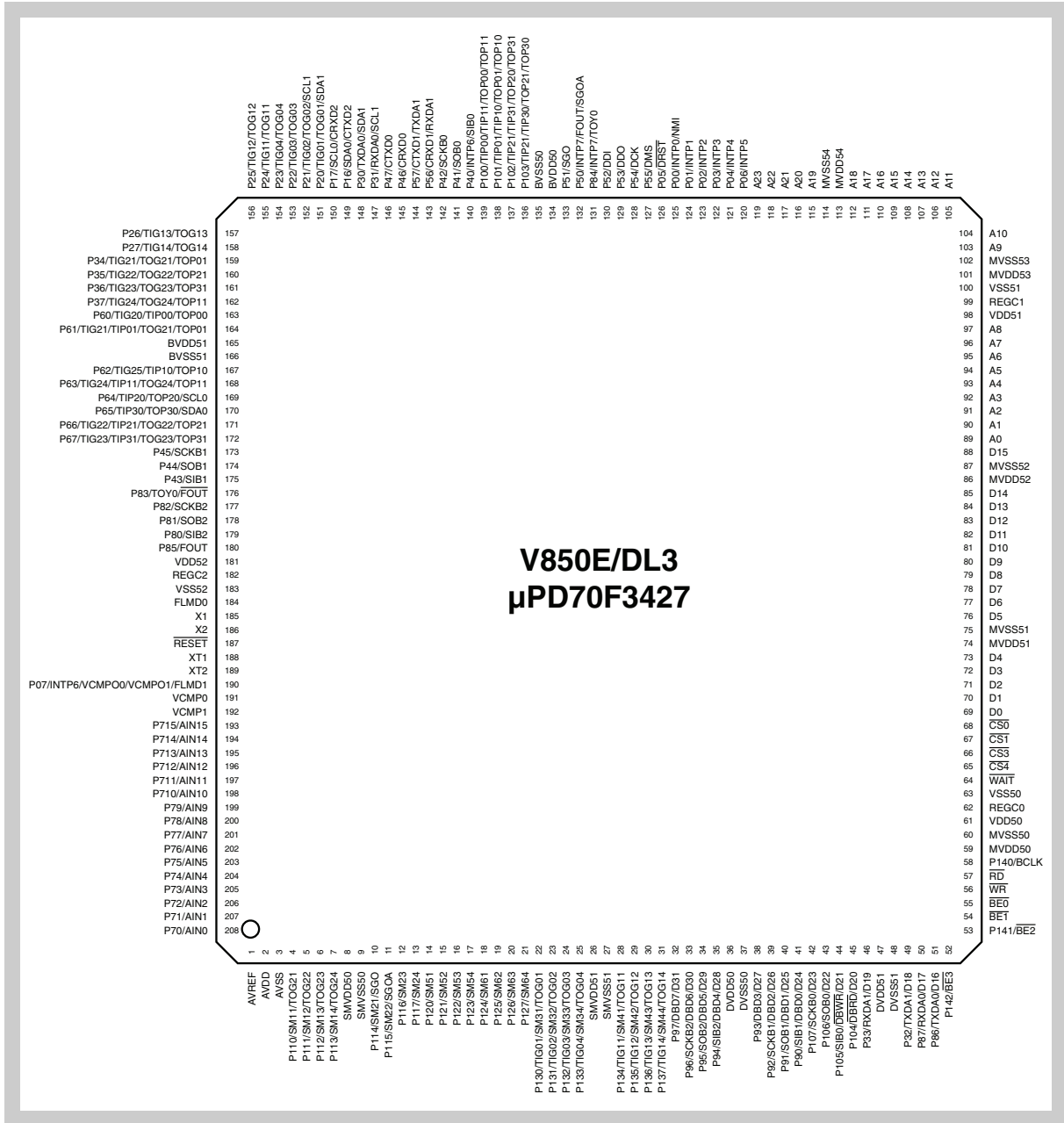


Figure 2-1 Pin Configuration μPD70F3427

## 2.2 Pin configuration $\mu$ PD70F3426A, $\mu$ PD70F3425, $\mu$ PD70F3424

- $\mu$ PD70F3426AGJ
- $\mu$ PD70F3425GJ
- $\mu$ PD70F3424GJ

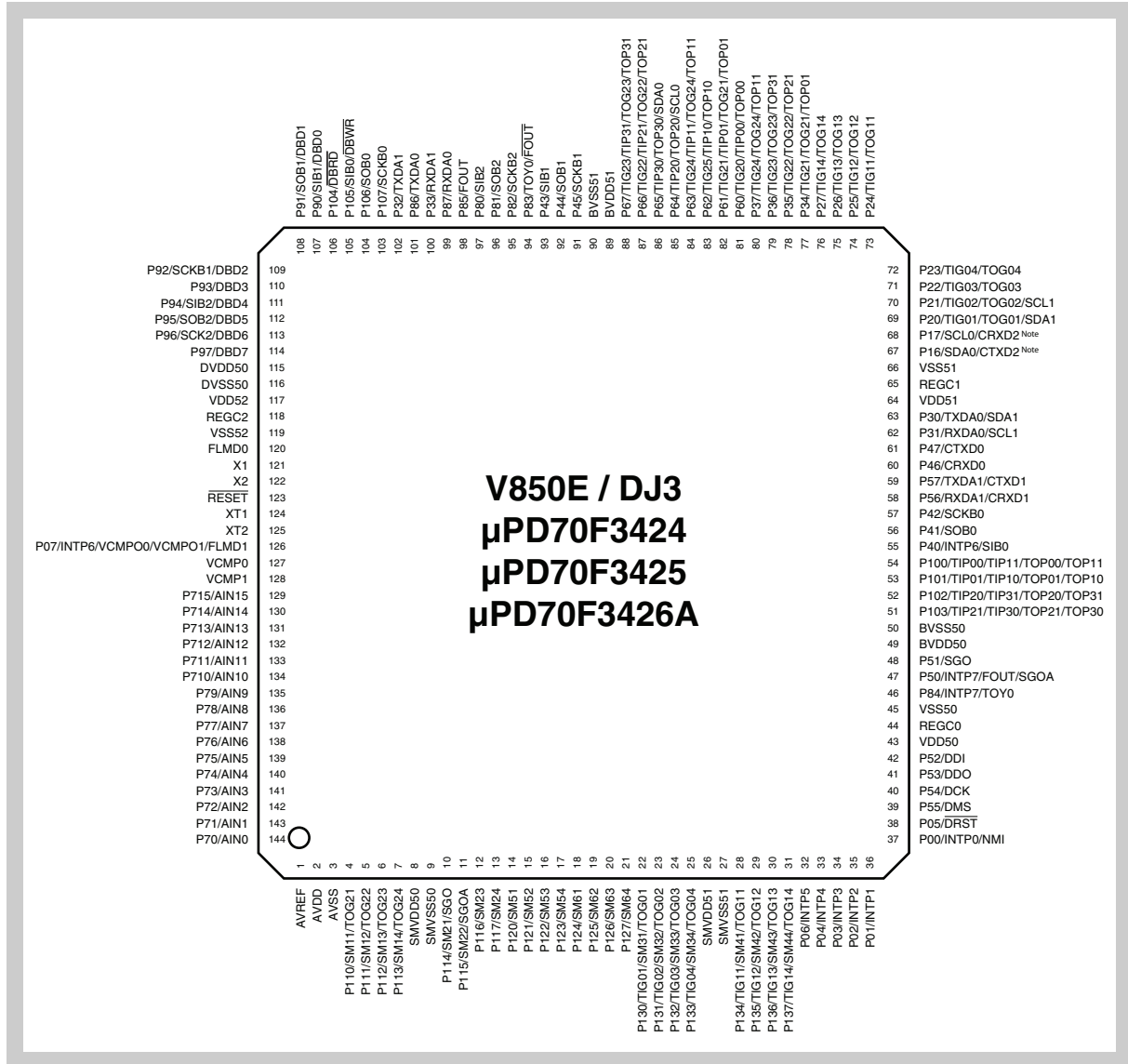


Figure 2-2 Pin Configuration  $\mu$ PD70F3426A,  $\mu$ PD70F3425,  $\mu$ PD70F3424

Note CRXD2, CTXD2 not available on  $\mu$ PD70F3426A.

## 2.3 Pin configuration $\mu$ PD70F3423, $\mu$ PD70F3422, $\mu$ PD70F3421

- $\mu$ PD70F3423GJ
- $\mu$ PD70F3422GJ
- $\mu$ PD70F3421GJ

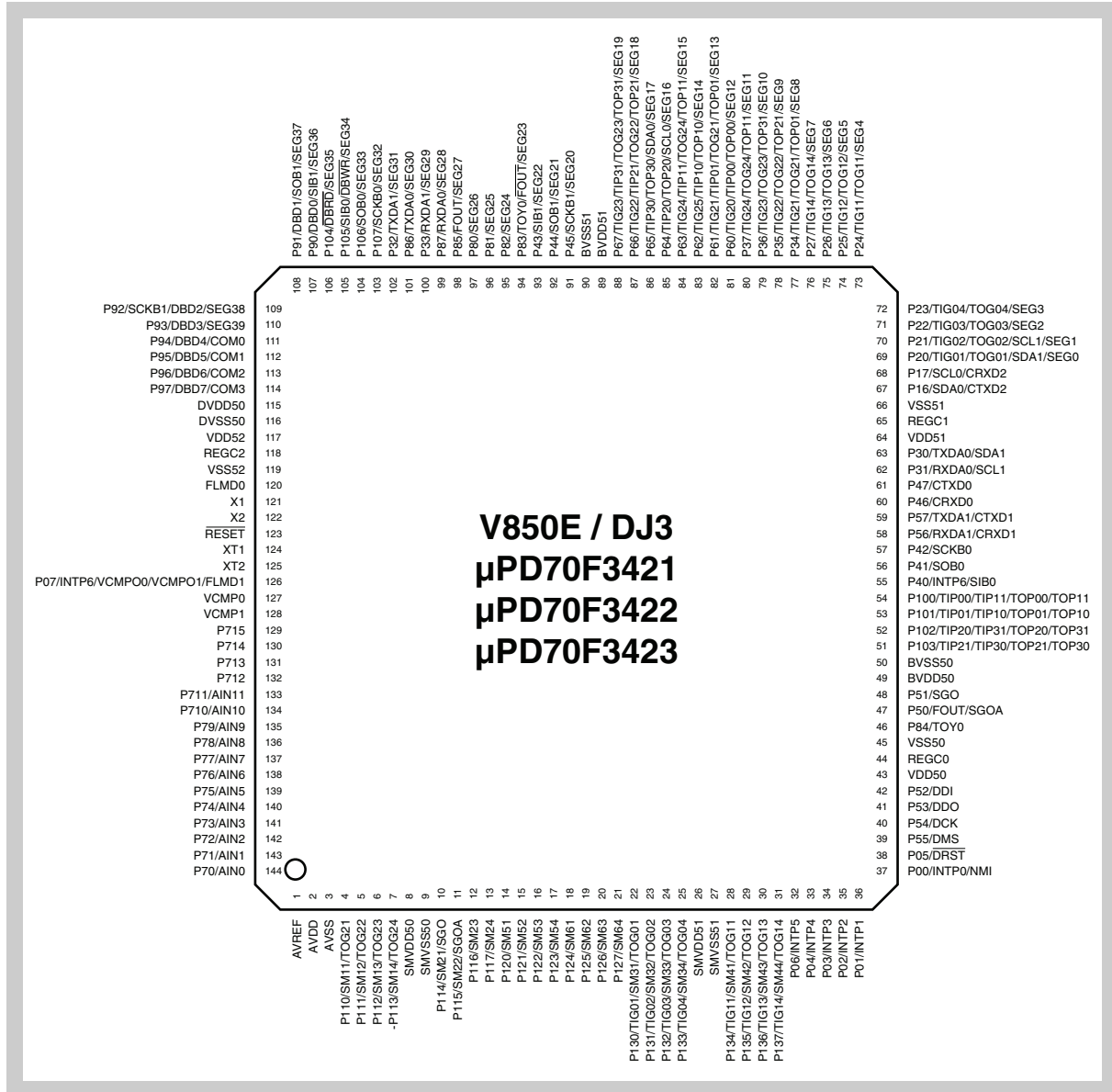


Figure 2-3 Pin Configuration  $\mu$ PD70F3423,  $\mu$ PD70F3422,  $\mu$ PD70F3421

## 2.4 Pin Group information

- Pin Groups 1x: Pins supplied by  $BV_{DD5}$  <sup>Note1</sup>
  - 1A: ( P00-06, P50-55, P84 )
  - 1B: ( P16-17, P30-31, P40-42, P46-47, P56-57, P100-103 )
  - 1C: ( P20-27, P34-37, P60-67 )
  - 1D: ( P43-45, P80-83, P85 )
- Pin Groups 1x: Pins supplied by  $BV_{DD5}$  <sup>Note2</sup>
  - 1A: ( P00-06, P50-55, P84 )
  - 1B: ( P16-17, P30-31, P40-42, P46-47, P56-57, P100-103 )
  - 1C: ( P20-27, P34-37, P60-61 )
  - 1D: ( P62-67, P43-45, P80-83, P85 )
- Pin Group 2: Pins supplied by  $V_{DD5}$ 
  - 2: (  $\overline{\text{RESET}}$ , FLMD0, P07 )
- Pin Group 3<sup>Note1</sup>: GPIO and LCD Bus interface supplied by  $DV_{DD5}$ 
  - 3: ( P32-33, P86-87, P90-97, P104-107 )
- Pin Group 3<sup>Note2</sup>: GPIO and LCD Bus and external memory interface supplied by  $DV_{DD5}$ 
  - 3: ( P32-33, P86-87, P90-97, P104-107, P141-142 )
  - 3A: ( P94-97 )
  - 3B: ( P90-93 )
  - 3C: ( P33, P104-107 )
  - 3D: ( P32, P86-87, P141-142 )
- Pin Group 4: Stepper Motor outputs supplied by  $SMV_{DD5}$ 
  - 4A: ( P110-117, P120-123 )
  - 4B: ( P124-127, P130-137 )
- Pin Group 5: ADC Inputs supplied by  $AV_{DD}$ 
  - 5: ( P70...P715 )
- Pin Group 6<sup>Note2</sup>: External memory Interface supplied by  $MV_{DD5}$ 
  - 6: ( A0-23, D0-15,  $\overline{\text{CS0-1}}$ ,  $\overline{\text{CS3-4}}$ ,  $\overline{\text{WAIT}}$ ,  $\overline{\text{RD}}$ ,  $\overline{\text{WR}}$ ,  $\overline{\text{BE0-1}}$ , P140 )
  - 6A: (  $\overline{\text{RD}}$ ,  $\overline{\text{WR}}$ ,  $\overline{\text{BE0-1}}$ , P140 )
  - 6B: (  $\overline{\text{CS0-1}}$ ,  $\overline{\text{CS3-4}}$ ,  $\overline{\text{WAIT}}$  )
  - 6C: ( D0-4 )
  - 6D: ( D5-9 )
  - 6E: ( D10-14 )
  - 6F: ( D15, A0-3 )
  - 6G: ( A4-18 )
  - 6H: ( A9-13 )
  - 6I: ( A14-18 )
  - 6J: ( A19-23 )
- Pin Group 8: Voltage Comparator Inputs supplied by  $AV_{DD}$ 
  - 8: ( VCMP0-1 )

- Note**
1.  $\mu\text{PD70F3426A}$ ,  $\mu\text{PD70F3425}$ ,  $\mu\text{PD70F3424}$ ,  $\mu\text{PD70F3423}$ ,  $\mu\text{PD70F3422}$ ,  $\mu\text{PD70F3421}$
  2.  $\mu\text{PD70F3427}$

## Chapter 3 Absolute Maximum Ratings

**Condition 1:**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,

Operation Modes: RUN, HALT, IDLE

Power dissipation:  $< 1.3\text{W}$  ( $\mu\text{PD70F3427}$ )

$< 1.2\text{W}$  ( $\mu\text{PD70F3426A}$ ,  $\mu\text{PD70F3425}$ ,  $\mu\text{PD70F3424}$ )

$< 1.0\text{W}$  ( $\mu\text{PD70F3423}$ ,  $\mu\text{PD70F3422}$ ,  $\mu\text{PD70F3421}$ )

Duration: 15000 hours

$V_{SS5} = 0\text{V}$

**Condition 2:**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation:  $< 0.5\text{W}$

Duration: 15 years

$V_{SS5} = 0\text{V}$

**Table 3-1 Absolute maximum ratings**

| Parameter            |                              | Symbol       | Test Conditions                    | Ratings <sup>a</sup> | Unit |
|----------------------|------------------------------|--------------|------------------------------------|----------------------|------|
| Supply voltage       |                              | $V_{DD5}$    |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $AV_{DD}$    |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $AV_{REF}$   |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $BV_{DD5}$   |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $DV_{DD5}$   |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $SMV_{DD5}$  |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $MV_{DD5}^b$ |                                    | -0.5 ~ +6.5          | V    |
|                      |                              | $AV_{SS}$    |                                    | -0.5 ~ +0.5          | V    |
|                      |                              | $BV_{SS5}$   |                                    | -0.5 ~ +0.5          | V    |
|                      |                              | $DV_{SS5}$   |                                    | -0.5 ~ +0.5          | V    |
|                      |                              | $SMV_{SS5}$  |                                    | -0.5 ~ +0.5          | V    |
|                      |                              | $MV_{SS5}^b$ |                                    | -0.5 ~ +0.5          | V    |
| Input voltage        | Group 1                      | $V_{I1}$     | $V_{I1} < BV_{DD5} + 0.5\text{V}$  | -0.5 ~ + 6.5         | V    |
|                      | Group 2                      | $V_{I2}$     | $V_{I2} < V_{DD5} + 0.5\text{V}$   | -0.5 ~ + 6.5         | V    |
|                      | Group 3                      | $V_{I3}$     | $V_{I3} < DV_{DD5} + 0.5\text{V}$  | -0.5 ~ + 6.5         | V    |
|                      | Group 4                      | $V_{I4}$     | $V_{I4} < SMV_{DD5} + 0.5\text{V}$ | -0.5 ~ + 6.5         | V    |
|                      | Group 5, 8<br>AVREF          | $V_{IA}$     | $V_{IA} < AV_{DD} + 0.5\text{V}$   | -0.5 ~ + 6.5         | V    |
|                      | Group 6 <sup>b</sup>         | $V_{I6}$     | $V_{IM} < MV_{DD5} + 0.5\text{V}$  | -0.5 ~ + 6.5         | V    |
| Special <sup>c</sup> | X1, X2, XT1,<br>XT2, REGC0-2 | $V_{IS}$     |                                    | -0.5 ~ + 3.6         | V    |

**Table 3-1 Absolute maximum ratings (Continued)**

| Parameter                       | Symbol     | Test Conditions | Ratings <sup>a</sup> | Unit |
|---------------------------------|------------|-----------------|----------------------|------|
| Output voltage                  | $V_O$      |                 | -0.5 ~ +6.5          | V    |
| Operating temperature (ambient) | $T_{OPR}$  |                 | -40 ~ +85            | °C   |
| Storage temperature             | $T_{STGB}$ |                 | -40 ~ +150           | °C   |

- a) Currents are average current over the given life time. Transient currents are not relevant as long as the average of transient is below the given value.
- b) xxx  $\mu$ PD70F3427 only
- c) These pins are for special use only and should not be used for other connections than specified. Pins operate with the internal generated core voltage.

**Note** Refer to “Pinout Information” on page 9 for pin to group association.

- $V_{DD5}$  is the supply voltage for the internal voltage regulators applied to pins  $V_{DD5x}$ .
- $V_{SS5}$  is the ground for the internal logic applied to pins  $V_{SS5x}$ .
- $A_{VDD}$  is the supply for analog part of the A/D converter.
- $A_{VSS}$  is the ground for the analog part of the A/D converter.
- $BV_{DD5}$  is the supply voltage for the I/O buffers applied to pins  $BV_{DD5x}$ .
- $BV_{SS5}$  is the ground for the I/O buffers applied to pins  $BV_{SS5x}$ .
- $DV_{DD5}$  is the supply voltage for the I/O buffers that support the LCD bus I/F applied to pins  $DV_{DD5x}$ .
- $DV_{SS5}$  is the ground for the I/O buffers that support the LCD bus I/F applied to pins  $DV_{SS5x}$ .
- $SMV_{DD5}$  is the supply voltage for the I/O buffers of the stepper motor drivers applied to pins  $SMV_{DD5x}$ .
- $SMV_{SS5}$  is the ground for the I/O buffers of the stepper motor drivers applied to pins  $SMV_{SS5x}$ .
- $\mu$ PD70F3427 only:
- $MV_{DD5}$  is the supply voltage for the I/O buffers of the external memory interface applied to pins  $MV_{DD5x}$ .
- $MV_{SS5}$  is the ground for the I/O buffers of the external memory interface applied to pins  $MV_{SS5x}$ .

Table 3-2 Absolute maximum ratings currents

| Parameter           | Symbol    | Test Conditions      | Ratings average <sup>a</sup>       | Ratings peak <sup>b</sup> | Unit |    |
|---------------------|-----------|----------------------|------------------------------------|---------------------------|------|----|
| Output current low  | 1 pin     | $I_{OL1}$            | Groups 1A, 1B, 1C, 1D              | 30                        | 50   | mA |
|                     | All pins  | $I_{OLA1A}$          | Group 1A                           | 50                        | 100  | mA |
|                     | All pins  | $I_{OLA1B}$          | Group 1B                           | 50                        | 100  | mA |
|                     | All pins  | $I_{OLA1SAB}$        | Sum of Groups 1A, 1B               | 100                       | 200  | mA |
|                     | All pins  | $I_{OLA1C}$          | Group 1C                           | 50                        | 100  | mA |
|                     | All pins  | $I_{OLA1D}$          | Group 1D                           | 50                        | 100  | mA |
|                     | All pins  | $I_{OLA1SCD}$        | Sum of Groups 1C, 1D               | 100                       | 200  | mA |
|                     | 1 pin     | $I_{OL3}$            | Group 3 <sup>c</sup>               | 30                        | 50   | mA |
|                     | All pins  | $I_{OLA3}$           |                                    | 50                        | 100  | mA |
|                     | 1 pin     | $I_{OL3}$            | Groups 3A, 3B, 3C, 3D <sup>d</sup> | 30                        | 50   | mA |
|                     | All pins  | $I_{OLA3}$           |                                    | 50                        | 100  | mA |
|                     | All pins  | $I_{OLA3SAB}$        | Sum of Groups 3A, 3B <sup>d</sup>  | 100                       | 200  | mA |
|                     | All pins  | $I_{OLA3SCD}$        | Sum of Groups 3C, 3D <sup>d</sup>  | 100                       | 200  | mA |
|                     | 1 pin     | $I_{OL4A}$           | Group 4A                           | 45                        | 55   | mA |
|                     | All pins  | $I_{OLA4A}$          |                                    | 200                       | 270  | mA |
|                     | 1 pin     | $I_{OL4B}$           | Group 4B                           | 45                        | 55   | mA |
|                     | All pins  | $I_{OLA4B}$          |                                    | 200                       | 270  | mA |
|                     | All pins  | $I_{OL5}$            | Group 5 <sup>e</sup>               | 32                        | 32   |    |
|                     | 1 pin     | $I_{OL6}$            | Group 6 <sup>d</sup>               | 30                        | 50   | mA |
|                     | All pins  | $I_{OLA6}$           |                                    | 70                        | 300  | mA |
| All pins            | $I_{OL8}$ | Group 8 <sup>e</sup> | 4                                  | 4                         | mA   |    |
| Output current high | 1 pin     | $I_{OH1}$            | Groups 1A, 1B, 1C, 1D              | -30                       | -50  | mA |
|                     | All pins  | $I_{OHA1A}$          | Group 1A                           | -50                       | -100 | mA |
|                     | All pins  | $I_{OHA1B}$          | Group 1B                           | -50                       | -100 | mA |
|                     | All pins  | $I_{OHA1SAB}$        | Sum of Groups 1A, 1B               | -100                      | -200 | mA |
|                     | All pins  | $I_{OHA1C}$          | Group 1C                           | -50                       | -100 | mA |
|                     | All pins  | $I_{OHA1D}$          | Group 1D                           | -50                       | -100 | mA |
|                     | All pins  | $I_{OHA1SCD}$        | Sum of Groups 1C, 1D               | -100                      | -200 | mA |
|                     | 1 pin     | $I_{OH3}$            | Group 3 <sup>c</sup>               | -30                       | -50  | mA |
|                     | All pins  | $I_{OHA3}$           |                                    | -50                       | -100 | mA |
|                     | 1 pin     | $I_{OH3}$            | Groups 3A, 3B, 3C, 3D <sup>d</sup> | -30                       | -50  | mA |
|                     | All pins  | $I_{OHA3}$           |                                    | -50                       | -100 | mA |
|                     | All pins  | $I_{OHA3SAB}$        | Sum of Groups 3A, 3B <sup>d</sup>  | -100                      | -200 | mA |
|                     | All pins  | $I_{OHA3SCD}$        | Sum of Groups 3C, 3D <sup>d</sup>  | -100                      | -200 | mA |
|                     | 1 pin     | $I_{OH4A}$           | Group 4A                           | -45                       | -55  | mA |
|                     | All pins  | $I_{OHA4A}$          |                                    | -200                      | -270 | mA |
|                     | 1 pin     | $I_{OH4B}$           | Group 4B                           | -45                       | -55  | mA |
|                     | All pins  | $I_{OHA4B}$          |                                    | -200                      | -270 | mA |



**Table 3-2 Absolute maximum ratings currents (Continued)**

| Parameter           |          | Symbol     | Test Conditions      | Ratings average <sup>a</sup> | Ratings peak <sup>b</sup> | Unit |
|---------------------|----------|------------|----------------------|------------------------------|---------------------------|------|
| Output current high | All pins | $I_{OH5}$  | Group 5 <sup>e</sup> | -32                          | -32                       | mA   |
|                     | 1 pin    | $I_{OH6}$  | Group 6 <sup>d</sup> | -30                          | -50                       | mA   |
|                     | All pins | $I_{OHA6}$ |                      | -70                          | -300                      | mA   |
|                     | All pins | $I_{OH8}$  | Group 8 <sup>e</sup> | -4                           | -4                        | mA   |

- a) Average currents are average current over the given life time. Transient currents are not relevant as long as the average of transient is below the given value.
- b) The peak current sets the limit for short term current flows.
- c)  $\mu$ PD70F3426A,  $\mu$ PD70F3425,  $\mu$ PD70F3424,  $\mu$ PD70F3423,  $\mu$ PD70F3422,  $\mu$ PD70F3421
- d)  $\mu$ PD70F3427 only
- e) Group 5 and group 8 have no output capability. This value is needed as reference, because injected current can influence the device in the same way as an output stage. Injected currents that may flow through any or both input pins of the Voltage-Comparators VCMP0, VCMP1 are included within the given parameter.

**Table 3-3 Power Supply Restrictions**

| Parameter                                | Symbol        | Test Conditions   | Ratings    | Unit |
|--|---------------|---|------------|------|
| Supply voltage up/down ramp <sup>a</sup> | $V_{DDRAMP}$  |   | $\leq 50$  | V/ms |
| Low voltage duration <sup>b</sup>        | $t_{VDD5Low}$ | $V_{DD5} < 3.2V$ ,<br>$AV_{DD5} < 3.2V$ ,<br>$SMV_{DD5} < 3.2V$ ,<br>$DV_{DD5} < 3.0V$ ,<br>$BV_{DD5} < 3.0V$ ,<br>$MV_{DD5} < 3.0V$ <sup>c</sup> | indefinite | s    |

- a) Not tested in production
- b) No device damage and no flash data loss.
- c) ( $\mu$ PD70F3427).

- Note**
1. A low resistive connection of all VSS pins on the PCB has to be ensured. This specification denotes this as:  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS5} = MV_{SS5}$  ( $\mu$ PD70F3427) = 0 V
  2. A low resistive connection of all  $V_{DD5x}$  pins among each other has to be ensured.

## Chapter 4 General Characteristics

### 4.1 Requirements for external connections

A low resistive connection of all VSS pins on the PCB has to be ensured. In the following this specification denotes this as:

$$V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = MV_{SS5} \text{ Note} = AV_{SS} = 0 \text{ V}$$

A low resistive connection of the following supply pins has to be ensured:

- all  $V_{DD5x}$  pins among each other
- all  $BV_{DD5x}$  pins among each other
- all  $SMV_{DD5x}$  pins among each other
- all  $DV_{DD5x}$  pins among each other
- all  $MV_{DD5x}$  pins among each other **Note**

**Note**  $\mu$ PD70F3427 only

### 4.2 Capacitance connected to REGCx

The device requires to connect capacitors with the following parameters to each of the pins REGC0, REGC1 and REGC2 individually.

The pins REGC0, REGC1, REGC2 must not be connected externally.

**Table 4-1 External Capacitance Requirement**

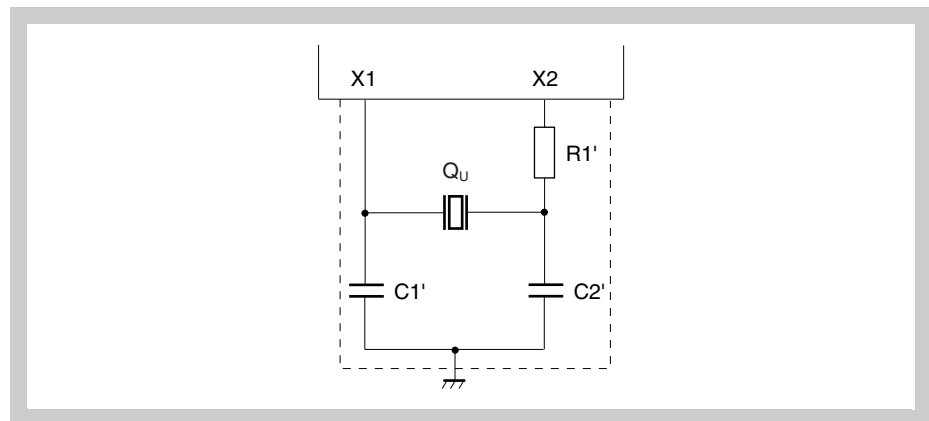
| Parameter          | Symbol    | Test Conditions | Min. | Typ | Max. | Unit     |
|--------------------|-----------|-----------------|------|-----|------|----------|
| Capacitance        | $C_{REG}$ |                 | 3.3  | 4.7 | 10   | $\mu$ F  |
| ESR of capacitance | $C_{ESR}$ | F0 = 100kHz     |      |     | 0.6  | $\Omega$ |

### 4.3 Main Oscillator Characteristics

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

A ceramic or crystal resonator has to be connected to the main clock input pins as shown in *Figure 4-1*.

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2. Values of  $C_1$ ,  $C_2$  and R depend on the used crystal or resonator and must be specified in cooperation with crystal/resonator manufacturer.



**Figure 4-1 Recommended Main Oscillator Circuit**

- Caution**
1. External clock input is prohibited.
  2. When using the main system clock oscillator, wire as follows in the area enclosed by the broken lines in the above figure to avoid an adverse effect from wiring capacitance.
    - Keep the wiring length as short as possible.
    - Do not cross the wiring with the other signal lines.
    - Do not route the wiring near a signal line through which a high fluctuating current flows.
    - Always make the ground point of the oscillator capacitor the same potential as  $V_{SS}$ .
    - Do not ground the capacitor to a ground pattern through which a high current flows.
    - Do not fetch signals from the oscillator.

**Table 4-2 Main Oscillator Characteristics**

| Parameter                      | Symbol           | Test Conditions | MIN. | TYP. | MAX.            | Unit |
|--------------------------------|------------------|-----------------|------|------|-----------------|------|
| Oscillation stabilization time | T <sub>OST</sub> | OSC MODE        |      |      | 16 <sup>a</sup> | ms   |
| X1, X2 Oscillator Frequency    | f <sub>OSC</sub> |                 | 3.6  | 4.0  | 4.4             | MHz  |

a) T<sub>OST</sub> depends on the external crystal. Value might be improved after evaluation

**Remark** These values are valid only for crystal operation.

**Table 4-3 Main Oscillator Characteristics - Crystal Type NDK LN-G8-1404**

| Parameter                      | Symbol           | Test Conditions | MIN. | TYP. | MAX.            | Unit |
|--------------------------------|------------------|-----------------|------|------|-----------------|------|
| Oscillation stabilization time | T <sub>OST</sub> | OSC MODE        |      |      | 10 <sup>a</sup> | ms   |
| X1, X2 Oscillator Frequency    | f <sub>OSC</sub> |                 | 3.6  | 4.0  | 4.4             | MHz  |

a) The given oscillation stabilization time is valid exclusively in case the below mentioned crystal-type from the manufacturer NDK is used for the main-oscillator operation. Beside the application of this specific crystal type, the PCB-design and capacitance configuration must ensure proper operation of the crystal enabling a load capacitance of about C<sub>L</sub>=12 pF. This parameter has to be verified by a dedicated crystal-evaluation based on the final PCB.

NDK Spec. No.: LN-G8-1404  
 Holder: AT-51GW  
 Frequency: 4.000 MHz

## 4.4 Sub-Oscillator Characteristics

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

A crystal resonator has to be connected to the sub clock input pins as shown in Figure 4-2.

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2. Values of  $C_{S1}$ ,  $C_{S2}$  and  $R_S$  depend on the used crystal and must be specified in cooperation with crystal manufacturer.

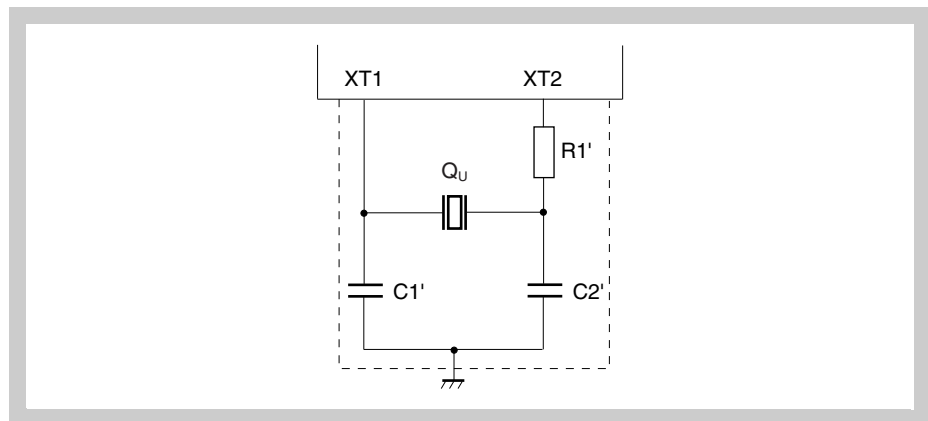


Figure 4-2 Recommended Sub Oscillator Circuit

- Caution**
1. External clock input is prohibited.
  2. When using the sub system clock oscillator, wire as follows in the area enclosed by the broken lines in the above figure to avoid an adverse effect from wiring capacitance.
    - Keep the wiring length as short as possible.
    - Do not cross the wiring with the other signal lines.
    - Do not route the wiring near a signal line through which a high fluctuating current flows.
    - Always make the ground point of the oscillator capacitor the same potential as  $V_{SS}$ .
    - Do not ground the capacitor to a ground pattern through which a high current flows.
    - Do not fetch signals from the oscillator.

**Table 4-4 Sub Oscillator Characteristics**

| Parameter                         | Symbol     | Test Conditions | Min. | Typ    | Max            | Unit |
|-----------------------------------|------------|-----------------|------|--------|----------------|------|
| XT1,XT2 Oscillator Frequency      | $f_{SOSC}$ |                 | 32   | 32.768 | 35             | KHz  |
| Sub oscillator stabilization time | $T_{SOST}$ |                 |      |        | 5 <sup>a</sup> | s    |

a)  $T_{SOST}$  depends on the external crystal. Value might be improved after evaluation

**Remark** These values are valid only for crystal operation.

## 4.5 Peripheral PLL Characteristics

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

**Note** Refer to "Power On Clear" on page 81 for further functional restriction.

**Table 4-5 Peripheral PLL Characteristics**

| Parameter                             | Symbol    | Test Conditions         | MIN. | TYP. | MAX. | Unit |
|---------------------------------------|-----------|-------------------------|------|------|------|------|
| PLL Startup Time                      | $T_{PST}$ | OSC MODE                |      |      | 1.2  | ms   |
| PLL Output period jitter <sup>a</sup> | $T_{PJ}$  | Peak to peak            |      |      | 1    | ns   |
| PLL Long term jitter <sup>a</sup>     | $T_{LJ}$  | Time = 20 $\mu\text{s}$ |      |      | 2    | ns   |

a) Not tested in production. Specified by design.

## 4.6 Spread Spectrum PLL Characteristics

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 4-6 Spread Spectrum PLL Characteristics**

| Parameter   | Symbol       | Test Conditions                 | MIN. | TYP.                   | MAX.      | Unit |
|---|--------------|---------------------------------|------|------------------------|-----------|------|
| SSCG Startup Time                                   | $T_{SSCGST}$ | OSC MODE                        |      |                        | 1.2       | ms   |
| SSCG Frequency modulation range <sup>a</sup>        | DITHER       | OSC MODE,<br>dither setting: 3% | 0    |                        | $\pm 4.2$ | %    |
|   |              | OSC MODE,<br>dither setting: 5% |      |                        | $\pm 6.8$ | %    |
| SSCG center frequency during dithering <sup>a</sup> | $f_{DITHER}$ |                                 |      | 1.0 *<br>$f_{nominal}$ |           |      |
| SSCG modulation frequency <sup>a</sup>              | $f_{Mod}$    | SCFMC1-0 = <sup>b</sup>         |      |                        |           |      |
|   |              | 00                              | 35   | 40                     | 46        | kHz  |
|   |              | 01                              | 41   | 50                     | 55        |      |
| 10  | 49           | 60                              | 63   |                        |           |      |

a) Not tested in production. Specified by design.

b) The typical modulation frequency can be selected by register SCFMC.

## 4.7 Ring Oscillator Characteristics

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 4-7 Ring Oscillator Characteristics**

| Parameter                                       | Symbol     | Test Conditions | Min. | Typ | Max | Unit          |
|---|------------|-----------------|------|-----|-----|---------------|
| Ring Oscillator Frequency                       | $f_{RING}$ |                 | 200  | 240 | 300 | KHz           |
| Ring oscillator Stabilization Time <sup>a</sup> | $T_{ROST}$ |                 |      |     | 20  | $\mu\text{s}$ |

a) Not tested in production. Specified by design.

## 4.8 I/O Capacitances

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 4-8 I/O Characteristics**

| Parameter  | Symbol    | Test Conditions  | MIN. | TYP. | MAX. | Unit |
|--|-----------|--|------|------|------|------|
| Input capacitance  | $C_I$     | $f_C = 1\text{ MHz}$<br>Unmeasured pins<br>returned to 0 V |      |      | 10   | pF   |
| Input/output capacitance,<br>all I/O pins except group 4 | $C_{IO}$  |  |      |      | 15   | pF   |
| Input/output capacitance Group<br>4                      | $C_{IO4}$ |  |      |      | 30   | pF   |



# Chapter 5 Operation Conditions

## 5.1 CPU Clock

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = (\mu\text{PD70F3427 only}) = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 5-1 CPU Clock Frequencies**

| Clock Mode         | Prescale | Operation Mode | Device  | CPU Operation Clock Frequency [MHz] |
|--------------------|----------|----------------|---|-------------------------------------|
| OSC mode           | n/a      | all modes      | all   | 4                                   |
| OSC mode, PLL x8   | 1/2      |                |   | 16                                  |
| OSC mode, PLL x8   | n/a      |                |   | 32                                  |
| OSC mode, SSCG x12 | 1/6      |                |   | 8                                   |
| OSC mode, SSCG x16 | 1/4      |                |   | 16                                  |
| OSC mode, SSCG x12 | 1/2      |                |   | 24                                  |
| OSC mode, SSCG x16 | 1/2      |                |   | 32                                  |
| OSC mode, SSCG x12 | 1/1      |                |   | 48                                  |
| OSC mode, SSCG x16 | 1/1      |                | $\mu\text{PD70F3427}$ ,<br>$\mu\text{PD70F3426A}$ ,<br>$\mu\text{PD70F3425}$ ,<br>$\mu\text{PD70F3424}$ | 64                                  |
| OSC mode, Ring OSC | n/a      |                | all   | 0.2                                 |
| OSC mode, Sub OSC  | n/a      |                |   | 0.032                               |

## 5.2 Peripheral Clock

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = (\mu\text{PD70F3427 only}) = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 5-2 Peripheral Clock Frequencies**

| Clock         | Clock Source      | Max                | Unit |
|---------------|-------------------|--------------------|------|
| PCLK0 - 1     | Main OSC          | 4                  | MHz  |
|               | Main OSC, PLL x 8 | 16, 8              | MHz  |
| PCLK2 - 15    | Main OSC          | 4, 2, ... , 1/2048 | MHz  |
| IICLK         | Main OSC          | 4                  | MHz  |
|               | Main OSC, PLL x8  | 32 <sup>a</sup>    | MHz  |
|               | Main OSC, SSCG    |                    |      |
| SPCLK0 - 1    | Main OSC          | 4                  | MHz  |
|               | Main OSC, PLL x8  | 16, 8 <sup>b</sup> | MHz  |
|               | Main OSC, SSCG    |                    |      |
| SPCLK2 - 15   | Main OSC          | 4, 2 ... 1/2048    | MHz  |
|               | Main OSC, SSCG    |                    |      |
| FOUT (CLKOUT) | Main OSC, PLL x8  | 32                 | MHz  |
|               | Main OSC, SSCG    | 32 <sup>c</sup>    | MHz  |
|               | Main OSC          | 4                  | MHz  |
|               | Ring OSC          | 0.2                | MHz  |
|               | Sub OSC           | 0.032              | MHz  |
| LCDCLK        | Main OSC          | 4                  | MHz  |
|               | Ring OSC          | 0.2                | MHz  |
|               | Sub OSC           | 0.032              | MHz  |
| WTCLK         | Main OSC          | 4                  | MHz  |
|               | Ring OSC          | 0.2                | MHz  |
|               | Sub OSC           | 0.032              | MHz  |
| WDTCLK        | Main OSC          | 4                  | MHz  |
|               | Ring OSC          | 0.2                | MHz  |
|               | Sub OSC           | 0.032              | MHz  |
| WCTCLK        | Main OSC          | 4                  | MHz  |
|               | PCLK1             | see PCLK1          | MHz  |

- a) needs to be ensured by proper configuration of the IICLK divider.  
b) needs to be ensured by proper configuration of the SPCLK divider.  
c) needs to be ensured by proper configuration of the FOUT (CLKOUT) divider.

### 5.3 AC Load Condition - Single Pin Switching

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = (\mu\text{PD70F3427 only}) = 0\text{ V}$

**Note** Full device operation is only available, when the supply voltage  $V_{DD5}$  is above the maximum threshold voltage. The device may stop operation due to reset condition generated by POC, if the supply voltage drops below the given max threshold voltage. Refer to “Power On Clear” on page 81. on page 95 for further details.

#### 5.3.1 Output Pins - Single Pin Switching

- Note**
1. Not tested in production. Specified by design.
  2. Special care must be taken for the power supply when high capacitive loads are switched. The buffers change from limited to unlimited mode when the output voltage is near to the supply or ground. At that time a current peak is driven to the load thus drawing a peak current on the supply. This will generate noise and may deteriorate the observed slopes at neighbor pins in the same pin group, when they switch at the same time.

**Table 5-3 AC Load Condition - Single Pin Switching**

| Parameter  | Pin Group                                | Symbol   | Test Conditions                      | Min. | Typ | Max. | Unit |
|--|--|----------|--------------------------------------|------|-----|------|------|
| Capacitive load per pin (Single pin) <sup>a</sup>    | 1, 2 <sup>b</sup> , 3, 4, 6 <sup>c</sup> | $C_{LS}$ | $f_{\text{switch}} < 100\text{ kHz}$ |      |     | 1    | nF   |
| Capacitive load per pin (Multiple pins) <sup>d</sup> |  | $C_{LM}$ | $f_{\text{switch}} < 1\text{ MHz}$   |      |     | 300  | pF   |

- a) The specified parameter does represent the maximum capacitive load one pin of one pin group is able to drive in case only that single pin is driving the specified capacitive load by switching its output level. In case more than one pin within one pin group need to drive that capacitive load dynamically they must be switched consecutively. Do not switch more than one port-pin at a given time. The given specification is valid for the condition the concerned pin is operating in Limit2 drive-strength-control-mode (5mA. Except Pin Group 4).
- b) The condition is only valid for pin P07 of pin group 2.
- c) Pin group 6 exists for the derivative  $\mu\text{PD70F3427}$  only.
- d) Multiple pins may switch simultaneously.

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### 5.3.2 Input Pins - Capacitive Loading

**Note** The maximum capacitive load that is allowed to be applied to a single ADC-Input channel, a voltage comparator input or a single port-input can be derived by examining the given parameters of:

- Injected Current
- Supply Voltage ramp down (refer to “*Power Supply Restrictions*“ on page 16)
- Absolute Maximum Ratings

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**Caution** When determining the maximum capacitive load according to the given parameters mentioned above, it must be secured that a possible back current being supplied by the external capacitor must never exceed the given maximum ratings.

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## Chapter 6 DC Characteristics

### 6.1 General DC Characteristics

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = (\mu\text{PD70F3427 only}) = 0\text{ V}$

**Note** Refer to "Power On Clear" on page 81 for further functional restriction.

**Table 6-1 Input Leakage Current**

| Parameter                                 | Pin Group      | Symbol     | Test Conditions             | Min. | Typ | Max. | Unit          |
|---|----------------|------------|-----------------------------|------|-----|------|---------------|
| Input leakage                             | 1 <sup>a</sup> | $I_{LI1}$  | $0 \leq V_1 \leq BV_{DD5}$  | -1   |     | +1   | $\mu\text{A}$ |
|   | 2              | $I_{LI2}$  | $0 \leq V_1 \leq V_{DD52}$  | -1   |     | +1   | $\mu\text{A}$ |
|   | 3              | $I_{LI3}$  | $0 \leq V_1 \leq DV_{DD5}$  | -1   |     | +1   | $\mu\text{A}$ |
|   | 5              | $I_{LIA}$  | $0 \leq V_1 \leq AV_{DD}$   | -0.2 |     | +0.2 | $\mu\text{A}$ |
|   | 6              | $I_{LI6}$  | $0 \leq V_1 \leq MV_{DD5}$  | -1   |     | +1   | $\mu\text{A}$ |
|   | 8              | $I_{LIAD}$ | $0 \leq V_1 \leq AV_{DD}$   | -2   |     | +1   | $\mu\text{A}$ |
|   | 4              | $I_{LIS}$  | $0 \leq V_1 \leq SMV_{DD5}$ | -10  |     | +10  | $\mu\text{A}$ |
| Injected Current per pin <sup>b, c</sup>  | All            | $I_{INJ}$  |                             | -2   |     | +2   | mA            |
| Injected Current All pins <sup>b, c</sup> | 5              | $I_{INJ}$  |                             | -15  |     | +32  | mA            |

- a) The pull-down resistor of P05 is active during RESET and must be switched-off during input leakage current measurement. Otherwise the pull-down resistor cause unintended current flow.
- b) The injected current will not be tested during production. Value will be verified by evaluation.  
 The total current per pin group (injected plus operating) has to be in the limits of the absolute maximum ratings for output currents (values for output current low and output current high).  
 The operation voltage must stay in the limits of the operating conditions. The user has to make sure that the injected current does not pull the supplied voltage outside of the operating conditions.
- c) The accuracy of the ADC specified in this document is only valid when the sum of all curenths of pin group 5 is in the range of -15 mA to +32 mA.

## 6.2 Pin Group 1

Pin Groups 1x: Pins supplied by  $BV_{DD5}$

- 1A: ( P00-06, P50-55, P84 )
- 1B: ( P16-17, P30-31, P40-42, P46-47, P56-57, P100-103 )
- 1C: ( P20-27, P34-37, P60-67 )
- 1D: ( P43-45, P80-83, P85 )

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 4.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-2 Pin Group 1 Normal Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Pin Group | Symbol     | Test Conditions           | Min.              | Typ | Max.           | Unit |
|---|-----------------------|-----------|------------|---------------------------|-------------------|-----|----------------|------|
| Input voltage high                        | Schmitt1              | 1         | $V_{IH1}$  |                           | $0.7 BV_{DD5}$    |     | $BV_{DD5}$     | V    |
|   | Schmitt2              | 1         | $V_{IH2}$  |                           | $0.8 BV_{DD5}$    |     | $BV_{DD5}$     | V    |
|   | CMOS1                 | 1         | $V_{IH3}$  |                           | $0.7 BV_{DD5}$    |     | $BV_{DD5}$     | V    |
|   | CMOS2                 | 1         | $V_{IH4}$  |                           | $0.8 BV_{DD5}$    |     | $BV_{DD5}$     | V    |
| Input voltage low                         | Schmitt1              | 1         | $V_{IL1}$  |                           | 0                 |     | $0.3 BV_{DD5}$ | V    |
|   | Schmitt2              | 1         | $V_{IL2}$  |                           | 0                 |     | $0.4 BV_{DD5}$ | V    |
|   | CMOS1                 | 1         | $V_{IL3}$  |                           | 0                 |     | $0.3 BV_{DD5}$ | V    |
|   | CMOS2                 | 1         | $V_{IL4}$  |                           | 0                 |     | $0.4 BV_{DD5}$ | V    |
| Input hysteresis <sup>b</sup>             | Schmitt1              | 1         | $V_{HY1}$  |                           | 150               |     |                | mV   |
|   | Schmitt2              | 1         | $V_{HY2}$  |                           | 150               |     |                | mV   |
| Output voltage high                       | Limit1                | 1         | $V_{OH}$   | $I_{OH} = -2.0\text{ mA}$ | $BV_{DD5} - 0.45$ |     |                | V    |
|   | Limit2                | 1         | $V_{OH}$   | $I_{OH} = -5.0\text{ mA}$ | $BV_{DD5} - 0.45$ |     |                | V    |
| Output voltage low                        | Limit1                | 1         | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$  |                   |     | 0.45           | V    |
|   | Limit2                | 1         | $V_{OL}$   | $I_{OL} = 5.0\text{ mA}$  |                   |     | 0.45           | V    |
| Maximum output short circuit current high | Limit1                | 1         | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$     | -2                |     | -12            | mA   |
|   | Limit2                |           | $I_{OHM2}$ |                           | -5                |     | -30            | mA   |
| Maximum output short circuit current low  | Limit1                | 1         | $I_{OLM1}$ | $V_{OL} = BV_{DD5}$       | 2                 |     | 12             | mA   |
|   | Limit2                |           | $I_{OLM2}$ |                           | 5                 |     | 30             | mA   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

Limit1 and Limit2 denote the two output characteristics with current limit functionality of the device pins. The characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 4.0\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-3 Pin Group 1 Low Voltage Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Pin Group | Symbol     | Test Conditions           | Min.              | Typ | Max.            | Unit |
|---|-----------------------|-----------|------------|---------------------------|-------------------|-----|-----------------|------|
| Input voltage high                        | Schmitt1              | 1         | $V_{IH1}$  |                           | 0.7 $BV_{DD5}$    |     | $BV_{DD5}$      | V    |
|   | Schmitt2              | 1         | $V_{IH2}$  |                           | 0.8 $BV_{DD5}$    |     | $BV_{DD5}$      | V    |
|   | CMOS1                 | 1         | $V_{IH3}$  |                           | 0.7 $BV_{DD5}$    |     | $BV_{DD5}$      | V    |
|   | CMOS2                 | 1         | $V_{IH4}$  |                           | 0.8 $BV_{DD5}$    |     | $BV_{DD5}$      | V    |
| Input voltage low                         | Schmitt1              | 1         | $V_{IL1}$  |                           | 0                 |     | 0.3 $BV_{DD5}$  | V    |
|   | Schmitt2              | 1         | $V_{IL2}$  |                           | 0                 |     | 0.35 $BV_{DD5}$ | V    |
|   | CMOS1                 | 1         | $V_{IL3}$  |                           | 0                 |     | 0.3 $BV_{DD5}$  | V    |
|   | CMOS2                 | 1         | $V_{IL4}$  |                           | 0                 |     | 0.4 $BV_{DD5}$  | V    |
| Input hysteresis <sup>b</sup>             | Schmitt1              | 1         | $V_{HY1}$  |                           | 100               |     |                 | mV   |
|   | Schmitt2              | 1         | $V_{HY2}$  |                           | 100               |     |                 | mV   |
| Output voltage high                       | Limit1                | 1         | $V_{OH}$   | $I_{OH} = -1.0\text{ mA}$ | $BV_{DD5} - 0.45$ |     |                 | V    |
|   | Limit2                | 1         | $V_{OH}$   | $I_{OH} = -2.0\text{ mA}$ | $BV_{DD5} - 0.45$ |     |                 | V    |
| Output voltage low                        | Limit1                | 1         | $V_{OL}$   | $I_{OL} = 1.0\text{ mA}$  |                   |     | 0.45            | V    |
|   | Limit2                | 1         | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$  |                   |     | 0.45            | V    |
| Maximum output short circuit current high | Limit1                | 1         | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$     | -1                |     |                 | mA   |
|   | Limit2                |           | $I_{OHM2}$ |                           | -2                |     |                 | mA   |
| Maximum output short circuit current low  | Limit1                | 1         | $I_{OLM1}$ | $V_{OL} = BV_{DD5}$       | 1                 |     |                 | mA   |
|   | Limit2                |           | $I_{OLM2}$ |                           | 2                 |     |                 | mA   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

Limit1 and Limit2 denote the two output characteristics with current limit functionality of the device pins. The characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-4 Pin P05 pulldown resistor**

| Parameter          | Pin mode | Pin Group | Symbol   | Test Conditions | Min. | Typ | Max. | Unit             |
|--------------------|----------|-----------|----------|-----------------|------|-----|------|------------------|
| Pull down resistor |          | P05       | $V_{PD}$ |                 | 14   | 28  | 56   | $\text{k}\Omega$ |



### 6.3 Pin group 2: $\overline{\text{RESET}}$ and FLMD0

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-5 Pin Group 2 (except P07) Normal Operating Range**

| Parameter          | Pin mode | Pin Group | Symbol    | Test Conditions | Min.           | Typ | Max.           | Unit |
|--------------------|----------|-----------|-----------|-----------------|----------------|-----|----------------|------|
| Input voltage high | Schmitt1 | 2         | $V_{IH1}$ |                 | $0.7 V_{DD52}$ |     | $V_{DD52}$     | V    |
| Input voltage low  | Schmitt1 | 2         | $V_{IL1}$ |                 | 0              |     | $0.3 V_{DD52}$ | V    |

## 6.4 Pin group 2: P07

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-6 P07 Normal Voltage Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Symbol     | Test Conditions           | Min               | Typ | Max            | Unit |
|---|-----------------------|------------|---------------------------|-------------------|-----|----------------|------|
| Input Voltage High                        | Schmitt1              | $V_{IH1}$  |                           | $0.7 V_{DD52}$    |     | $V_{DD52}$     | V    |
|   | Schmitt2              | $V_{IH2}$  |                           | $0.8 V_{DD52}$    |     | $V_{DD52}$     | V    |
|   | CMOS1                 | $V_{IH3}$  |                           | $0.7 V_{DD52}$    |     | $V_{DD52}$     | V    |
|   | CMOS2                 | $V_{IH4}$  |                           | $0.8 V_{DD52}$    |     | $V_{DD52}$     | V    |
| Input Voltage Low                         | Schmitt1              | $V_{IL1}$  |                           | 0                 |     | $0.3 V_{DD52}$ | V    |
|   | Schmitt2              | $V_{IL2}$  |                           | 0                 |     | $0.5 V_{DD52}$ |      |
|   | CMOS1                 | $V_{IL3}$  |                           | 0                 |     | $0.3 V_{DD52}$ | V    |
|   | CMOS2                 | $V_{IL4}$  |                           | 0                 |     | $0.5 V_{DD52}$ | V    |
| Input Voltage Hysteresis <sup>b</sup>     | Schmitt1              | $V_{HI1}$  |                           | 150               |     |                | mV   |
|   | Schmitt2              | $V_{HI2}$  |                           | 150               |     |                | mV   |
| Output voltage high                       | Limit1                | $V_{OH}$   | $I_{OH} = -2.0\text{ mA}$ | $V_{DD52} - 0.45$ |     |                | V    |
|   | Limit2                | $V_{OH}$   | $I_{OH} = -5.0\text{ mA}$ | $V_{DD52} - 0.45$ |     |                | V    |
| Output voltage low                        | Limit1                | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$  |                   |     | 0.45           | V    |
|   | Limit2                | $V_{OL}$   | $I_{OL} = 5.0\text{ mA}$  |                   |     | 0.45           | V    |
| Maximum output short circuit current high | Limit1                | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$     | -2                |     |                | mA   |
|   | Limit2                | $I_{OHM2}$ |                           | -5                |     |                | mA   |
| Maximum output short circuit current low  | Limit1                | $I_{OLM1}$ | $V_{OL} = V_{DD52}$       | 2                 |     |                | mA   |
|   | Limit2                | $I_{OLM2}$ |                           | 5                 |     |                | mA   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt 2 denote the non-schmitt trigger and the schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-7 P07 Low Voltage Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Symbol     | Test Conditions           | Min               | Typ | Max             | Unit |
|---|-----------------------|------------|---------------------------|-------------------|-----|-----------------|------|
| Input Voltage High                        | Schmitt1              | $V_{IH1}$  |                           | $0.7 V_{DD52}$    |     | $V_{DD52}$      | V    |
|   | Schmitt2              | $V_{IH2}$  |                           | $0.8 V_{DD52}$    |     |                 |      |
|   | CMOS1                 | $V_{IH3}$  |                           | $0.7 V_{DD52}$    |     |                 |      |
|   | CMOS2                 | $V_{IH4}$  |                           | $0.8 V_{DD52}$    |     |                 |      |
| Input Voltage Low                         | Schmitt1              | $V_{IL1}$  |                           | 0                 |     | $0.3 V_{DD52}$  | V    |
|   | Schmitt2              | $V_{IL2}$  |                           | 0                 |     | $0.35 V_{DD52}$ | V    |
|   | CMOS1                 | $V_{IL3}$  |                           |                   |     | $0.3 V_{DD52}$  |      |
|   | CMOS2                 | $V_{IL4}$  |                           |                   |     | $0.5 V_{DD52}$  |      |
| Input Voltage Hysteresis <sup>b</sup>     | Schmitt1              | $V_{HI1}$  |                           | 100               |     |                 | mV   |
|   | Schmitt2              | $V_{HI2}$  |                           | 100               |     |                 | mV   |
| Output voltage high                       | Limit1                | $V_{OH}$   | $I_{OH} = -1.0\text{ mA}$ | $V_{DD52} - 0.45$ |     |                 | V    |
|   | Limit2                | $V_{OH}$   | $I_{OH} = -2.0\text{ mA}$ | $V_{DD52} - 0.45$ |     |                 | V    |
| Output voltage low                        | Limit1                | $V_{OL}$   | $I_{OL} = 1.0\text{ mA}$  |                   |     | 0.45            | V    |
|   | Limit2                | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$  |                   |     | 0.45            | V    |
| Maximum output short circuit current high | Limit1                | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$     | -1                |     |                 | mA   |
|   | Limit2                | $I_{OHM2}$ |                           | -2                |     |                 | mA   |
| Maximum output short circuit current low  | Limit1                | $I_{OLM1}$ | $V_{OL} = V_{DD52}$       | 1                 |     |                 | mA   |
|   | Limit2                | $I_{OLM2}$ |                           | 2                 |     |                 | mA   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt trigger and the schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

## 6.5 Analog Input

This chapter describes the digital functions available at the pins supplied by AV<sub>DD</sub>. The number of available analog conversion channels differ between the devices. VCMP0/1 have no digital function.

- Pin Group 5: Pins supplied by AV<sub>DD</sub>  
5: (P70 .. P715)  
Digital buffer function is only available for P70..P715.
- Pin Group 8: Pins supplied by AV<sub>DD</sub>  
8: (VCMP0, VCMP1)  
VCMP0 and VCMP1 have only analog comparator function.

**Conditions** T<sub>A</sub> = -40°C ~ +85°C,  
DV<sub>DD5</sub> = 3.0 V ~ 5.5 V, BV<sub>DD5</sub> = 3.0 V ~ 5.5 V,  
AV<sub>DD</sub> = 3.2 V ~ 5.5 V, SMV<sub>DD5</sub> = 3.2 V ~ 5.5 V,  
MV<sub>DD5</sub> = 3.0 V ~ 5.5 V (μPD70F3427 only),  
V<sub>DD5</sub> = 3.2 V ~ 5.5 V,  
V<sub>SS5</sub> = BV<sub>SS5</sub> = DV<sub>SS5</sub> = SMV<sub>SS5</sub> = AV<sub>SS</sub> = 0 V,  
MV<sub>SS5</sub> = 0 V (μPD70F3427 only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-8 Pin Group 5 Normal Operating Range**

| Parameter                             | Pin mode <sup>a</sup> | Symbol           | Test Conditions | Min                   | Typ | Max                   | Unit |
|---------------------------------------|-----------------------|------------------|-----------------|-----------------------|-----|-----------------------|------|
| Input Voltage High                    | Schmitt1              | V <sub>IH1</sub> |                 | 0.7 AV <sub>DD5</sub> |     | AV <sub>DD5</sub>     | V    |
|                                       | Schmitt2              | V <sub>IH2</sub> |                 | 0.8 AV <sub>DD5</sub> |     | AV <sub>DD5</sub>     | V    |
| Input Voltage Low                     | Schmitt1              | V <sub>IL1</sub> |                 | 0                     |     | 0.3 AV <sub>DD5</sub> | V    |
|                                       | Schmitt2              | V <sub>IL2</sub> |                 | 0                     |     | 0.5 AV <sub>DD5</sub> | V    |
| Input Voltage Hysteresis <sup>b</sup> | Schmitt1              | V <sub>HI1</sub> |                 | 150                   |     |                       | mV   |
|                                       | Schmitt2              | V <sub>HI2</sub> |                 | 150                   |     |                       | mV   |

a) Schmitt1 and Schmitt2 denote the schmitt trigger input characteristics of the device pins.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5}$  ( $\mu\text{PD70F3427}$  only) = 0 V

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-9 Pin Group 5 Low Voltage Operating Range**

| Parameter                             | Pin mode <sup>a</sup> | Symbol    | Test Conditions | Min            | Typ | Max             | Unit |
|---------------------------------------|-----------------------|-----------|-----------------|----------------|-----|-----------------|------|
| Input Voltage High                    | Schmitt1              | $V_{IH1}$ |                 | $0.7 AV_{DD5}$ |     | $AV_{DD5}$      | V    |
|                                       | Schmitt2              | $V_{IH2}$ |                 | $0.8 AV_{DD5}$ |     | $AV_{DD5}$      | V    |
| Input Voltage Low                     | Schmitt1              | $V_{IL1}$ |                 | 0              |     | $0.3 AV_{DD5}$  | V    |
|                                       | Schmitt2              | $V_{IH2}$ |                 | 0              |     | $0.35 AV_{DD5}$ | V    |
| Input Voltage Hysteresis <sup>b</sup> | Schmitt1              | $V_{HI1}$ |                 | 150            |     |                 | mV   |
|                                       | Schmitt2              | $V_{IH2}$ |                 | 150            |     |                 | mV   |

<sup>a)</sup> Schmitt1 and Schmitt2 denote the schmitt trigger input characteristics of the device pins.

<sup>b)</sup> Not tested in production. Specified by design.

## 6.6 Pin Group 3: GPIO and LCD Bus Interface ( $\mu$ PD70F3426A, $\mu$ PD70F3425, $\mu$ PD70F3424, $\mu$ PD70F3423, $\mu$ PD70F3422, $\mu$ PD70F3421)

- Pin Group 3: GPIO and LCD Bus interface supplied by  $DV_{DD5}$   
3: ( P32-33, P86-87, P90-97, P104-107 )

**Note** LCD bus function on these pins is not available in  $\mu$ PD70F3423,  $\mu$ PD70F3422 and  $\mu$ PD70F3421.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 4.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-10 Pin Group 3 Normal Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Pin Group  | Symbol                   | Test Conditions           | Min.              | Typ  | Max.           | Unit |
|---|-----------------------|------------|--------------------------|---------------------------|-------------------|------|----------------|------|
| Input voltage high                        | Schmitt1              | 3          | $V_{IH1}$                |                           | 0.7 $DV_{DD5}$    |      | $DV_{DD5}$     | V    |
|   | Schmitt2              |            | $V_{IH2}$                |                           | 0.8 $DV_{DD5}$    |      | $DV_{DD5}$     | V    |
|   | CMOS1                 |            | $V_{IH3}$                |                           | 0.7 $DV_{DD5}$    |      | $DV_{DD5}$     | V    |
|   | CMOS 2                |            | $V_{IH4}$                |                           | 0.8 $DV_{DD5}$    |      | $DV_{DD5}$     | V    |
| Input voltage low                         | Schmitt1              |            | $V_{IL1}$                |                           | 0                 |      | 0.3 $DV_{DD5}$ | V    |
|   | Schmitt2              |            | $V_{IL2}$                |                           | 0                 |      | 0.4 $DV_{DD5}$ | V    |
|   | CMOS1                 |            | $V_{IL3}$                |                           | 0                 |      | 0.3 $DV_{DD5}$ | V    |
|   | CMOS2                 |            | $V_{IL4}$                |                           | 0                 |      | 0.4 $DV_{DD5}$ | V    |
| Input hysteresis <sup>b</sup>             | Schmitt1              |            | $V_{HY1}$                |                           | 150               |      |                | mV   |
|   | Schmitt2              |            | $V_{HY2}$                |                           | 150               |      |                | mV   |
| Output voltage high                       | Limit1                |            | $V_{OH}$                 | $I_{OH} = -2.0\text{ mA}$ | $DV_{DD5} - 0.45$ |      |                | V    |
|   | Limit2                |            | $V_{OH}$                 | $I_{OH} = -5.0\text{ mA}$ | $DV_{DD5} - 0.45$ |      |                | V    |
| Output voltage low                        | Limit1                | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$ |                           |                   | 0.45 | V              |      |
|   | Limit2                | $V_{OL}$   | $I_{OL} = 5.0\text{ mA}$ |                           |                   | 0.45 | V              |      |
| Maximum output short circuit current high | Limit1                | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$    | -2                        |                   | -12  | mA             |      |
|   | Limit2                | $I_{OHM2}$ |                          | -5                        |                   | -30  | mA             |      |
| Maximum output short circuit current low  | Limit1                | $I_{OLM1}$ | $V_{OL} = DV_{DD5}$      | 2                         |                   | 12   | mA             |      |
|   | Limit2                | $I_{OLM2}$ |                          | 5                         |                   | 30   | mA             |      |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software. CMOS2 and SCHMITT2 are only available on Port P8.

Limit1 and Limit2 denote the two output characteristics with current limit functionality of the device pins. The characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 4.0\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-11 Pin Group 3 Low Voltage Operating Range**

| Parameter                                 | Pin mode <sup>a</sup> | Pin Group  | Symbol                   | Test Conditions           | Min.              | Typ  | Max.            | Unit |
|---|-----------------------|------------|--------------------------|---------------------------|-------------------|------|-----------------|------|
| Input voltage high                        | Schmitt1              | 3          | $V_{IH1}$                |                           | $0.7 DV_{DD5}$    |      | $DV_{DD5}$      | V    |
|   | Schmitt2              |            | $V_{IH2}$                |                           | $0.8 DV_{DD5}$    |      | $DV_{DD5}$      | V    |
|   | CMOS1                 |            | $V_{IH3}$                |                           | $0.7 DV_{DD5}$    |      | $DV_{DD5}$      | V    |
|   | CMOS2                 |            | $V_{IH4}$                |                           | $0.8 DV_{DD5}$    |      | $DV_{DD5}$      | V    |
| Input voltage low                         | Schmitt1              |            | $V_{IL1}$                |                           | 0                 |      | $0.3 DV_{DD5}$  | V    |
|   | Schmitt2              |            | $V_{IL2}$                |                           | 0                 |      | $0.35 DV_{DD5}$ | V    |
|   | CMOS1                 |            | $V_{IL3}$                |                           | 0                 |      | $0.3 DV_{DD5}$  | V    |
|   | CMOS2                 |            | $V_{IL4}$                |                           | 0                 |      | $0.4 DV_{DD5}$  | V    |
| Input hysteresis <sup>b</sup>             | Schmitt1              |            | $V_{HY1}$                |                           | 100               |      |                 | mV   |
|   | Schmitt2              |            | $V_{HY2}$                |                           | 100               |      |                 | mV   |
| Output voltage high                       | Limit1                |            | $V_{OH}$                 | $I_{OH} = -1.0\text{ mA}$ | $DV_{DD5} - 0.45$ |      |                 | V    |
|   | Limit2                |            | $V_{OH}$                 | $I_{OH} = -2.0\text{ mA}$ | $DV_{DD5} - 0.45$ |      |                 | V    |
| Output voltage low                        | Limit1                | $V_{OL}$   | $I_{OL} = 1.0\text{ mA}$ |                           |                   | 0.45 | V               |      |
|   | Limit2                | $V_{OL}$   | $I_{OL} = 2.0\text{ mA}$ |                           |                   | 0.45 | V               |      |
| Maximum output short circuit current high | Limit1                | $I_{OHM1}$ | $V_{OH} = 0\text{ V}$    | -1                        |                   |      | mA              |      |
|   | Limit2                | $I_{OHM2}$ |                          | -2                        |                   |      | mA              |      |
| Maximum output short circuit current low  | Limit1                | $I_{OLM1}$ | $V_{OL} = DV_{DD5}$      | 1                         |                   |      | mA              |      |
|   | Limit2                | $I_{OLM2}$ |                          | 2                         |                   |      | mA              |      |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

Limit1 and Limit2 denote the two output characteristics with current limit functionality of the device pins. The characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Caution** Do not operate buffers of pin group 3 in current limit state, when the LCD function is used. Failing to do so may lead to a decreased accuracy of the LCD waveforms.

## 6.7 Pin Group 3: GPIO and LCD Bus and external Memory Interface ( $\mu$ PD70F3427)

- Pin Group 3: GPIO and LCD Bus interface and external memory interface supplied by  $DV_{DD5}$   
3: ( P32-33, P86-87, P90-97, P104-107, P141-142 )

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$ ,  
 $MV_{SS5} = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-12 Pin Group 3 Normal Operating Range**

| Parameter           | Pin mode <sup>a</sup> | Pin Group | Symbol    | Test Conditions           | Min.              | Typ | Max.           | Unit |
|---------------------|-----------------------|-----------|-----------|---------------------------|-------------------|-----|----------------|------|
| Input voltage high  | CMOS1                 | 3         | $V_{IH3}$ |                           | $0.7 DV_{DD5}$    |     | $DV_{DD5}$     | V    |
| Input voltage low   | CMOS1                 |           | $V_{IL3}$ |                           | 0                 |     | $0.3 DV_{DD5}$ | V    |
| Output voltage high | No Limit              |           | $V_{OH}$  | $I_{OH} = -5.0\text{ mA}$ | $DV_{DD5} - 0.45$ |     |                | V    |
| Output voltage low  | No Limit              |           | $V_{OL}$  | $I_{OL} = 5.0\text{ mA}$  |                   |     | 0.45           | V    |

<sup>a)</sup> CMOS1 denotes the fixed non-schmitt input characteristics of these device pins. This pin group does not support current limitation.



## 6.8 Pin Group 6: External Memory Interface (μPD70F3427)

- Pin Group 6: External Memory Interface supplied by  $MV_{DD5}$   
6: (A0-23, D0-15,  $\overline{CS0-1}$ , CS3-4,  $\overline{WAIT}$ ,  $\overline{RD}$ ,  $\overline{WR}$ ,  $\overline{BE0-1}$ , P140)

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$   
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = 0\text{ V}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-13 Pin Group 3 Normal Operating Range**

| Parameter           | Pin mode <sup>a</sup> | Pin Group | Symbol    | Test Conditions           | Min.              | Typ | Max.           | Unit |
|---------------------|-----------------------|-----------|-----------|---------------------------|-------------------|-----|----------------|------|
| Input voltage high  | CMOS1                 | 6         | $V_{IH6}$ |                           | $0.7 MV_{DD5}$    |     | $MV_{DD5}$     | V    |
| Input voltage low   | CMOS1                 |           | $V_{IL6}$ |                           | 0                 |     | $0.3 MV_{DD5}$ | V    |
| Output voltage high | No Limit              |           | $V_{OH}$  | $I_{OH} = -5.0\text{ mA}$ | $MV_{DD5} - 0.45$ |     |                | V    |
| Output voltage low  | No Limit              |           | $V_{OL}$  | $I_{OL} = 5.0\text{ mA}$  |                   |     | 0.45           | V    |

<sup>a)</sup> CMOS1 denotes the fixed non-schmitt input characteristics of the device pins. This pin group does not support current limitation.

## 6.9 LCD Common and Segment Lines

**Note** The LCD common and segment function is only available in  $\mu$ PD70F3423,  $\mu$ PD70F3422 and  $\mu$ PD70F3421.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = BV_{DD5} = 4.5\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$

- Note**
1. Refer to “Power On Clear” on page 81 for further functional restriction.
  2. The power supply configuration is restricted, when the LCD is used. The LCD voltages are generated centrally. Since the LCD output buffers are supplied by different supplies ( $BV_{DD5}$  and  $DV_{DD5}$ ) it is necessary that  $BV_{DD5}$  is equal to  $DV_{DD5}$ .

**Table 6-14 DC Characteristics LCD Common and Segment Lines**

| Parameter                             | Symbol      | TestConditions   | Min.             | Typ          | Max              | Unit          |
|---------------------------------------|-------------|--|------------------|--------------|------------------|---------------|
| LCD Segment Output Voltage (unloaded) | $V_{ODS}$   | $IO = \pm 1\mu\text{A}$  | $V_{LCDn} - 0.2$ | $V_{LCDn}^a$ | $V_{LCDn} + 0.2$ | V             |
| LCD Common Output Voltage (unloaded)  | $V_{ODC}$   | $IO = \pm 1\mu\text{A}$  | $V_{LCDn} - 0.2$ | $V_{LCDn}$   | $V_{LCDn} + 0.2$ | V             |
| LCD split voltage <sup>b</sup>        | $V_{LC0}$   | $IO = \pm 1.5\text{ mA}$   | $V_{LCD0} - 0.1$ | $V_{LCD0}$   | $V_{LCD0} + 0.1$ | V             |
|                                       | $V_{LC1}$   | $IO = \pm 1.0\text{ mA}$   | $V_{LCD1} - 0.1$ | $V_{LCD1}$   | $V_{LCD1} + 0.1$ | V             |
|                                       | $V_{LC2}$   | $IO = \pm 1.0\text{ mA}$   | $V_{LCD2} - 0.1$ | $V_{LCD2}$   | $V_{LCD2} + 0.1$ | V             |
|                                       | $V_{LC3}$   | $IO = \pm 1.5\text{ mA}$   | $V_{LCD3} - 0.1$ | $V_{LCD3}$   | $V_{LCD3} + 0.1$ | V             |
| LCD Series resistance <sup>c</sup>    | $R_{LCDS}$  | Segment lines,<br>$V_{LCDn}$ to pin  |                  |              | 1.8              | $k\Omega$     |
|                                       | $R_{LCDC}$  | Common lines,<br>$V_{LCDn}$ to pin   |                  |              | 1.8              | $k\Omega$     |
| LCD operation current                 | $IDD_{LCD}$ | Frame frequency 244Hz,<br>all segment and common<br>lines set to LCD mode and<br>open. |                  |              | 280              | $\mu\text{A}$ |

a)  $V_{LCDn}$  ( $n=0..3$ ) represents one of the four possible voltage levels at the LCD pins. See table below for reference.

b) The split voltage is an internal design value. Direct measurement is not possible.

c) The series resistance is an internal design value. Direct measurement is not possible.

**Caution** Do not operate buffers of pin group 3 in current limit state, when the LCD function is used. Failing to do so may lead to a decreased accuracy of the LCD waveforms.

**Table 6-15** Definitions for  $V_{LCD}$ 

| Parameter | Voltage <sup>a</sup>           |
|-----------|--------------------------------|
| VLCD0     | $DV_{DD5}$                     |
| VLCD1     | $2/3 \times DV_{DD5}$          |
| VLCD2     | $1/3 \times DV_{DD5}$          |
| VLCD3     | $0 \times DV_{DD5} = DV_{SS5}$ |

a) The LCD voltage is always derived from one central supply  $DV_{DD5}$ , even when the pin is supplied by a different supply in port or special function mode.

## 6.10 Stepper Motor Driver IO

- Pin Group 4: Stepper Motor outputs supplied by  $SMV_{DD5}$   
 4A: (P110-117, P120-123)  
 4B: (P124-127, P130-137)

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  $SMV_{DD5} = 4.0\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-16 DC Characteristics Stepper Motor Driver Input Normal Voltage Operation**

| Parameter                             | Pin mode <sup>a</sup> | Symbol    | Test Conditions | Min             | Typ | Max             | Unit |
|---------------------------------------|-----------------------|-----------|-----------------|-----------------|-----|-----------------|------|
| Input Voltage High                    | Schmitt1              | $V_{IH1}$ |                 | 0.7 $SMV_{DD5}$ |     | $SMV_{DD5}$     | V    |
|                                       | Schmitt2              | $V_{IH2}$ |                 | 0.8 $SMV_{DD5}$ |     | $SMV_{DD5}$     | V    |
|                                       | CMOS1                 | $V_{IH3}$ |                 | 0.7 $SMV_{DD5}$ |     | $SMV_{DD5}$     | V    |
|                                       | CMOS2                 | $V_{IH4}$ |                 | 0.8 $SMV_{DD5}$ |     | $SMV_{DD5}$     | V    |
| Input Voltage Low                     | Schmitt1              | $V_{IL1}$ |                 | 0               |     | 0.3 $SMV_{DD5}$ | V    |
|                                       | Schmitt2              | $V_{IL2}$ |                 | 0               |     | 0.5 $SMV_{DD5}$ | V    |
|                                       | CMOS1                 | $V_{IL3}$ |                 | 0               |     | 0.3 $SMV_{DD5}$ | V    |
|                                       | CMOS2                 | $V_{IL4}$ |                 | 0               |     | 0.5 $SMV_{DD5}$ | V    |
| Input Voltage Hysteresis <sup>b</sup> | Schmitt1              | $V_{HI1}$ |                 | 150             |     |                 | mV   |
|                                       | Schmitt2              | $V_{HI2}$ |                 | 150             |     |                 | mV   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt trigger and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-17 DC Characteristics Stepper Motor Driver Input Low Voltage Operation**

| Parameter                             | Pin mode <sup>a</sup> | Symbol    | Test Conditions | Min                    | Typ | Max                     | Unit |
|---------------------------------------|-----------------------|-----------|-----------------|------------------------|-----|-------------------------|------|
| Input Voltage High                    | Schmitt1              | $V_{IH1}$ |                 | $0.7\text{ SMV}_{DD5}$ |     | $SMV_{DD5}$             | V    |
|                                       | Schmitt2              | $V_{IH2}$ |                 | $0.8\text{ SMV}_{DD5}$ |     |                         |      |
|                                       | CMOS1                 | $V_{IH3}$ |                 | $0.7\text{ SMV}_{DD5}$ |     |                         |      |
|                                       | CMOS2                 | $V_{IH4}$ |                 | $0.8\text{ SMV}_{DD5}$ |     |                         |      |
| Input Voltage Low                     | Schmitt1              | $V_{IL1}$ |                 | 0                      |     | $0.3\text{ SMV}_{DD5}$  | V    |
|                                       | Schmitt2              | $V_{IL2}$ |                 | 0                      |     | $0.35\text{ SMV}_{DD5}$ | V    |
|                                       | CMOS1                 | $V_{IL3}$ |                 | 0                      |     | $0.3\text{ SMV}_{DD5}$  | V    |
|                                       | CMOS2                 | $V_{IL4}$ |                 | 0                      |     | $0.35\text{ SMV}_{DD5}$ | V    |
| Input Voltage Hysteresis <sup>b</sup> | Schmitt1              | $V_{HI1}$ |                 | 100                    |     |                         | mV   |
|                                       | Schmitt2              | $V_{HI2}$ |                 | 100                    |     |                         | mV   |

a) CMOS1, CMOS2, Schmitt1 and Schmitt2 denote the non-schmitt trigger and the two schmitt trigger input characteristics of the device pins. This characteristic can be selected bitwise by software.

b) Not tested in production. Specified by design.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 4.75\text{ V} \sim 5.25\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2. The stepper output drivers have no current limitation and are not protected regarding short circuit.

**Table 6-18 DC Characteristics Stepper Motor Driver Output Normal Operation**

| Parameter                                  | Pin mode | Symbol      | Test Conditions   | Min               | Typ | Max         | Unit |
|--|----------|-------------|---|-------------------|-----|-------------|------|
| Output Voltage High                        |          | $V_{OH}$    | $I_{OH} = -40\text{ mA}$ ,<br>$T_A = -40^\circ\text{C}$ | $SMV_{DD5} - 0.5$ |     | $SMV_{DD5}$ | V    |
|  |          | $V_{OH}$    | $I_{OH} = -30\text{ mA}$ ,<br>$T_A = +25^\circ\text{C}$ | $SMV_{DD5} - 0.5$ |     | $SMV_{DD5}$ | V    |
|  |          | $V_{OH}$    | $I_{OH} = -27\text{ mA}$ ,<br>$T_A = +85^\circ\text{C}$ | $SMV_{DD5} - 0.5$ |     | $SMV_{DD5}$ | V    |
| Output Voltage Low                         |          | $V_{OL}$    | $I_{OL} = 40\text{ mA}$ ,<br>$T_A = -40^\circ\text{C}$  | 0                 |     | 0.5         | V    |
|  |          | $V_{OL}$    | $I_{OL} = 30\text{ mA}$ ,<br>$T_A = +25^\circ\text{C}$  | 0                 |     | 0.5         | V    |
|  |          | $V_{OL}$    | $I_{OL} = 27\text{ mA}$ ,<br>$T_A = +85^\circ\text{C}$  | 0                 |     | 0.5         | V    |
| Output voltage deviation <sup>a</sup>      |          | $V_{DEV}$   |   | 0                 |     | 50          | mV   |
| Output Slew rate <sup>b</sup>              |          | $t_{RF}$    | 10% - 90%   | 12                | 25  | 70          | ns   |
| Peak Cross Current <sup>c</sup>            |          | $I_{CROSS}$ |   |                   |     | 50          | mA   |
| Output Pulse width <sup>d</sup>            |          | $t_{MO}$    |   | 125               |     |             | ns   |
| Output Pulse length deviation <sup>e</sup> |          | $t_{SMDEV}$ |   | -10               | +5  | +45         | ns   |

- a) Output voltage deviation defines the difference of the outputs levels of the same stepper motor.  
 $V_{DEV} = \max(|V_{OHx} - V_{OHy}|, |V_{OLx} - V_{OLy}|) @ I_{OHx} = I_{OHy}, I_{OLx} = I_{OLy}$ .  
 x and y denote any combination of two pins of the following pin groups: (P110-P113, P114-117, P120-123, P124-P127, P130-P133, P134-P137)  
 The output voltage deviation is not tested, but specified by design.
- b) The slew rate is not tested, but derived from simulation.
- c) The slew rate control generates a cross current in the output stage to control the energy of the external inductive load. The cross current flows only during the output transition time  $t_{RF}$ . It flows in addition to the output current. The cross current is not tested, but derived from simulation.
- d) The output buffer can not generate high or low pulses shorter than this time, because of its slew rate control system. This value is not tested, but derived from simulation.
- e) The slew rate control function causes a deviation of output pulse time compared to the ideal selected output pulse setting. This value is not tested, but derived from simulation.

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 4.75\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-19 DC Characteristics Stepper Motor Driver Output Low Voltage Operation**

| Parameter           | Pin mode | Symbol   | Test Conditions           | Min               | Typ | Max         | Unit |
|---------------------|----------|----------|---------------------------|-------------------|-----|-------------|------|
| Output Voltage High |          | $V_{OH}$ | $I_{OH} = -5\text{ mA}$ , | $SMV_{DD5} - 0.5$ |     | $SMV_{DD5}$ | V    |
| Output Voltage Low  |          | $V_{OL}$ | $I_{OL} = +5\text{ mA}$ , | 0                 |     | 0.5         | V    |

- Pin Group 7: All pins supplied with Zero Point detection function  
This group is a subset of group 4  
7: (P113, P117, P120-127, P133, P137)

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 4.0\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-20 DC Characteristics Stepper Motor Driver Zeropoint Detection**

| Parameter         | Symbol     | Test Conditions               | Min                                  | Typ | Max                                  | Unit |
|-------------------|------------|-------------------------------|--------------------------------------|-----|--------------------------------------|------|
| Threshold voltage | $V_{IL1}$  |                               | $1/9\text{ SMV}_{DD5} - 70\text{mV}$ |     | $1/9\text{ SMV}_{DD5} + 70\text{mV}$ | V    |
| Detection delay   | $t_{zPDD}$ | 100mV Step,<br>50mV overdrive |                                      |     | 100 <sup>a</sup>                     | ns   |

<sup>a)</sup> Not tested in production. Specified by design.



## 6.11 Current Limit Function of I/O buffers

The output buffers of following pin groups incorporate a current limiting function:

- $\mu$ PD70F3426A,  $\mu$ PD70F3425,  $\mu$ PD70F3424,  $\mu$ PD70F3423,  $\mu$ PD70F3422,  $\mu$ PD70F3421:  
pin groups 1, 3 and P07 of pin group 2
- $\mu$ PD70F3427: pin group 1 and P07 of pin group 2

This function limits the output current of the buffer to a certain value during output signal switching.

The limit is disabled when the buffer output voltage is near to its target voltage, thus providing full drivability. During full drivability the current may reach values given in absolute maximum ratings for a single pin.

The user can select different limit ranges by software (refer to User's Manual for details).

The limit function is independent from the operation mode of the device.

A permanent short circuit of these outputs is not permitted.

The stepper motor driver outputs do not support a current limiting function.

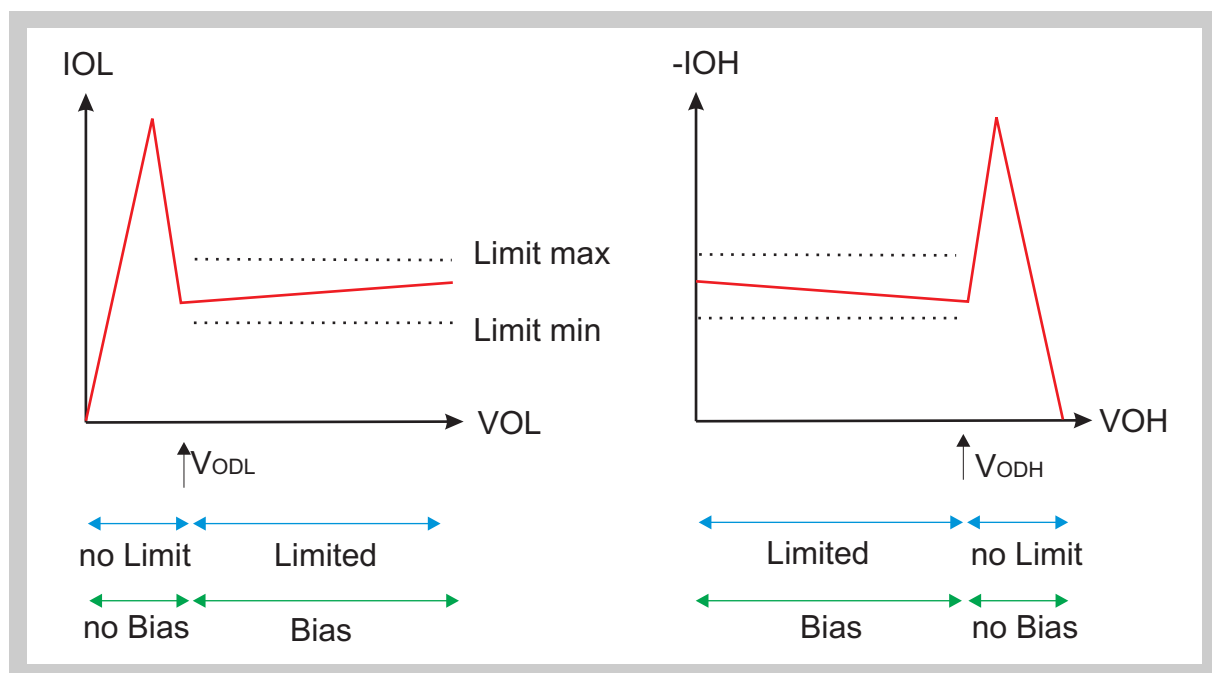


Figure 6-1 Current Limit Function Principle

**Note** The current limit function of the I/O buffers needs additional bias current to control the output stage. The additional bias current depend on the status of each buffer. Each buffer with either high or low output and in the stage of current limiting will draw this bias current.

**Table 6-21 Buffer status for bias current**

| Intended Output | Current limit | additional current |
|-----------------|---------------|--------------------|
| L               | No            | No                 |
| L               | Yes           | Yes                |
| H               | No            | No                 |
| H               | Yes           | Yes                |

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

- Note**
1. Refer to “Power On Clear” on page 81 for further functional restriction.
  2. The function of the current limiting operation is sensitive against inductive loads under a certain condition:
    - The load of the pin is below the selected current limit and the device could reach a sufficient output voltage. The device changed to full drivability.
    - The external circuitry sinks/sources more and more current.
    - The current creates an increasing voltage drop in the output stage of the device.
    - The increasing voltage drop enables the current limiting function.
    - The enabling of the current limit together with an external inductance may lead to an oscillation of the output between the limited and unlimited state. The external inductance creates voltage peaks that change the state of the output buffers current limiting function.
    - Recommendation: keep external inductance small (keep external wiring short).
  3. The pin group 3 of the derivative  $\mu\text{PD70F3427}$  does not include a current limit function.

**Table 6-22 DC Characteristics of Current Limiting Function <sup>a</sup>**

| Parameter   | Pin mode | Symbol      | Test Conditions | Min               | Typ | Max             | Unit |
|---|----------|-------------|-----------------|-------------------|-----|-----------------|------|
| Limit disable threshold voltage for $V_{OH}$                  |          | $V_{ODH}$   |                 | $V_{DDx}^b - 1.6$ |     | $V_{DDx} - 1.1$ | V    |
| Limit disable threshold voltage for $V_{OL}$                  |          | $V_{ODL}$   |                 | 1.1               |     | 1.6             | V    |
| Supply Current per buffer for current limitation <sup>c</sup> | Limit1   | $I_{DDCL1}$ |                 |                   |     | 0.8             | mA   |
|   | Limit2   | $I_{DDCL2}$ |                 |                   |     | 1.7             | mA   |

a) These values are not tested. They are given based on design simulation.

b)  $V_{DDx}$  denotes the corresponding voltage supply of the pin.

c) This current need not be considered during absolute maximum current calculation.

## 6.12 Supply Current

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 6-23 DC Characteristics Supply Current  $\mu\text{PD70F3426A}^a$**

| Parameter      | Symbol     | Test Conditions  | Min | Typ | Max | Unit |
|----------------|------------|--|-----|-----|-----|------|
| Supply current | $I_{DD10}$ | Operating<br>( $f_{\text{CPU}} = 64\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 100 | 130 | mA   |
|                | $I_{DD11}$ | Operating<br>( $f_{\text{CPU}} = 48\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 77  | 100 | mA   |
|                | $I_{DD12}$ | Operating<br>( $f_{\text{CPU}} = 32\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 57  | 75  | mA   |
|                | $I_{DD13}$ | Operating<br>( $f_{\text{CPU}} = 24\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 46  | 60  | mA   |
|                | $I_{DD13}$ | Operating<br>( $f_{\text{CPU}} = 16\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 35  | 45  | mA   |
|                | $I_{DD13}$ | Operating<br>( $f_{\text{CPU}} = 8\text{ MHz}$ ;<br>SSCG,PLL: on)    |     | 24  | 30  | mA   |
|                | $I_{DD14}$ | Operating<br>( $f_{\text{CPU}} = 4\text{ MHz}$ ;<br>SSCG,PLL: off)   |     | 15  | 19  | mA   |
|                | $I_{DD15}$ | Operating<br>( $f_{\text{CPU}} = 32\text{ kHz}$ ;<br>SSCG,PLL: off)  |     | 1   | 1.3 | mA   |
|                | $I_{DD16}$ | Operating<br>( $f_{\text{CPU}} = \text{RingOSC}$ ;<br>SSCG,PLL: off) |     | 8.1 | 11  | mA   |
|                | $I_{DD20}$ | HALT Mode<br>( $f_{\text{PLL}} = 64\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 48  | 65  | mA   |
|                | $I_{DD21}$ | HALT Mode<br>( $f_{\text{PLL}} = 48\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 39  | 50  | mA   |
|                | $I_{DD30}$ | IDLE Mode<br>( $f_{\text{PLL}} = 64\text{ MHz}$ ;<br>SSCG,PLL: on)   |     | 5   | 7   | mA   |

**Table 6-23 DC Characteristics Supply Current  $\mu$ PD70F3426A <sup>a</sup> (Continued)**

| Parameter      | Symbol     | Test Conditions                                     | Min | Typ | Max | Unit    |
|----------------|------------|---|-----|-----|-----|---------|
| Supply current | $I_{DD31}$ | IDLE Mode<br>( $f_{PLL} = 48$ MHz;<br>SSCG,PLL: on) |     | 5   | 7   | mA      |
|                | $I_{DD5}$  | STOP  |     | 10  | 190 | $\mu$ A |
|                | $I_{DD6}$  | WATCH   |     | 190 | 390 | $\mu$ A |
|                | $I_{DD6A}$ | WATCH Monitored                                     |     | 205 | 430 | $\mu$ A |
|                | $I_{DD7}$  | SUB WATCH   |     | 50  | 200 | $\mu$ A |
|                | $I_{DD7A}$ | SUB WATCH Monitored                                 |     | 65  | 215 | $\mu$ A |
|                | $I_{DD7B}$ | SUB WATCH on Ring-Osc                               |     | 65  | 215 | $\mu$ A |

a) These values are target values without current consumption due to external circuitry at the IO-pins.

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**Caution** Valid for all devices:  
 In case any flash-self-programming library function is executed during any operating condition mentioned above the current consumption of the concerned operating condition may increase.  
 The additional current consumption that may arise during the execution of any flash-self-programming library function is specified in the table below.

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**Table 6-24 Additional Supply Current (Operating) during Self-Flash-Programming**

| Parameter                 | Symbol     | Test Conditions | Min | Typ | Max | Unit |
|---------------------------|------------|-----------------|-----|-----|-----|------|
| Additional supply current | $I_{DD1x}$ | Any Operating   |     | 1   | 3   | mA   |

Table 6-25 DC Characteristics Supply Current  $\mu$ PD70F3427<sup>a</sup>

| Parameter      | Symbol                | Test Conditions   | Min | Typ | Max | Unit    |         |
|----------------|-----------------------|---|-----|-----|-----|---------|---------|
| Supply current | $I_{DD10}$            | Operating<br>( $f_{CPU} = 64$ MHz;<br>SSCG,PLL: on)           |     | 82  | 123 | mA      |         |
|                | $I_{DD11}$            | Operating<br>( $f_{CPU} = 48$ MHz;<br>SSCG,PLL: on)           |     | 65  | 98  | mA      |         |
|                | $I_{DD12}$            | Operating<br>( $f_{CPU} = 32$ MHz;<br>SSCG,PLL: on)           |     | 48  | 72  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 24$ MHz;<br>SSCG,PLL: on)           |     | 40  | 60  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 16$ MHz;<br>SSCG,PLL: on)           |     | 32  | 36  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 8$ MHz;<br>SSCG,PLL: on)            |     | 24  | 36  | mA      |         |
|                | $I_{DD14}$            | Operating<br>( $f_{CPU} = 4$ MHz;<br>SSCG,PLL: off)           |     | 10  | 15  | mA      |         |
|                | $I_{DD15}$            | Operating<br>( $f_{CPU} = 32$ kHz;<br>SSCG,PLL: off)          |     | 0.2 | 1.2 | mA      |         |
|                | $I_{DD16}$            | Operating<br>( $f_{CPU} = \text{RingOSC}$ ;<br>SSCG,PLL: off) |     | 3.3 | 6   | mA      |         |
|                | $I_{DD20}$            | HALT Mode<br>( $f_{PLL} = 64$ MHz;<br>SSCG,PLL: on)           |     | 40  | 60  | mA      |         |
|                | $I_{DD21}$            | HALT Mode<br>( $f_{PLL} = 48$ MHz;<br>SSCG,PLL: on)           |     | 32  | 48  | mA      |         |
|                | $I_{DD30}$            | IDLE Mode<br>( $f_{PLL} = 64$ MHz;<br>SSCG,PLL: on)           |     | 6   | 9   | mA      |         |
|                | $I_{DD31}$            | IDLE Mode<br>( $f_{PLL} = 48$ MHz;<br>SSCG,PLL: on)           |     | 5   | 7   | mA      |         |
|                | $I_{DD5}$             | STOP  |     |     | 10  | 190     | $\mu$ A |
|                | $I_{DD6}$             | WATCH   |     |     | 150 | 350     | $\mu$ A |
|                | $I_{DD6A}$            | WATCH Monitored   |     |     | 165 | 390     | $\mu$ A |
|                | $I_{DD7}$             | SUB WATCH   |     |     | 50  | 200     | $\mu$ A |
|                | $I_{DD7A}$            | SUB WATCH Monitored   |     |     | 65  | 215     | $\mu$ A |
| $I_{DD7B}$     | SUB WATCH on Ring-OSC |   |     | 65  | 215 | $\mu$ A |         |

<sup>a)</sup> These values are target values without current consumption due to external circuitry at the IO-pins.

Table 6-26 DC Characteristics Supply Current  $\mu$ PD70F3425,  $\mu$ PD70F3424 <sup>a</sup>

| Parameter      | Symbol                | Test Conditions   | Min | Typ | Max | Unit    |         |
|----------------|-----------------------|---|-----|-----|-----|---------|---------|
| Supply current | $I_{DD10}$            | Operating<br>( $f_{CPU} = 64\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 82  | 123 | mA      |         |
|                | $I_{DD11}$            | Operating<br>( $f_{CPU} = 48\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 65  | 98  | mA      |         |
|                | $I_{DD12}$            | Operating<br>( $f_{CPU} = 32\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 48  | 72  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 24\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 40  | 60  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 16\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 32  | 48  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 8\text{MHz}$ ;<br>SSCG,PLL: on)     |     | 24  | 36  | mA      |         |
|                | $I_{DD14}$            | Operating<br>( $f_{CPU} = 4\text{MHz}$ ;<br>SSCG,PLL: off)    |     | 10  | 15  | mA      |         |
|                | $I_{DD15}$            | Operating<br>( $f_{CPU} = 32\text{kHz}$ ;<br>SSCG,PLL: off)   |     | 0.2 | 1.2 | mA      |         |
|                | $I_{DD16}$            | Operating<br>( $f_{CPU} = \text{RingOSC}$ ;<br>SSCG,PLL: off) |     | 3.3 | 6   | mA      |         |
|                | $I_{DD20}$            | HALT Mode<br>( $f_{PLL} = 64\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 40  | 60  | mA      |         |
|                | $I_{DD21}$            | HALT Mode<br>( $f_{PLL} = 48\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 32  | 48  | mA      |         |
|                | $I_{DD30}$            | IDLE Mode<br>( $f_{PLL} = 64\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 6   | 9   | mA      |         |
|                | $I_{DD31}$            | IDLE Mode<br>( $f_{PLL} = 48\text{MHz}$ ;<br>SSCG,PLL: on)    |     | 5   | 7.5 | mA      |         |
|                | $I_{DD5}$             | STOP  |     |     | 10  | 190     | $\mu$ A |
|                | $I_{DD6}$             | WATCH   |     |     | 150 | 350     | $\mu$ A |
|                | $I_{DD6A}$            | WATCH Monitored   |     |     | 165 | 390     | $\mu$ A |
|                | $I_{DD7}$             | SUB WATCH   |     |     | 50  | 200     | $\mu$ A |
|                | $I_{DD7A}$            | SUB WATCH Monitored   |     |     | 65  | 215     | $\mu$ A |
| $I_{DD7B}$     | SUB WATCH on Ring-OSC |   |     | 65  | 215 | $\mu$ A |         |

<sup>a)</sup> These values are target values without current consumption due to external circuitry at the IO-pins.

**Table 6-27 DC Characteristics Supply Current  $\mu$ PD70F3423,  $\mu$ PD70F3422,  $\mu$ PD70F3421<sup>a</sup>**

| Parameter      | Symbol                | Test Conditions  | Min | Typ | Max | Unit    |         |
|----------------|-----------------------|--|-----|-----|-----|---------|---------|
| Supply current | $I_{DD12}$            | Operating<br>( $f_{CPU} = 32$ MHz;<br>SSCG,PLL: on)                    |     | 48  | 72  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 24$ MHz;<br>SSCG,PLL: on)                    |     | 40  | 60  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 16$ MHz;<br>SSCG,PLL: on)                    |     | 32  | 48  | mA      |         |
|                | $I_{DD13}$            | Operating<br>( $f_{CPU} = 8$ MHz;<br>SSCG,PLL: on)                     |     | 24  | 36  | mA      |         |
|                | $I_{DD14}$            | Operating<br>( $f_{CPU} = 4$ MHz;<br>SSCG,PLL: off)                    |     | 10  | 15  | mA      |         |
|                | $I_{DD15}$            | Operating<br>( $f_{CPU} = 32$ kHz;<br>SSCG,PLL: off)                   |     | 0.2 | 1.2 | mA      |         |
|                | $I_{DD16}$            | Operating<br>( $f_{CPU} = \text{RingOSC} = 300$<br>kHz; SSCG,PLL: off) |     | 3.3 | 6   | mA      |         |
|                | $I_{DD20}$            | HALT Mode<br>( $f_{PLL} = 32$ MHz;<br>SSCG,PLL: on)                    |     | 24  | 36  | mA      |         |
|                | $I_{DD20}$            | HALT Mode<br>( $f_{PLL} = 24$ MHz;<br>SSCG,PLL: on)                    |     | 20  | 30  | mA      |         |
|                | $I_{DD21}$            | HALT Mode<br>( $f_{PLL} = 16$ MHz;<br>SSCG,PLL: on)                    |     | 16  | 24  | mA      |         |
|                | $I_{DD30}$            | IDLE Mode<br>( $f_{PLL} = 32$ MHz;<br>SSCG,PLL: on)                    |     | 3.8 | 5.7 | mA      |         |
|                | $I_{DD30}$            | IDLE Mode<br>( $f_{PLL} = 24$ MHz;<br>SSCG,PLL: on)                    |     | 3.5 | 5.3 | mA      |         |
|                | $I_{DD31}$            | IDLE Mode<br>( $f_{PLL} = 16$ MHz;<br>SSCG,PLL: on)                    |     | 3.2 | 4.8 | mA      |         |
|                | $I_{DD5}$             | STOP   |     |     | 10  | 190     | $\mu$ A |
|                | $I_{DD6}$             | WATCH  |     |     | 150 | 350     | $\mu$ A |
|                | $I_{DD6A}$            | WATCH Monitored  |     |     | 165 | 390     | $\mu$ A |
|                | $I_{DD7}$             | SUB WATCH  |     |     | 50  | 200     | $\mu$ A |
|                | $I_{DD7A}$            | SUB WATCH Monitored  |     |     | 65  | 215     | $\mu$ A |
| $I_{DD7B}$     | SUB WATCH on Ring-OSC |  |     | 65  | 215 | $\mu$ A |         |

<sup>a)</sup> These values are target values without current consumption due to external circuitry at the IO-pins.

**Note** The low current modes (STOP, WATCH, SUB WATCH) are tested under the following conditions:

- Operation modes setting as described in table below.
- All functional pins with output possibility are set to output with alternating high and low output levels.
- Testequipment is disconnected from output pins.
- $I_{DD}$  is the total sum of currents to the device supply pins  $V_{DD5}$ ,  $BV_{DD5}$ ,  $DV_{DD5}$ ,  $SMV_{DD5}$ ,  $AV_{DD}$
- Device drives its own leakage currents by its output stages.
- The leakage current is included in the given  $I_{DD}$  values.

**Table 6-28 Operational Conditions for Measurement**

| Unit                   | Watch                 | Watch monitored       | Sub Watch | Sub Watch on Ring-OSC | Sub Watch monitored | STOP     |
|------------------------|-----------------------|-----------------------|-----------|-----------------------|---------------------|----------|
| Main-oscillator        | running               | running               | stopped   | stopped               | stopped             | stopped  |
| Sub-oscillator         | stopped (XT1 clamped) | stopped (XT1 clamped) | running   | stopped (XT1 clamped) | running             | stopped  |
| Ring-oscillator        | stopped               | running               | stopped   | running               | running             | stopped  |
| SSCG                   | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| PLL                    | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| CPU system             | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| IICCLK                 | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| PCLK0, PCLK1           | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| PCLK2...PCLK15         | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| SPCLK0, SPCLK1         | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| SPCLK2...SPCLK15       | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| FOUT                   | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| WTCLK                  | running               | running               | running   | running               | running             | stopped  |
| WDTCLK                 | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| TM0CLK                 | stopped               | stopped               | stopped   | stopped               | stopped             | stopped  |
| LCD                    | disabled              | disabled              | disabled  | disabled              | disabled            | disabled |
| ADC                    | disabled              | disabled              | disabled  | disabled              | disabled            | disabled |
| VCOMP                  | disabled              | disabled              | disabled  | disabled              | disabled            | disabled |
| Regulator <sup>a</sup> | Standby               | Standby               | Standby   | Standby               | Standby             | Standby  |

a) Regulator in standby: STBCTL = 0x03



## Chapter 7 AC Characteristics

### 7.1 AC Test Input/Output Waveform

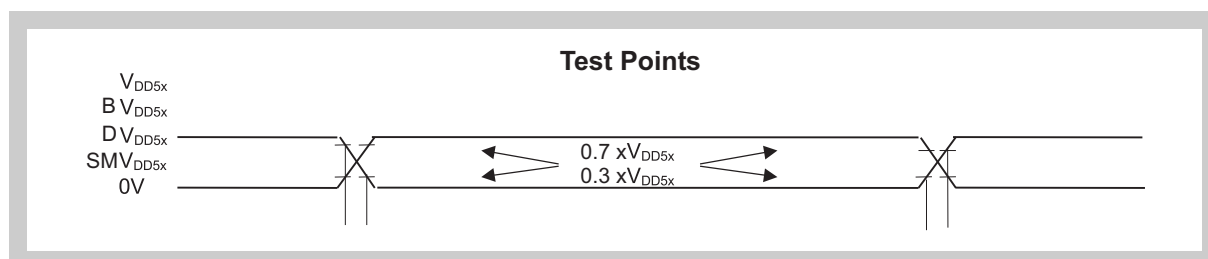


Figure 7-1 AC Test Input/Output Waveform

### 7.2 AC Test Load Condition

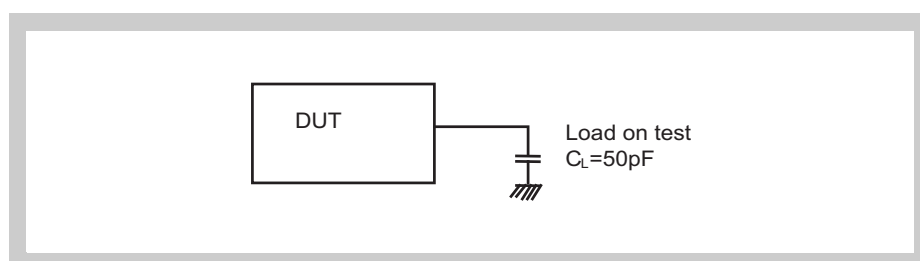


Figure 7-2 AC Test Load Condition

## 7.3 Reset

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

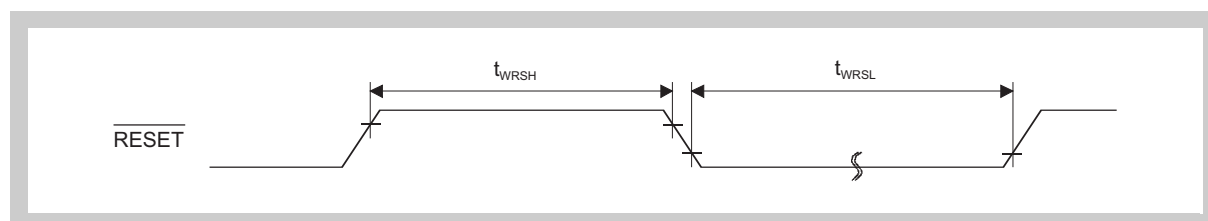
**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 7-1 Reset AC Characteristics**

| Parameter   | Symbol            | Test Conditions | MIN. | MAX. | Unit |
|---|-------------------|-----------------|------|------|------|
| $\overline{\text{RESET}}$ high-level width <sup>a</sup> | $t_{\text{WRSH}}$ |                 | 500  |      | ns   |
| $\overline{\text{RESET}}$ low-level width <sup>b</sup>  | $t_{\text{WRSL}}$ |                 | 500  |      | ns   |
| $\overline{\text{RESET}}$ Pulse rejection <sup>c</sup>  | $t_{\text{WRRJ}}$ |                 | 50   |      | ns   |

- a) This signal high time is needed to ensure that the internal  $\overline{\text{RESET}}$  release operation starts.  
 b) This signal low time is needed to ensure that the internal  $\overline{\text{RESET}}$  is activated.  
 c) The  $\overline{\text{RESET}}$  input incorporates an analog filter. Pulses shorter than this minimum will be ignored. Not tested in production.

**Note** Reset pulses shorter than the given value may not be recognized by the device, they do not cause undefined states of the device.



**Figure 7-3 Reset Timing**

## 7.4 Interrupt Timing

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

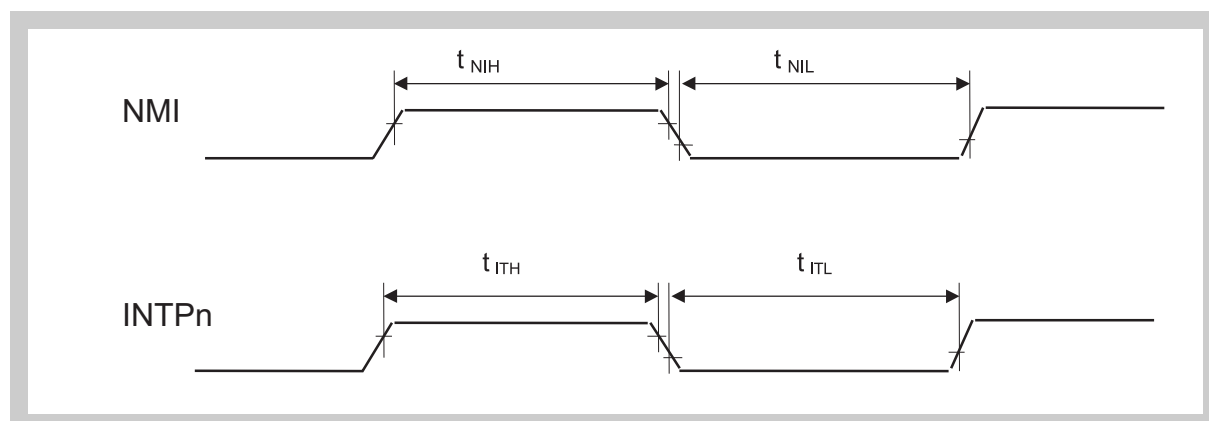
**Table 7-2 Interrupt AC Characteristics**

| Parameter  | Symbol     | Test Conditions | Min | Typ | Max | Unit |
|--|------------|-----------------|-----|-----|-----|------|
| NMI high-level width <sup>a</sup>                | $t_{NIH}$  |                 | 360 |     |     | ns   |
| NMI low-level width <sup>a</sup>                 | $t_{NIL}$  |                 | 360 |     |     | ns   |
| NMI pulse rejection <sup>b</sup>                 | $t_{NIRJ}$ |                 | 50  |     | 360 | ns   |
| INTPn <sup>c</sup> high-level width <sup>a</sup> | $t_{ITH}$  |                 | 360 |     |     | ns   |
| INTPn <sup>c</sup> low-level width <sup>a</sup>  | $t_{ITL}$  |                 | 360 |     |     | ns   |
| INTPn <sup>c</sup> pulse rejection <sup>b</sup>  | $t_{ITRJ}$ |                 | 50  |     | 360 | ns   |

a) Pulses longer than this value will pass the input filter.

b) Pulses shorter than this value do not pass the input filters. not tested in production.

c)  $n = 0$  to 7



**Figure 7-4 Interrupt Timing**

**Note** Interrupt timing is generated by analog delay elements. Delay characteristics have a wide range in production.

## 7.5 Peripheral Function Characteristics

The following conditions are valid for all peripheral function characteristics unless otherwise noted.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to "Power On Clear" on page 81 for further functional restriction.

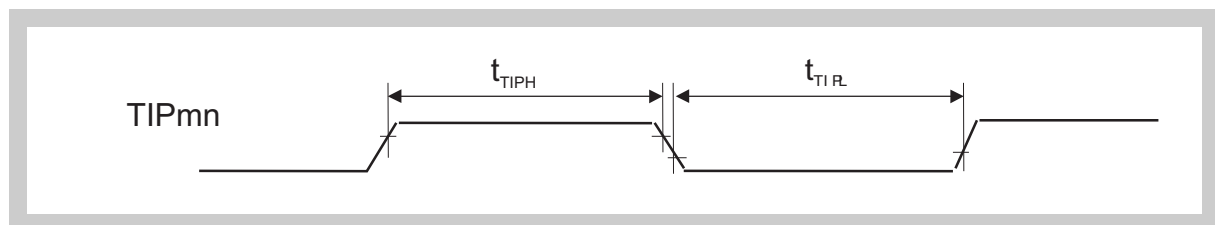
### 7.5.1 Timer P

**Table 7-3 Timer P AC Characteristics**

| Parameter                           | Symbol       | Test Conditions                         | Min                             | Typ | Max | Unit |
|-------------------------------------|--------------|---|---------------------------------|-----|-----|------|
| TIPmn <sup>a</sup> high-level width | $t_{TIPHD}$  | Digital filter                          | $45 + 3/f_{PCLK0}$ <sup>b</sup> |     |     | ns   |
|                                     | $t_{TIPHNB}$ | No digital filter, react on both edge   | $45 + 2/f_{PCLK0}$              |     |     | ns   |
|                                     | $t_{TIPHNS}$ | No digital filter, react on single edge | $45 + 1/f_{PCLK0}$              |     |     | ns   |
| TIPmn <sup>a</sup> low-level width  | $t_{TIPL}$   | Digital filter                          | $45 + 3/f_{PCLK0}$              |     |     | ns   |
|                                     | $t_{TIPLNB}$ | No digital filter, react on both edge   | $45 + 2/f_{PCLK0}$              |     |     | ns   |
|                                     | $t_{TIPLNS}$ | No digital filter, react on single edge | $45 + 1/f_{PCLK0}$              |     |     | ns   |

a)  $m = 3 \dots 0$ ,  $n = 1 \dots 0$

b)  $f_{PCLK0}$  is the clock frequency of the digital filter connected to the input pin.



**Figure 7-5 Timer P Input Timing**

## 7.5.2 Timer G

**Table 7-4 Timer G Input Characteristics**

| Parameter                           | Symbol             | Test Conditions   | Min                       | Typ | Max | Unit |
|-------------------------------------|--------------------|---|---------------------------|-----|-----|------|
| TIGmn <sup>a</sup> high-level width | t <sub>TIGH1</sub> | Digital filter,<br>f <sub>PCLK0</sub> <sup>b</sup> = f <sub>CCLK</sub> <sup>c</sup> | 45 + 3/f <sub>PCLK0</sub> |     |     | ns   |
|                                     | t <sub>TIGH2</sub> | Digital filter,<br>f <sub>PCLK0</sub> > f <sub>CCLK</sub>                           | 45 + 2/f <sub>CCLK</sub>  |     |     | ns   |
|                                     | t <sub>TIGH0</sub> | No digital filter   | 45 + 2/f <sub>CCLK</sub>  |     |     | ns   |
| TIGmn <sup>a</sup> low-level width  | t <sub>TIGL1</sub> | Digital filter,<br>f <sub>PCLK0</sub> = f <sub>CCLK</sub>                           | 45 + 3/f <sub>PCLK0</sub> |     |     | ns   |
|                                     | t <sub>TIGL2</sub> | Digital filter,<br>f <sub>PCLK0</sub> > f <sub>CCLK</sub>                           | 45 + 2/f <sub>CCLK</sub>  |     |     | ns   |
|                                     | t <sub>TIGL0</sub> | No digital filter   | 45 + 2/f <sub>CCLK</sub>  |     |     | ns   |

a) m = 0...1: n = 1...4; m = 2: n = 0...5

b) f<sub>SPCLK0</sub> is the clock frequency of the digital filter connected to the input pin.

c) f<sub>CCLK</sub> is the count clock frequency of the Timer G.

## 7.5.3 UARTA

**Table 7-5 UARTA AC Characteristics**

| Parameter     | Symbol             | Test Conditions | Min | Max  | Unit |
|---------------|--------------------|-----------------|-----|------|------|
| Transfer rate | T <sub>UARTA</sub> |                 | 0.3 | 1000 | Kbps |

## 7.5.4 CAN

**Table 7-6 CAN AC Characteristics**

| Parameter     | Symbol            | Test Conditions                       | Min | Max | Unit |
|---------------|-------------------|---------------------------------------|-----|-----|------|
| Transfer rate | T <sub>FCAN</sub> | f <sub>CAN</sub> <sup>a</sup> ≥ 8 MHz |     | 1   | Mbps |

a) f<sub>CAN</sub> is the CAN macro clock frequency. For CAN clock selection refer to User's Manual of the CAN.

## 7.5.5 CSIB (High Voltage Operation)

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 4.5\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 4.5\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 3.6\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2.  $n = 0$  to 2

### (1) CSIB Master Mode

#### (a) With Digital Filter

**Table 7-7 CSIB Master Mode AC Characteristics with Digital Filter**

| Parameter   | Symbol            | Test Conditions | MIN.                                 | MAX. | Unit |
|---|-------------------|-----------------|--------------------------------------|------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | $8/f_{\text{PCLK0}}$                 |      | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$           |      | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$           |      | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | $50 + 4/f_{\text{PCLK0}}^{\text{a}}$ |      | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | $-31 - 4/f_{\text{PCLK0}}$           |      | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                                      | 6    | ns   |

a)  $f_{\text{PCLK0}}$  is the clock frequency of the digital filter connected to the input pin.

#### (b) Without Digital Filter

**Table 7-8 CSIB Master Mode AC Characteristics without Digital Filter**

| Parameter   | Symbol            | Test Conditions | MIN.                       | MAX. | Unit |
|---|-------------------|-----------------|----------------------------|------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | 125                        |      | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$ |      | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$ |      | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | 50                         |      | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | -31                        |      | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                            | 6    | ns   |

**(2) CSIB Slave Mode****(a) With Digital Filter****Table 7-9 CSIB Slave Mode AC Characteristics with Digital Filter**

| Parameter   | Symbol            | Test Conditions | Min                                  | Max                       | Unit |
|---|-------------------|-----------------|--------------------------------------|---------------------------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | $8/f_{\text{PCLK0}}$                 |                           | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $4/f_{\text{PCLK0}} - 5$             |                           | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $4/f_{\text{PCLK0}} - 5$             |                           | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | $15 + 2/f_{\text{PCLK0}}^{\text{a}}$ |                           | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | $5 + 2/f_{\text{PCLK0}}$             |                           | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                                      | $45 + 3/f_{\text{PCLK0}}$ | ns   |

a)  $f_{\text{PCLK0}}$  is the clock frequency of the digital filter connected to the input pin.

**(b) Without Digital Filter****Table 7-10 CSIB Slave Mode AC Characteristics without Digital Filter**

| Parameter   | Symbol            | Test Conditions | Min | Max | Unit |
|---|-------------------|-----------------|-----|-----|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | 125 |     | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | 50  |     | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | 50  |     | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | 15  |     | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | 5   |     | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |     | 45  | ns   |

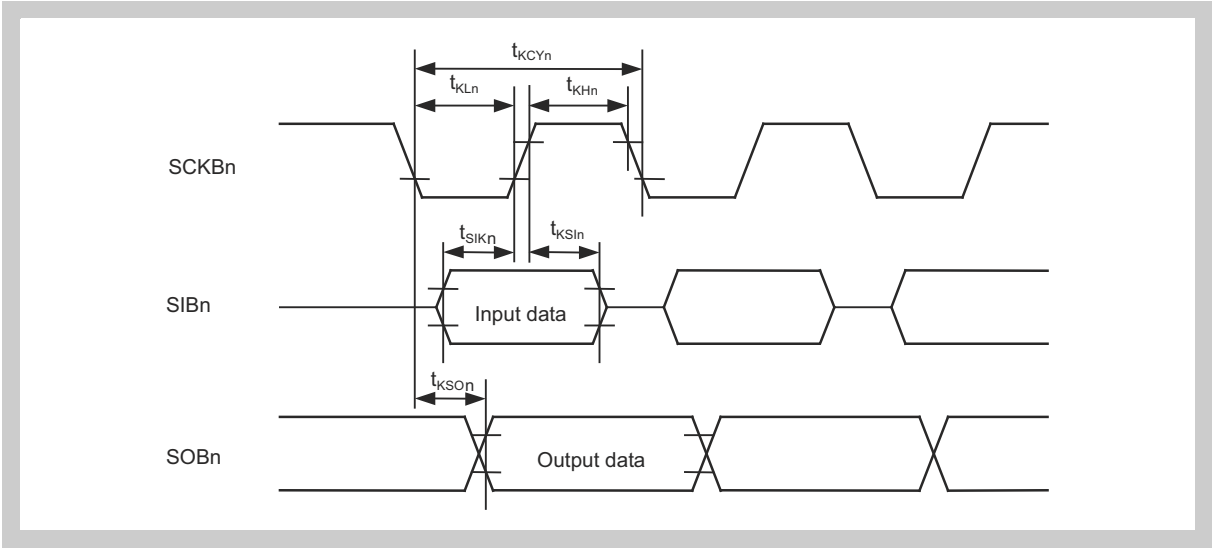


Figure 7-6 CSI Master/Slave Mode Timing

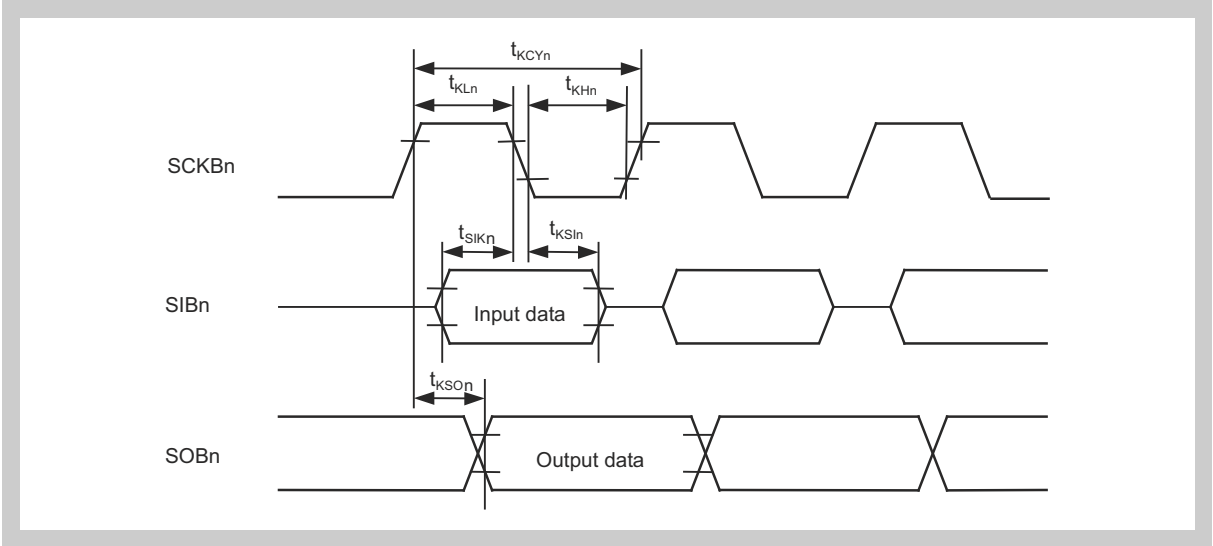


Figure 7-7 CSI Master/Slave Mode Timing Inverted Clock



## 7.5.6 CSIB (Low Voltage Operation)

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 4.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 4.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 3.6\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2.  $n = 0$  to 2

### (1) CSIB Master Mode

#### (a) With Digital Filter

**Table 7-11 CSIB Master Mode AC Characteristics with Digital Filter**

| Parameter   | Symbol            | Test Conditions | MIN.                                 | MAX. | Unit |
|---|-------------------|-----------------|--------------------------------------|------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | $8/f_{\text{PCLK0}}$                 |      | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$           |      | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $0.5 t_{\text{KCY1}} - 15$           |      | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | $93 + 4/f_{\text{PCLK0}}^{\text{a}}$ |      | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | $-49 - 4/f_{\text{PCLK0}}$           |      | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                                      | 45   | ns   |

a)  $f_{\text{PCLK0}}$  is the clock frequency of the digital filter connected to the input pin.

#### (b) Without Digital Filter

**Table 7-12 CSIB Master Mode AC Characteristics without Digital Filter**

| Parameter   | Symbol            | Test Conditions | MIN.                       | MAX. | Unit |
|---|-------------------|-----------------|----------------------------|------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | 125                        |      | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $0.5 t_{\text{KCY1}} - 80$ |      | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $0.5 t_{\text{KCY1}} - 80$ |      | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | 93                         |      | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | -49                        |      | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                            | 45   | ns   |

**(2) CSIB Slave Mode****(a) With Digital Filter****Table 7-13 CSIB Slave Mode AC Characteristics with Digital Filter**

| Parameter   | Symbol            | Test Conditions | Min                                  | Max                        | Unit |
|---|-------------------|-----------------|--------------------------------------|----------------------------|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | $8/f_{\text{PCLK0}}$                 |                            | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | $4/f_{\text{PCLK0}} - 5$             |                            | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | $4/f_{\text{PCLK0}} - 5$             |                            | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | $15 + 2/f_{\text{PCLK0}}^{\text{a}}$ |                            | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | $5 + 2/f_{\text{PCLK0}}$             |                            | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |                                      | $100 + 3/f_{\text{PCLK0}}$ | ns   |

a)  $f_{\text{PCLK0}}$  is the clock frequency of the digital filter connected to the input pin.

**(b) Without Digital Filter****Table 7-14 CSIB Slave Mode AC Characteristics without Digital Filter**

| Parameter   | Symbol            | Test Conditions | Min | Max | Unit |
|---|-------------------|-----------------|-----|-----|------|
| $\overline{\text{SCKBn}}$ cycle time              | $t_{\text{KCY1}}$ |                 | 125 |     | ns   |
| $\overline{\text{SCKBn}}$ high level width        | $t_{\text{KH1}}$  |                 | 50  |     | ns   |
| $\overline{\text{SCKBn}}$ low level width         | $t_{\text{KL1}}$  |                 | 50  |     | ns   |
| SIBn setup time (to $\overline{\text{SCKBn}}$ )   | $t_{\text{SIK1}}$ |                 | 15  |     | ns   |
| SIBn hold time (from $\overline{\text{SCKBn}}$ )  | $t_{\text{KSI1}}$ |                 | 5   |     | ns   |
| Delay time from $\overline{\text{SCKBn}}$ to SOBn | $t_{\text{KSO1}}$ |                 |     | 100 | ns   |

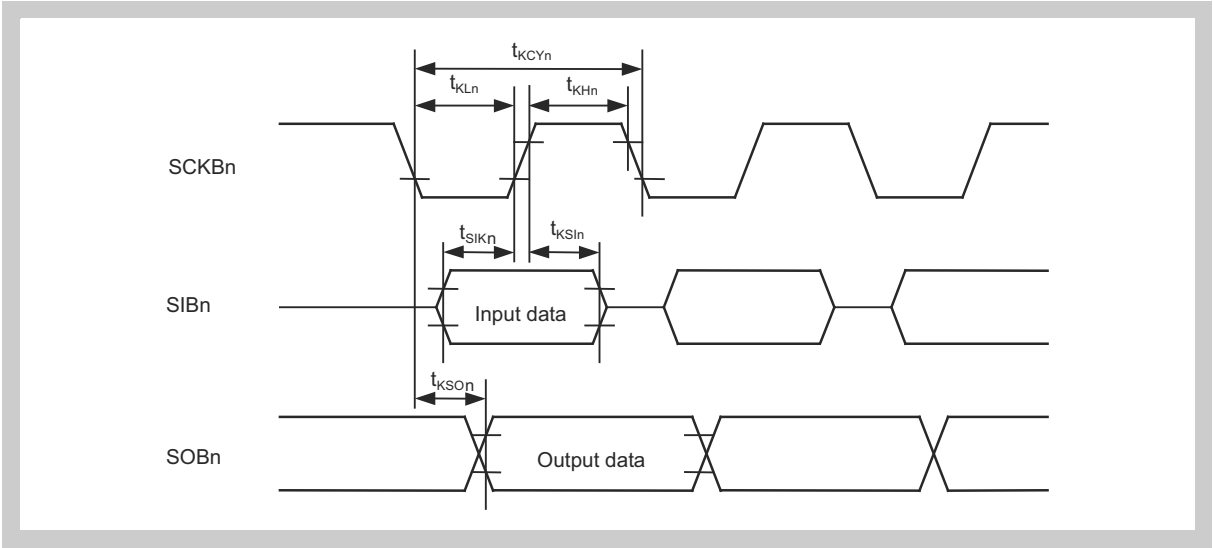


Figure 7-8 CSI Master/Slave Mode Timing

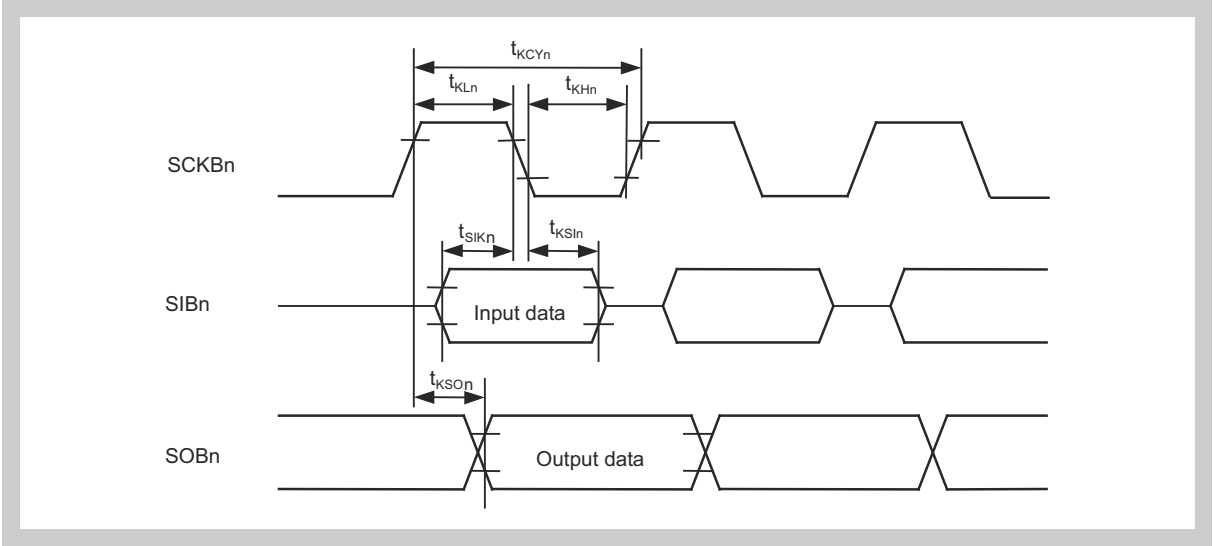


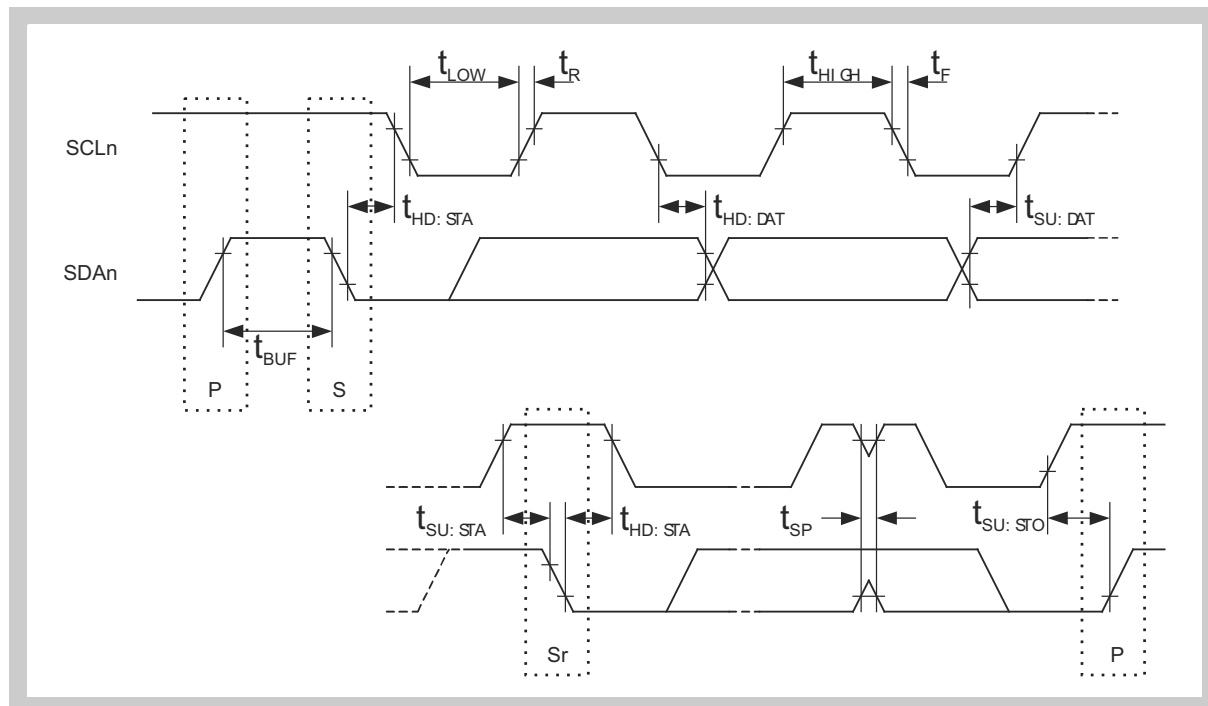
Figure 7-9 CSI Master/Slave Mode Timing Inverted Clock

7.5.7 I<sup>2</sup>CTable 7-15: I<sup>2</sup>C AC Characteristics

| Parameter                                     |                        | Symbol              | Normal Mode    |                   | Fast-speed Mode     |                                 | Unit |
|---|------------------------|---------------------|----------------|-------------------|---------------------|---------------------------------|------|
|   |                        |                     | min            | max               | min                 | max                             |      |
| SCLn clock frequency                          |                        | f <sub>CLK</sub>    | 0              | 100               | 0                   | 380                             | kHz  |
| Bus-free time (between stop/start conditions) |                        | t <sub>BUF</sub>    | 4.7            | —                 | 1.3                 | —                               | μs   |
| Hold time <sup>a</sup>                        |                        | t <sub>HD:STA</sub> | 4.0            | —                 | 0.6                 | —                               | μs   |
| SCLn clock low-level width                    |                        | t <sub>LOW</sub>    | 4.7            | —                 | 1.3                 | —                               | μs   |
| SCLn clock high-level width                   |                        | t <sub>HIGH</sub>   | 4.0            | —                 | 0.6                 | —                               | μs   |
| Setup time for start/restart conditions       |                        | t <sub>SU:STA</sub> | 4.7            | —                 | 0.6                 | —                               | μs   |
| Data hold time                                | CBUS compatible master | t <sub>HD:DAT</sub> | 5.0            | —                 | —                   | —                               | μs   |
|   | I <sup>2</sup> C mode  |                     | 0 <sup>b</sup> | 3.45 <sup>c</sup> | 0 <sup>Note b</sup> | 0.9 <sup>c</sup>                | μs   |
| Data setup time                               |                        | t <sub>SU:DAT</sub> | 250            | —                 | 100 <sup>d</sup>    | —                               | ns   |
| STOP condition setup time                     |                        | t <sub>SU:STO</sub> | 4.0            | —                 | 0.6                 | —                               | μs   |
| Noise suppression <sup>e</sup>                |                        | t <sub>SP</sub>     |                |                   |                     | t <sub>IICLK</sub> <sup>f</sup> | ns   |
| Capacitive load of each bus line              |                        | C <sub>b</sub>      | —              | 400               | —                   | 400                             | pF   |

- a) At the start condition, the first clock pulse is generated after the hold time
- b) The system requires a minimum of 300ns hold time Internally for the SDA<sub>n</sub> signal ( at V<sub>IHmin</sub> of SCL<sub>n</sub> signal ) in order to occupy the undefined area at the falling edge of SCL<sub>n</sub>.
- c) If the system does not extend the SCL<sub>n</sub> signal low hold time ( t<sub>low</sub> ), only the maximum data hold time ( t<sub>HD:DAT</sub> ) needs to be satisfied.
- d) The fast-speed-mode IIC bus can be used In a normal-mode IIC bus system.  
In this case, set the fast-speed-mode IIC bus so that It meets the following conditions:  
- If the system does not extend the SCL<sub>n</sub> signal's low state hold time: t<sub>SU:DAT</sub> ≥ 250ns  
- If the system extends the SCL<sub>n</sub> signal's low state hold time:  
Transmit the following data bit to the SDA<sub>n</sub> line prior to releasing the SCL<sub>n</sub> line  
(t<sub>Rmax</sub> + t<sub>SU:DAT</sub> = 1000 + 250 = 1250ns: Normal mode IIC bus specification ).
- e) Noise suppression is only available in Fast-speed mode.
- f) t<sub>IICLK</sub> is the period of the IICLK supplied by the clock controller.

**Note** n = 0, 1

Figure 7-10 I<sup>2</sup>C Timing

- Remarks**
1. P: Stop condition
  2. S: Start condition
  3. Sr: Restart condition
  4. Rise and Fall time depend on the actual load of the signal and the selected output current limit. For a capacitive load the time can be roughly calculated from:  
 $(t_R = V_{OH} / I_{OH} * C_L)$ ,  
 $(t_F = V_{OH} / I_{OL} * C_L)$

## 7.6 LCD Bus Interface

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.15\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

The following tables shows the timing of pin group 3 used as LCD bus interface with Schmitt1 input characteristic and unlimited output current.

**Table 7-16 LCD Bus Interface AC Characteristics**

| Parameter                 | Symbol           | Cond. | Min. <sup>a</sup>                      | Max.         | Unit |
|---------------------------|------------------|-------|--|--------------|------|
| Cycle Time                | $t_{\text{CYC}}$ |       | $\text{CYC} \times T - 5$              | -            | ns   |
| Control LOW-Pulse Width   | $t_{\text{CL}}$  |       | $(\text{WST}+1)T - 50$                 | -            | ns   |
| Enable Active Pulse Width | $t_{\text{ELH}}$ |       | $(\text{WST}+1)T - 35$                 | -            | ns   |
| Control Setup Time        | $t_{\text{RWS}}$ |       | $0.5 T + 2$                            | -            | ns   |
| Control Hold Time         | $t_{\text{RWH}}$ |       | $0.5 T$                                | -            | ns   |
| Data Output Setup Time    | $t_{\text{DOS}}$ |       | $0.5 T - 20$                           | $0.5 T + 12$ | ns   |
| Data output Hold Time     | $t_{\text{DOH}}$ |       | $[\text{CYC}-(\text{WST}+1.5)] T - 88$ | -            | ns   |
| Data Input Setup Time     | $t_{\text{DIS}}$ |       | 117                                    | -            | ns   |
| Data Input Hold Time      | $t_{\text{DIH}}$ |       | 0                                      | -            | ns   |
| Output Disable Time       | $t_{\text{OD}}$  |       | $0.5 T + 5$                            | -            | ns   |

a)  $T: 1/f_{\text{LCD}}$  (LCD Bus Interface macro clock frequency)  
 For clock selection refer to functional specification of the LCD Bus Interface  
 Always keep  $\text{CYC} \geq 2$   
 Always keep  $\text{WST} \leq (\text{CYC}-2)$

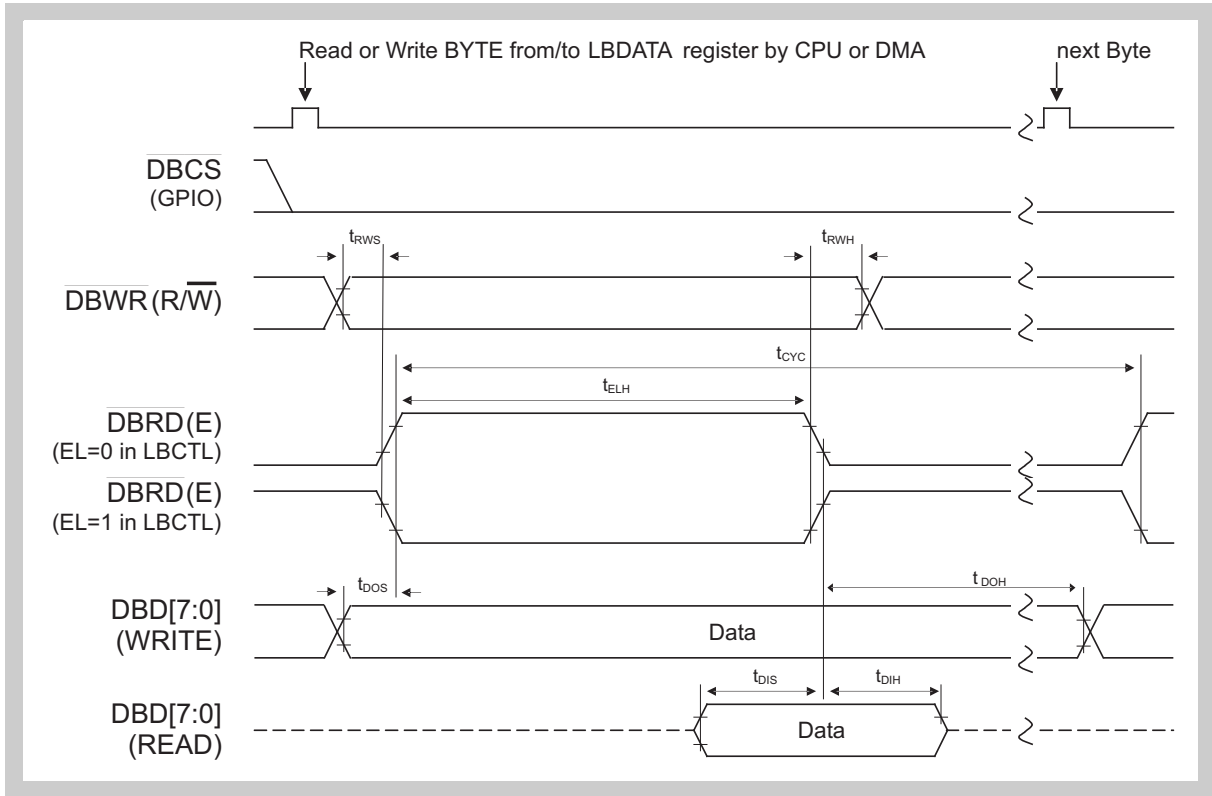


Figure 7-11 LCD Bus Interface mod68 Mode Timing

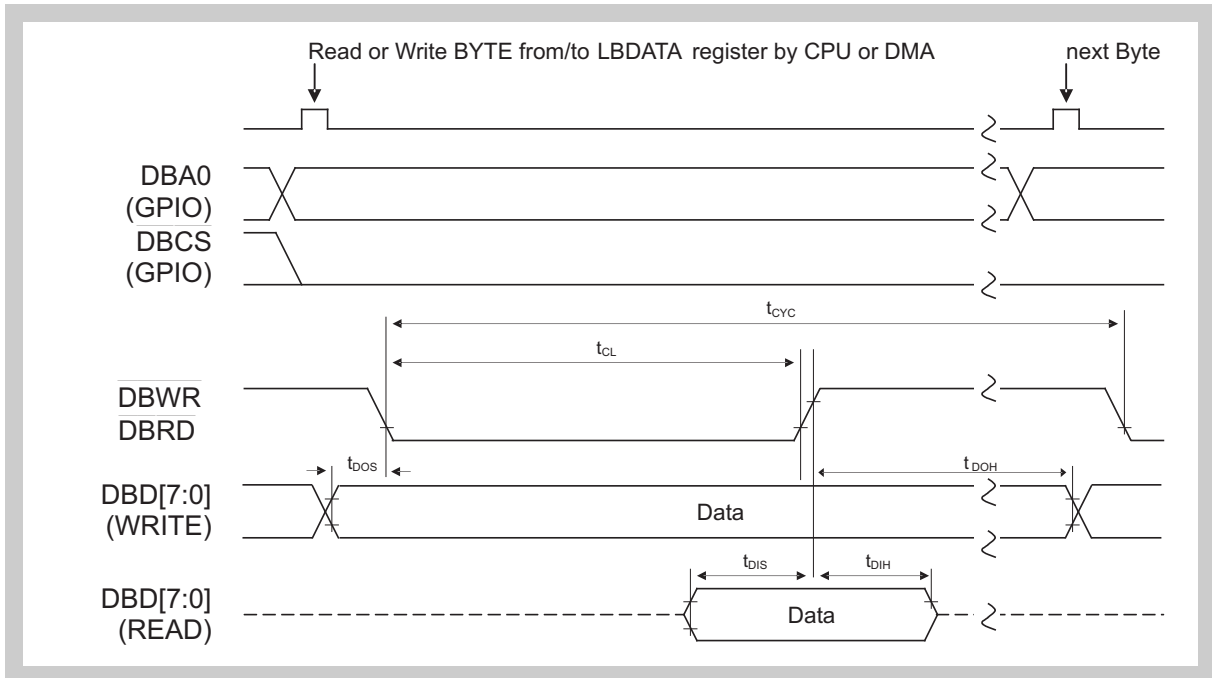


Figure 7-12 LCD Bus Interface mod80 Mode Timing

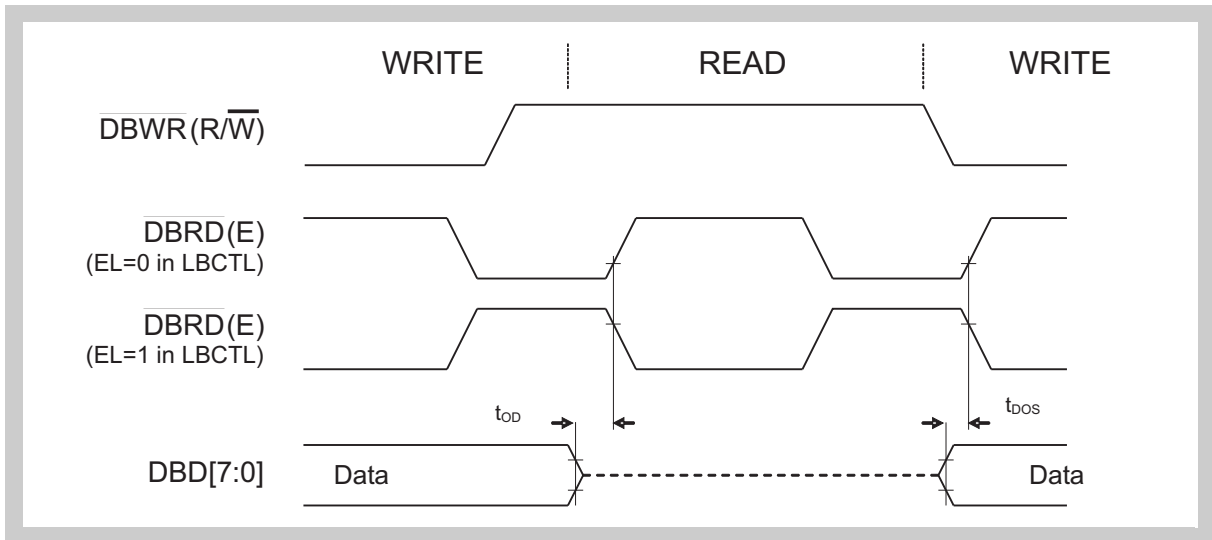


Figure 7-13 LCD Bus Interface mod68 Mode Turnaround Timing

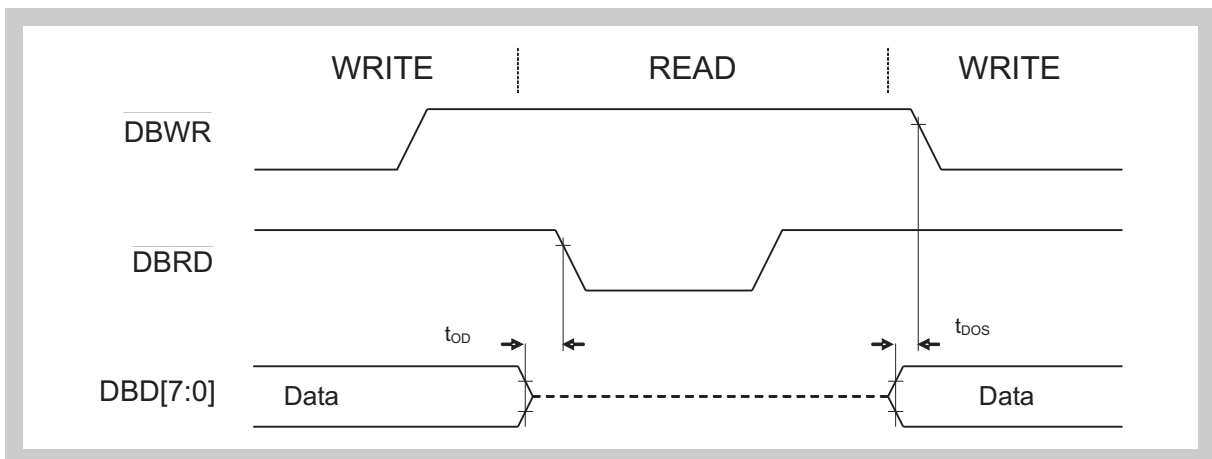


Figure 7-14 LCD Bus Interface mod80 Mode Turnaround Timing



## 7.7 External Memory Access ( $\mu$ PD70F3427)

### 7.7.1 Asynchronous bus timing

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  (if used as ext. mem. I/F,  $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  otherwise),  
 $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 3.6\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = 0\text{ V}$   
Output pin load capacitance:  $C_L = 50\text{pF}$

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 7-17 External Memory Access Asynchronous Read Timing**

| Parameter  | Symbol | Conditions  | Min                    | Max               | Unit |
|--|--------|-------------|------------------------|-------------------|------|
| Data input set up time D0-D15 (vs.address)                         | <10>   | $T_{SAID}$  |                        | $(2.0+W_T)T - 22$ | ns   |
| Data input set up time D0-D15 (vs. $\overline{RD}\downarrow$ )     | <11>   | $T_{SRDID}$ |                        | $(1.5+W_D)T - 21$ | ns   |
| Data input set up time D16-D31 (vs.address)                        | <10>   | $T_{SAID}$  |                        | $(2.0+W_T)T - 27$ | ns   |
| Data input set up time D16-D31 (vs. $\overline{RD}\downarrow$ )    | <11>   | $T_{SRDID}$ |                        | $(1.5+W_D)T - 26$ | ns   |
| $\overline{RD}$ Low level width                                    | <12>   | $T_{WRDL}$  | $(1.5+W_D)T - 12$      |                   | ns   |
| $\overline{RD}$ Low level width (delayed $\overline{RD}$ )         | <12a>  | $T_{WRDL}$  | $(2+W_D)T - 12$        |                   | ns   |
| $\overline{RD}$ High level width                                   | <13>   | $T_{WRDH}$  | $(1.5+W_{AS}+i)T - 12$ |                   | ns   |
| $\overline{RD}$ High level width (delayed $\overline{RD}$ )        | <13a>  | $T_{WRDH}$  | $(1+W_{AS}+i)T - 12$   |                   | ns   |
| Address to $\overline{RD}$ delay time                              | <14>   | $T_{DARD}$  | $(0.5+W_{AS})T - 5$    |                   | ns   |
| $\overline{CSn}$ to $\overline{RD}$ delay time                     | <14a>  | $T_{DCRD}$  | $(0.5+W_{AS})T - 5$    |                   | ns   |
| $\overline{BEn}$ to $\overline{RD}$ delay time                     | <14b>  | $T_{DCRD}$  | $(0.5+W_{AS})T - 5$    |                   | ns   |
| $\overline{RD}$ address delay time                                 | <15>   | $T_{DRDA}$  | $iT - 7$               |                   | ns   |
| $\overline{RD}$ address delay time (delayed $\overline{RD}$ )      | <15a>  | $T_{DRDA}$  | $(-0.5+i)T - 7$        |                   | ns   |
| Data input hold time (vs. $\overline{RD}\uparrow$ )                | <16>   | $T_{HRDID}$ | -11                    |                   | ns   |
| Data input hold time (vs. delayed $\overline{RD}\uparrow$ )        | <16a>  | $T_{HRDID}$ | $-0.5T - 11$           |                   | ns   |
| Write data output delay time after $\overline{RD}\uparrow$         | <17>   | $T_{DRDOD}$ | $(1+i)T - 12$          |                   | ns   |
| Write data output delay time after delayed $\overline{RD}\uparrow$ | <17a>  | $T_{DRDOD}$ | $(0.5+i)T - 12$        |                   | ns   |

**Note** T:  $1 / f_{CPU}$  (= frequency of system clock)  
i: Number of idle states specified by BCC register  
 $W_T$ : Total Number of waits,  $W_T = W_{AS} + W_D$   
 $W_{AS}$ : Number of waits specified by ASC register  
 $W_D$ : Number of waits specified by DWC0, DWC1 register in SRAM mode and during off-page access in page mode. PRC register during on-page access in page mode.

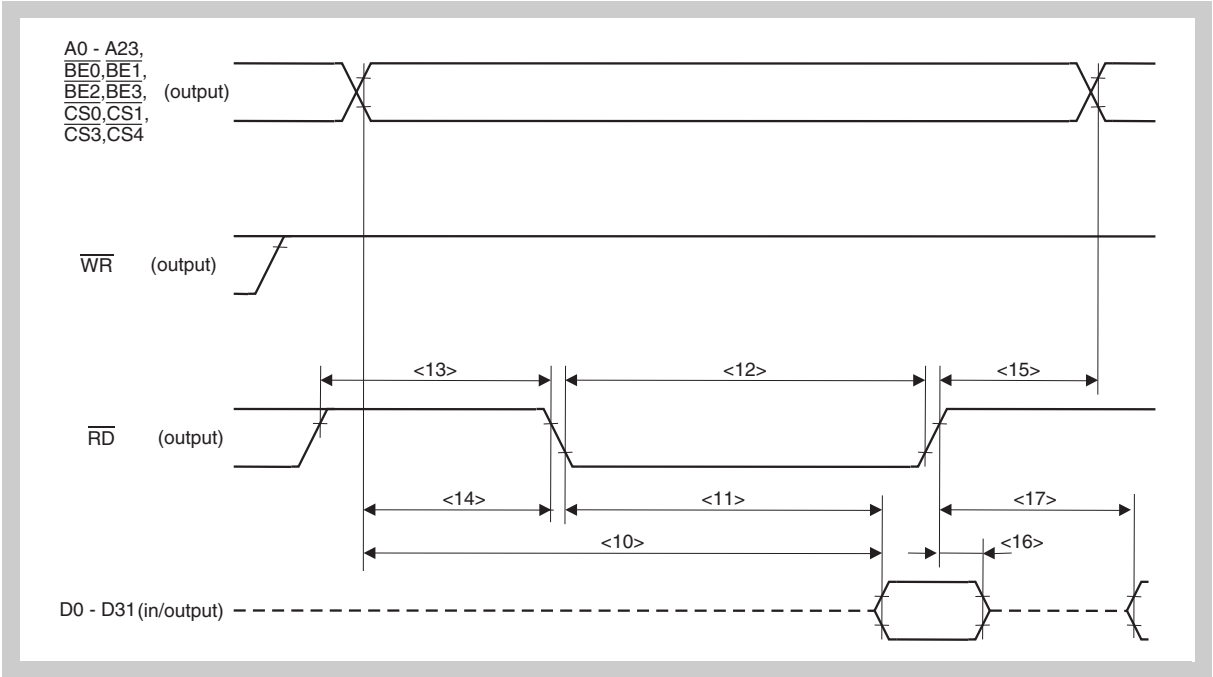
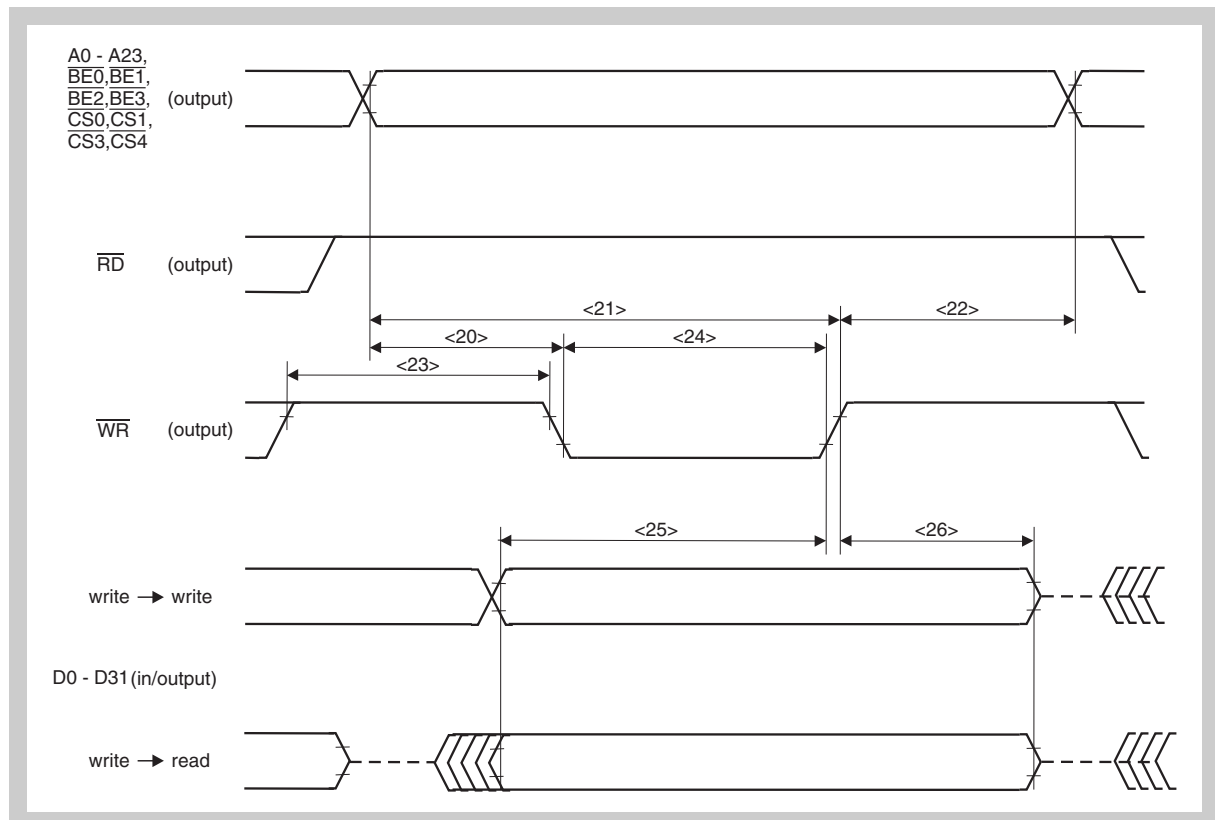


Figure 7-15 SRAM Asynchronous Read Timing

**Table 7-18 External Memory Access Asynchronous Write Timing**

| Parameter   | Symbol | Conditions  | Min                  | Max | Unit |
|---|--------|-------------|----------------------|-----|------|
| Address, $\overline{WR}$ delay time                           | <20>   | $T_{DAWR}$  | $(0.5+W_{AS})T - 4$  |     | ns   |
| $\overline{CSn}$ , $\overline{WR}$ delay time                 | <20a>  | $T_{DAWR}$  | $(0.5+W_{AS})T - 4$  |     | ns   |
| $\overline{BEn}$ , $\overline{WR}$ delay time                 | <20b>  | $T_{DAWR}$  | $(0.5+W_{AS})T - 4$  |     | ns   |
| Address set up (vs. $\overline{WR}\uparrow$ )                 | <21>   | $T_{SAWR}$  | $(1.5+W_T)T - 4$     |     | ns   |
| $\overline{WR}$ address delay time                            | <22>   | $T_{DWRA}$  | $(0.5+i)T - 8$       |     | ns   |
| $\overline{WR}$ $\overline{CSn}$ delay time                   | <22a>  | $T_{DWRA}$  | $(0.5+i)T - 8$       |     | ns   |
| $\overline{WR}$ High level width                              | <23>   | $T_{WWRH}$  | $(1+i+W_{AS})T - 12$ |     | ns   |
| $\overline{WR}$ Low level width                               | <24>   | $T_{WWRL}$  | $(1+W_D)T - 8$       |     | ns   |
| Data output set up time D0-15 (vs. $\overline{WR}\uparrow$ )  | <25>   | $T_{SODWR}$ | $(1.5+W_T)T - 10$    |     | ns   |
| Data output hold time D0-D15 (vs. $\overline{WR}\uparrow$ )   | <26>   | $T_{HWROD}$ | $0.5iT + 2$          |     | ns   |
| Data output set up time D16-31 (vs. $\overline{WR}\uparrow$ ) | <25>   | $T_{SODWR}$ | $(1.5+W_T)T - 15$    |     | ns   |
| Data output hold time D16-D31 (vs. $\overline{WR}\uparrow$ )  | <26>   | $T_{HWROD}$ | $0.5iT + 2$          |     | ns   |

**Note** T:  $1 / f_{CPU}$  (= frequency of system clock)  
i: Number of idle states specified by BCC register  
 $W_T$ : Total Number of waits,  $W_T = W_{AS} + W_D$   
 $W_{AS}$ : Number of waits specified by ASC register  
 $W_D$ : Number of waits specified by DWC1, DWC2 register

**Figure 7-16 SRAM Asynchronous Write Timing**

## 7.7.2 Synchronous Bus Timing

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  (if used as ext. mem. I/F,  $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  otherwise),  
 $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 3.6\text{ V}$ ,  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = MV_{SS5} = 0\text{ V}$   
 Output pin load capacitance:  $C_L = 50\text{ pF}$

**Note** Refer to "Power On Clear" on page 81 for further functional restriction.

**Table 7-19 External Memory Access Synchronous Read Timing**

| Parameter                                       | Symbol              | Conditions | Min | Max | Unit |
|---|---------------------|------------|-----|-----|------|
| BCLK cycle time                                 | <90> $T_{BCYC}$     |            | 28  |     | ns   |
| BCLK low  | <91> $T_{BH}$       |            | 7.1 |     | ns   |
| BCLK high                                       | <92> $T_{BL}$       |            | 7.1 |     | ns   |
| A0-23 Hold time from BCLK↓                      | <93> $T_{HAD}$      |            | 5   |     | ns   |
| A0-23 Setup time to BCLK↓                       | <94> $T_{HSAD}$     |            | 8   |     | ns   |
| CSx Hold time from BCLK↓                        | <95> $T_{HCS}$      |            | 5   |     | ns   |
| CSx Setup time to BCLK↓                         | <96> $T_{SCS}$      |            | 8   |     | ns   |
| RD↓ after BLCK↑ Hold                            | <97> $T_{HRDF}$     |            | 5   |     | ns   |
| RD↓ to BLCK↑ setup                              | <98> $T_{SRDF}$     |            | 6   |     | ns   |
| RD↑ after BLCK↓ Hold                            | <99> $T_{HRDR}$     |            | 5   |     | ns   |
| RD↑ to BLCK↓ setup                              | <100> $T_{SRDR}$    |            | 6   |     | ns   |
| Delayed RD↑ after BLCK↑ Hold                    | <99a> $T_{HRDRD}$   |            | 5   |     | ns   |
| Delayed RD↑ to BLCK↑ setup                      | <100a> $T_{SRDRD}$  |            | 6   |     | ns   |
| Data input set up time D0-15 (vs. BCLK↑)        | <101> $T_{SRDID}$   |            | 26  |     | ns   |
| Data input set up time D16-31 (vs. BCLK↑)       | <101a> $T_{SRDIDa}$ |            | 31  |     | ns   |
| Data input hold time D0-15 (vs. BCLK↑)          | <102> $T_{HRDID}$   |            | -11 |     | ns   |
| Data input hold time D16-31 (vs. BCLK↑)         | <102a> $T_{HRDIDa}$ |            | -11 |     | ns   |
| WAIT input set up time <sup>a</sup> (vs. BCLK↑) | <103> $T_{SWK}$     |            | 26  |     | ns   |
| WAIT input hold time (vs. BCLK↑)                | <104> $T_{HWK}$     |            | -11 |     | ns   |

<sup>a)</sup> The setup and hold time for WAIT may be violated, but if the device reacts with an additional wait state is than not defined.

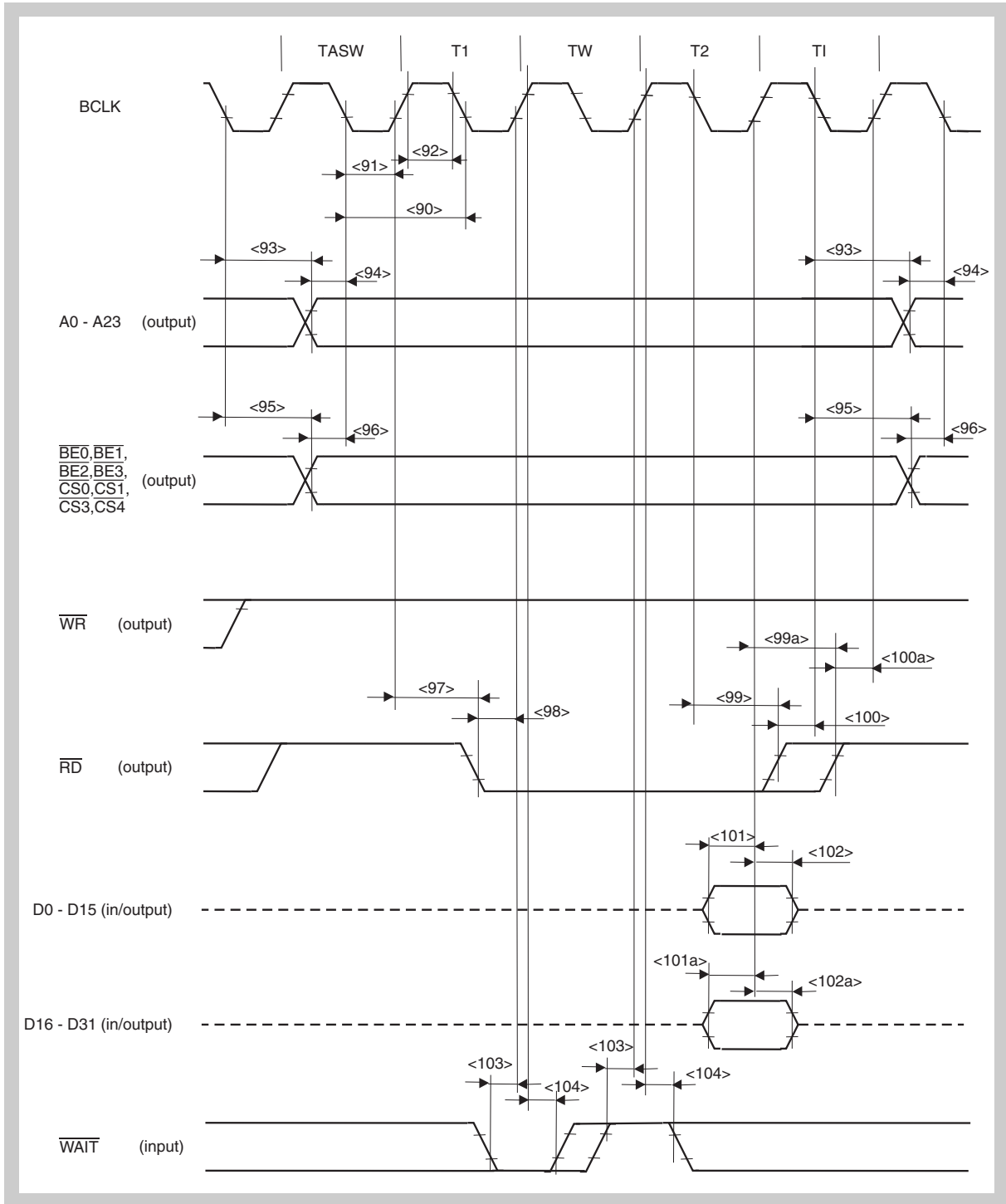


Figure 7-17 External Memory Access Synchronous Read Timing

**Table 7-20 External Memory Access Synchronous Write Timing**

| Parameter                                       | Symbol             | Conditions | Min | Max | Unit |
|---|--------------------|------------|-----|-----|------|
| BCLK cycle time                                 | <110> $T_{BCYC}$   |            | 28  |     | ns   |
| BCLK low  | <111> $T_{BH}$     |            | 7.1 |     | ns   |
| BCLK high                                       | <112> $T_{BL}$     |            | 7.1 |     | ns   |
| A0-23 Hold time from BCLK↓                      | <113> $T_{HAD}$    |            | 5   |     | ns   |
| A0-23 Setup time to BCLK↓                       | <114> $T_{HSAD}$   |            | 8   |     | ns   |
| CSx, BEx Hold time from BCLK↓                   | <115> $T_{HCS}$    |            | 5   |     | ns   |
| CSx, BEx Setup time to BCLK↓                    | <116> $T_{SCS}$    |            | 8   |     | ns   |
| WR↓ after BLCK↑ Hold                            | <117> $T_{HWRF}$   |            | 5   |     | ns   |
| WR↓ to BLCK↑ setup                              | <118> $T_{SWRF}$   |            | 8   |     | ns   |
| WR↑ after BLCK↓ Hold                            | <119> $T_{HWRR}$   |            | 5   |     | ns   |
| WR↑ to BLCK↓ setup                              | <120> $T_{SWRR}$   |            | 8   |     | ns   |
| Data output set up time D0-15 (vs. BCLK↑)       | <121> $T_{SWDO}$   |            | -7  | 7   | ns   |
| Data output set up time D16-31 (vs. BCLK↑)      | <121a> $T_{SWDOa}$ |            | -7  | 11  | ns   |
| Data output hold time D0-15 (vs. BCLK↑)         | <122> $T_{HWDO}$   |            | -7  | 7   | ns   |
| Data output hold time D16-31 (vs. BCLK↑)        | <122a> $T_{HWDOa}$ |            | -7  | 11  | ns   |
| WAIT input set up time <sup>a</sup> (vs. BCLK↑) | <123> $T_{SWK}$    |            | 26  |     | ns   |
| WAIT input hold time (vs. BCLK↑)                | <124> $T_{HWK}$    |            | -11 |     | ns   |

<sup>a)</sup> The setup and hold time for WAIT may be violated, but if the device reacts with an additional wait state is than not defined.

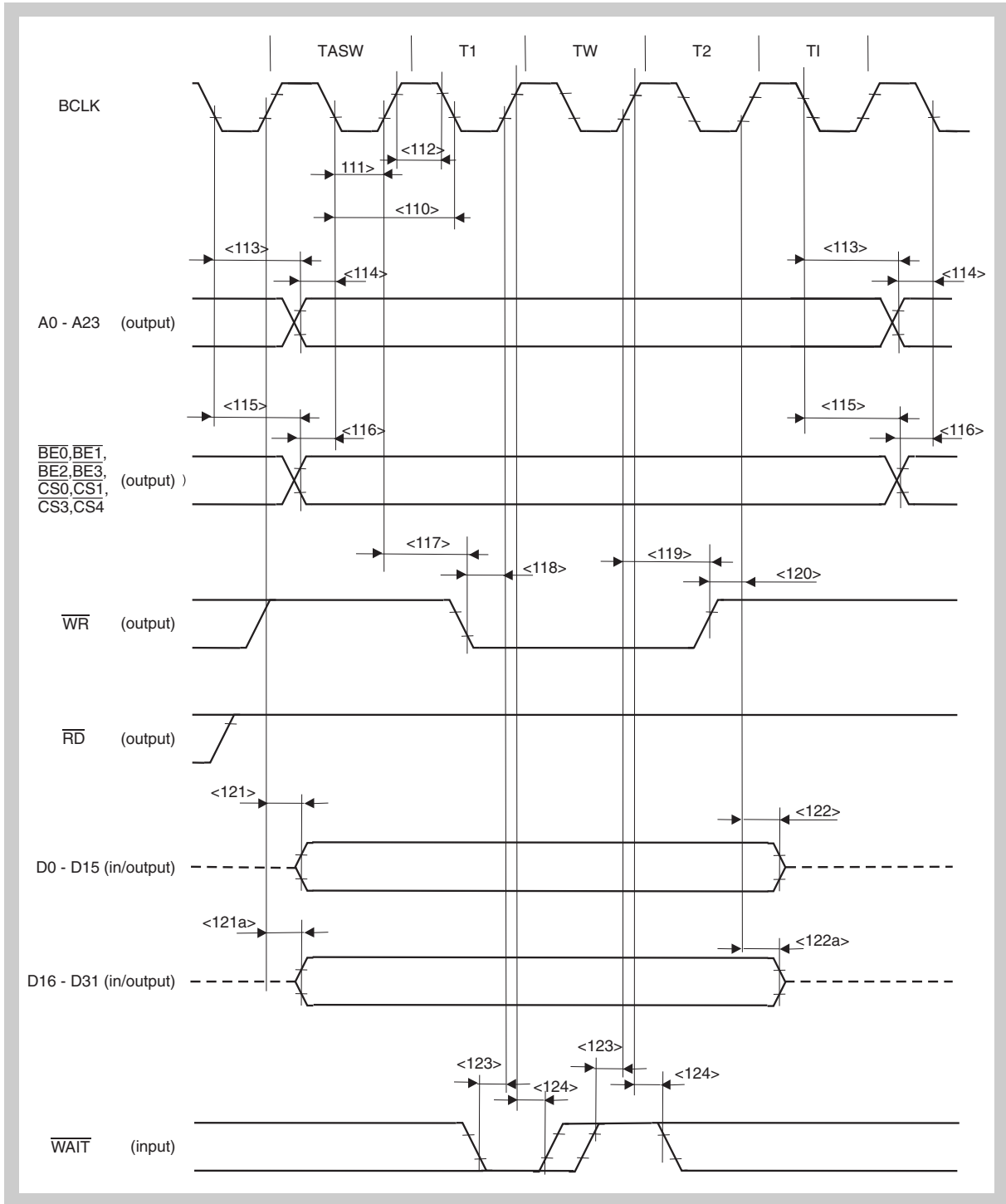


Figure 7-18 External Memory Access Synchronous Write Timing



## Chapter 8 Analog Functions

### 8.1 A/D Converter

The number of available analog input channels depends on the device:

- $\mu$ PD70F3427,  $\mu$ PD70F3426A,  $\mu$ PD70F3425,  $\mu$ PD70F3424: 16 channels input P70..P715.
- $\mu$ PD70F3423,  $\mu$ PD70F3422,  $\mu$ PD70F3421: 12 channels input P70..P711.

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu$ PD70F3427 only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu$ PD70F3427 only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 8-1 A/D Converter Characteristics**

| Parameter   | Symbol            | Test Conditions   | Min  | Typ | Max     | Unit       |
|---|-------------------|---|------|-----|---------|------------|
| Resolution  | -                 |   |      | 10  |         | Bit        |
| Reference voltage   | AVREF             |   | AVSS |     | AVDD    | V          |
| Overall error <sup>a</sup>  | -                 | $AV_{SS} \leq AIN \leq AV_{REF}$ ,<br>$4.5\text{V} \leq (AV_{REF} = AV_{DD}) \leq 5.5\text{V}$  |      |     | +/- 3.5 | LSB        |
|   | -                 | $AV_{SS} \leq AIN \leq AV_{REF}$ ,<br>$3.5\text{V} = AV_{REF}$ ,<br>$4.0\text{V} \leq AV_{DD} \leq 5.5\text{V}$   |      |     | +/- 10  | LSB        |
| Integral non linearity error  | INL               | $AV_{SS} \leq AIN \leq AV_{REF}$ ,<br>$AV_{DD} - 0.5\text{V} \leq AV_{REF}$ ,<br>$4.0\text{V} \leq AV_{REF}$ ,<br>$4.0\text{V} \leq AV_{DD} \leq 5.5\text{V}$ |      |     | 2       | LSB        |
| Additional error due to disturbance by digital read of P70..P715 <sup>b</sup> | DRERR             |   |      |     | 1       | LSB        |
| Conversion time <sup>c</sup>  | T <sub>CONV</sub> |   | 3.88 |     | 15.50   | $\mu$ s    |
| Analog input voltage  | V <sub>IAN</sub>  |   | AVSS |     | AVDD    | V          |
| Analogue supply current   | I <sub>AVDD</sub> |   |      |     | 10      | mA         |
| Analog input equivalent circuit resistanceb)                                  | R <sub>INA</sub>  |   | 0.3  |     | 2.55    | k $\Omega$ |
| Analog input equivalent circuit capacitanceb)                                 | C <sub>INA</sub>  |   | 4.0  |     | 8.0     | pF         |

**Table 8-1 A/D Converter Characteristics (Continued)**

| Parameter                                     | Symbol      | Test Conditions | Min | Typ | Max | Unit    |
|---|-------------|-----------------|-----|-----|-----|---------|
| Analogue supply current                       | $I_{AVDD}$  |                 |     |     | 10  | mA      |
| Reference voltage supply current <sup>d</sup> | $I_{AVREF}$ |                 |     |     | 350 | $\mu$ A |

- a) Quantization error of  $\pm 0.5$  LSB is not included  
 b) This value is not tested during production.  
 c)  $T_{CONV}$  depends on register setting  
 d) The reference current is mainly a transient current that is influenced by the conversion time. The given value is the maximum value. Value is not tested during production.

## 8.2 Power On Clear

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $V_{DD5} = 0 \sim 5.5 \text{ V}$ ,  
 $V_{SS} = 0 \text{ V}$

**Table 8-2 Power On Clear Characteristics**

| Parameter                   | Symbol     | Test Conditions                 | Min | Typ  | Max | Unit    |
|-----------------------------|------------|---------------------------------|-----|------|-----|---------|
| Threshold Voltage           | $V_{IP}$   |                                 | 3.2 | 3.35 | 3.5 | V       |
| Detection time <sup>a</sup> | $T_{DETP}$ | $V_{DD5}$ slope > 25mV/ $\mu$ s |     |      | 2   | $\mu$ s |

- a) Not tested in production.

- Note**
1. The POC ensures that the device stops operation (RESET condition) when the device is outside the operation voltage range, under the condition that the supply voltage slope on  $V_{DD5}$  is  $\leq 25\text{mV}/\mu\text{s}$ .
  2. Full device operation is only available, when the supply voltage is above the maximum threshold voltage. The device may stop operation due to reset condition generated by POC, if the supply voltage drops below the given max threshold voltage.

### 8.3 Voltage Comparator

The voltage comparator is supplied by  $A_{VDD}$ .

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 8-3 Voltage Comparator Characteristics**

| Parameter                                | Symbol      | Test Conditions                  | Min            | Typ  | Max            | Unit          |
|--|-------------|----------------------------------|----------------|------|----------------|---------------|
| Threshold Voltage (calibrated)           | $V_{IV}$    |                                  | 1.73<br>-0.065 | 1.73 | 1.73<br>+0.065 | V             |
| Detection Time <sup>a</sup>              | $T_{DETV1}$ | slope = 50mV/ $\mu\text{s}$      |                |      | 2              | $\mu\text{s}$ |
|  | $T_{DETV2}$ | step = 100mV,<br>overdrive = 5mV |                |      | 2              | $\mu\text{s}$ |
| Power-On Stabilization Time <sup>b</sup> | $T_S$       |                                  |                |      | 2              | ms            |

a) Not tested in production.

b) That time must be passed after having enabled a voltage-comparator (Set VCEn bit) and before being able to read the correct status of the concerned voltage-comparator status flag (VCFn).

## Chapter 9 Flash Memory

### 9.1 Basic Characteristics

**Conditions**  $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

**Table 9-1 Memory Operation Characteristics**

| Parameter           | Symbol           | Device  | Min | Typ | Max <sup>a</sup> | Unit |
|---------------------|------------------|---|-----|-----|------------------|------|
| Operation Frequency | $f_{\text{CPU}}$ | $\mu\text{PD70F3427}$ ,<br>$\mu\text{PD70F3426A}$ ,<br>$\mu\text{PD70F3425}$ ,<br>$\mu\text{PD70F3424}$ | 32k |     | 64M              | Hz   |
|                     |                  | $\mu\text{PD70F3423}$ ,<br>$\mu\text{PD70F3422}$ ,<br>$\mu\text{PD70F3421}$                             | 32k |     | 24M              | Hz   |

<sup>a)</sup> The above maximum operation frequency specification lists the center frequency of the SSCG. The maximum dithering range of the SSCG is assured for this center frequency.

## 9.2 Flash Memory Characteristics

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 4.5\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

- Note**
1. Refer to "Power On Clear" on page 81 for further functional restriction.
  2. The values given in Table 9-2 are valid for a CPU frequency of 24MHz and 32MHz.

**Table 9-2 Flash Memory Selfprogramming Characteristics**

| Parameter                            | Symbol                | Test Conditions                    |  | Min                             | Typ                             | Max  | Unit             |                  |
|--------------------------------------|-----------------------|------------------------------------|--|---------------------------------|---------------------------------|------|------------------|------------------|
| Number of Rewrites                   | $C_{\text{WRT}}$      |                                    |  |                                 |                                 | 1000 | times            |                  |
| Data retention                       | $t_{\text{RET}}$      |                                    |  | 15                              |                                 |      | years            |                  |
| Blank Check Time <sup>a</sup>        | $t_{\text{IVBL}}$     |                                    |  | $f_{\text{CPU}} = 24\text{MHz}$ | 570                             | 570  | $\mu\text{s}$    |                  |
|                                      |                       |                                    |  | $f_{\text{CPU}} = 32\text{MHz}$ | 450                             | 450  | $\mu\text{s}$    |                  |
| Erase Time                           | $t_{\text{IERT4k}}$   | One memory block (4k) <sup>b</sup> |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 13   | 130              | ms               |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ |      |                  | ms               |
|                                      | $t_{\text{IERT256k}}$ | 64 memory blocks (256k)            |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 29   | 290              | ms               |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ |      |                  | ms               |
| Write Time                           | $t_{\text{IWRT}}$     | Write two words <sup>c</sup>       |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 520  | 1120             | $\mu\text{s}$    |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ | 300  | 900              | $\mu\text{s}$    |
|                                      | $t_{\text{IWRT4k}}$   | One memory block (4k) <sup>d</sup> |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 48   | 348              | ms               |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ | 45   | 345              | ms               |
| Verify Time                          | $t_{\text{IVRT4k}}$   | One memory block (4k)              |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 16   | 20               | ms               |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ |      |                  | ms               |
|                                      | $t_{\text{IVRT256k}}$ | 64 memory block (256k)             |  |                                 | $f_{\text{CPU}} = 24\text{MHz}$ | 1.1  | 1.3              | s                |
|                                      |                       |                                    |  |                                 | $f_{\text{CPU}} = 32\text{MHz}$ |      |                  | s                |
| Erase/Write Current <sup>e</sup>     | $I_{\text{DDFL}}$     |                                    |  |                                 | 1                               | 3    | mA               |                  |
| Programming Temperature <sup>f</sup> | $t_{\text{PRG}}$      |                                    |  | -40                             |                                 | +65  | $^\circ\text{C}$ |                  |
|                                      |                       | maximum power dissipation 0.8W     |  |                                 | -40                             |      | +85              | $^\circ\text{C}$ |

- a) Blank check of one memory block (4 kB).  
 b) Erase of one memory block (4kB).  
 c) The corresponding library call is configured for 2 word-write per call.  
 d) The corresponding library call uses a 4kB source buffer.  
 e) Additional current that is only needed during erase or write of flash.  
 f) The power dissipation may be reduced by disabling some functionality or reducing the CPU operation speed.

### 9.3 Special Conditions for End-of-Line Programming

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 4.8\text{ V} \sim 5.15\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to “Power On Clear” on page 81 for further functional restriction.

#### (1) Flash Memory End-of-Line Programming Characteristics (PG-FP4)

**Table 9-3 Flash Memory End-of-Line Programming Characteristics (PG-FP4: CSI)**

| Parameter               | Symbol     | Device   | Test Conditions     | Min | Typ | Max | Unit |
|-------------------------|------------|--|---------------------|-----|-----|-----|------|
| Blank Check             | $t_{IVBL}$ | All  | W/E cycles $\leq 5$ |     | 1   | 1   | s    |
| Erase Time <sup>a</sup> | $t_{IERT}$ |  |                     |     | 1   | 1   | s    |
| Write Time <sup>b</sup> | $t_{IWRT}$ | $\mu\text{PD70F3427}$ ,<br>$\mu\text{PD70F3426A}$ ,<br>$\mu\text{PD70F3425}$ |                     |     | 20  | 32  | s    |
|                         |            | $\mu\text{PD70F3424}$ ,<br>$\mu\text{PD70F3423}$                             |                     |     | 10  | 16  | s    |
|                         |            | $\mu\text{PD70F3421}$  |                     |     | 5   | 8   | s    |
| Verify Time             | $t_{IVRT}$ | $\mu\text{PD70F3427}$ ,<br>$\mu\text{PD70F3426A}$ ,<br>$\mu\text{PD70F3425}$ |                     |     | 16  | 20  | s    |
|                         |            | $\mu\text{PD70F3424}$ ,<br>$\mu\text{PD70F3423}$                             |                     |     | 8   | 10  | s    |
|                         |            | $\mu\text{PD70F3421}$  |                     |     | 5   | 7   | s    |

a) Erase of all flash-memory blocks (0 .. 255)

b) Write of complete flash area.

**Table 9-4 Flash Memory End-of-Line Programming Characteristics (PG-FP4: UART)**

| Parameter               | Symbol     | Device                              | Test Conditions     | Min | Typ | Max | Unit |
|-------------------------|------------|-------------------------------------|---------------------|-----|-----|-----|------|
| Blank Check             | $t_{IVBL}$ | All                                 | W/E cycles $\leq 5$ |     | 1   | 1   | s    |
| Erase Time <sup>a</sup> | $t_{IERT}$ |                                     |                     |     | 1   | 1   | s    |
| Write Time <sup>b</sup> | $t_{IWRT}$ | $\mu$ PD70F3426A                    |                     |     | 230 | 300 | s    |
|                         |            | $\mu$ PD70F3427,<br>$\mu$ PD70F3425 |                     |     | 115 | 150 | s    |
|                         |            | $\mu$ PD70F3424,<br>$\mu$ PD70F3423 |                     |     | 60  | 80  | s    |
|                         |            | $\mu$ PD70F3421                     |                     |     | 30  | 40  | s    |
| Verify Time             | $t_{IVRT}$ | $\mu$ PD70F3426A                    |                     |     | 230 | 300 | s    |
|                         |            | $\mu$ PD70F3427,<br>$\mu$ PD70F3425 |                     |     | 115 | 150 | s    |
|                         |            | $\mu$ PD70F3424,<br>$\mu$ PD70F3423 |                     |     | 60  | 80  | s    |
|                         |            | $\mu$ PD70F3421                     |                     |     | 30  | 40  | s    |

a) Erase of all flash-memory blocks (0 .. 255)

b) Write of complete flash area.

## (2) Flash Memory End-of-Line Programming Characteristic (Flash-Selfprogramming)

**Note** The values given in Table 9-5 are valid for a CPU frequency of 24MHz and 32MHz.

**Table 9-5 Flash Memory End-of-Line Programming Characteristics (Flash-Selfprogramming)**

| Parameter                                     | Symbol         | Test Conditions   | Min                 | Typ | Max | Unit    |         |
|---|----------------|-------------------|---------------------|-----|-----|---------|---------|
| Blank Check <sup>a</sup>                      | $t_{IVBL}$     | $f_{CPU} = 24MHz$ |                     | 570 | 570 | $\mu s$ |         |
|   |                | $f_{CPU} = 32MHz$ |                     | 450 | 450 | $\mu s$ |         |
| Erase Time one memory block (4k)              | $t_{IERT4k}$   | $f_{CPU} = 24MHz$ |                     | 13  | 52  | ms      |         |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |
| Erase Time 64 memory blocks (256k)            | $t_{IERT256k}$ | $f_{CPU} = 24MHz$ |                     | 29  | 116 | ms      |         |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |
| Write Time (Write two words) <sup>b</sup>     | $t_{IWRT}$     | $f_{CPU} = 24MHz$ | W/E cycles $\leq 5$ |     | 520 | 1120    | $\mu s$ |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |
| Write Time (One memory block 4k) <sup>c</sup> | $t_{IWRT4k}$   | $f_{CPU} = 24MHz$ |                     |     | 48  | 198     | ms      |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |
| Verify Time (One memory block 4k)             | $t_{IVRT4k}$   | $f_{CPU} = 24MHz$ |                     |     | 16  | 20      | ms      |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |
| Verify Time (64 memory blocks 256k)           | $t_{IVRT256k}$ | $f_{CPU} = 24MHz$ |                     |     | 1.1 | 1.3     | s       |
|   |                | $f_{CPU} = 32MHz$ |                     |     |     |         |         |

a) Blank check of one memory block (4kB).

b) The corresponding library call is configured for 2 word per call.

c) The corresponding library call uses a 4kB source buffer.

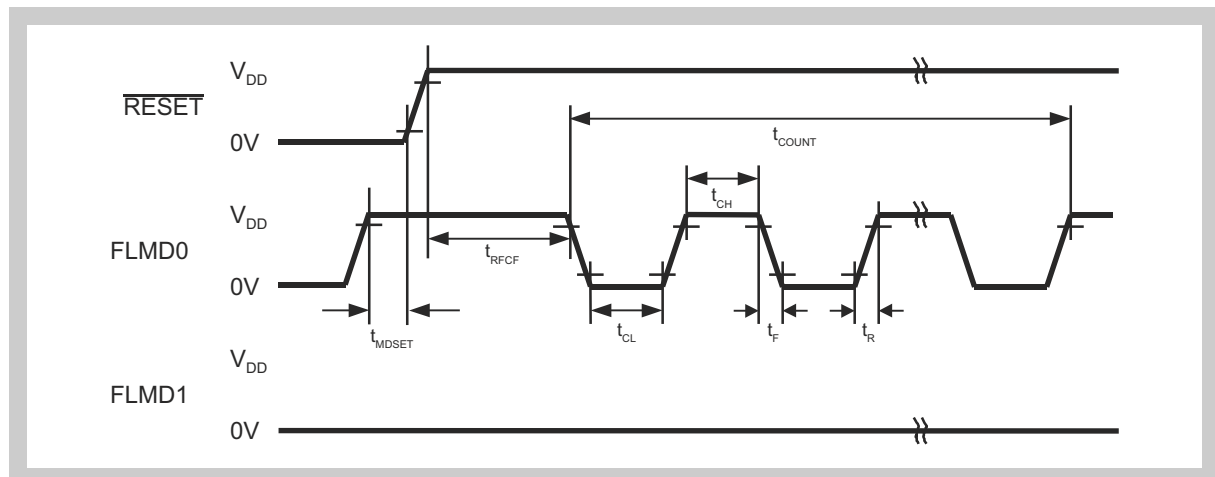
## 9.4 Serial Write Operation Characteristics

**Conditions**  $T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$ ,  
 $DV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  $BV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$ ,  
 $AV_{DD} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  $SMV_{DD5} = 3.2\text{ V} \sim 5.5\text{ V}$ ,  
 $MV_{DD5} = 3.0\text{ V} \sim 5.5\text{ V}$  ( $\mu\text{PD70F3427}$  only),  
 $V_{DD5} = 4.5\text{ V} \sim 5.5\text{ V}$ ,  
 $V_{SS5} = BV_{SS5} = DV_{SS5} = SMV_{SS5} = AV_{SS} = 0\text{ V}$   
 $MV_{SS5} = 0\text{ V}$  ( $\mu\text{PD70F3427}$  only)

**Note** Refer to "Power On Clear" on page 81 for further functional restriction.

**Table 9-6 Flash Memory AC Characteristics**

| Parameter   | Symbol                         | Test Conditions | Min | Typ | Max | Unit          |
|---|--------------------------------|-----------------|-----|-----|-----|---------------|
| FLMD0 setup time to rising edge of $\overline{\text{RESET}}$            | $t_{\text{MDSET}}$             |                 | 2   |     |     | ms            |
| Count start time from rising edge of $\overline{\text{RESET}}$ to FLMD0 | $t_{\text{RFCF}}$              |                 | 0.8 |     |     | ms            |
| Count ending time from end of $t_{\text{RFCF}}$ to FLMD0                | $t_{\text{COUNT}}$             |                 | 20  |     |     | ms            |
| FLMD0 counter High/Low level width                                      | $t_{\text{CH}}, t_{\text{CL}}$ |                 | 10  |     | 100 | $\mu\text{s}$ |
| FLMD0 counter rise/fall time  | $t_{\text{R}}, t_{\text{F}}$   |                 |     |     | 50  | ns            |



**Figure 9-1 Flash Memory Timing**

**Note** FLMD1 is a shared function of the P07 pin.



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## Chapter 10 Special Conditions for Device Operation at extended Operating Temperature Range

**Condition**  $T_A = -40^{\circ}\text{C} \sim +105^{\circ}\text{C}$

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**Caution** For any device's operation within the extended operating temperature range ( $T_A = -40^{\circ}\text{C} \sim +105^{\circ}\text{C}$ ), the device's total power consumption must be reduced. The following tables within this chapter describe additional device conditions securing the requested decrease of the device's power consumption.

In case any device may operate within the extended operating temperature range ( $T_A = -40^{\circ}\text{C} \sim +105^{\circ}\text{C}$ ) all of the below mentioned conditions must never be exceeded at any time.

All of the below mentioned device conditions must be applied in addition to any other parameter that is described within this document.

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**Note** The operation conditions for an extended temperature range ( $T_A = -40^{\circ}\text{C} \sim +105^{\circ}\text{C}$ ) mentioned in this chapter are valid for all parameters which were described within this document.  
In all conditions in this document the normal temperature range ( $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ) is replaced by the extended temperature range of  $T_A = -40^{\circ}\text{C} \sim +105^{\circ}\text{C}$  in case the operating conditions mentioned in this chapter are applied.

**(1)  $\mu$ PD70F3427****Condition 1**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: RUN, HALT, IDLE

Power dissipation:  $< 1.0\text{ W}$ 

Duration: 15000 hours

 $V_{SS5} = 0\text{V}$ **Condition 2**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation:  $< 0.5\text{W}$ 

Duration: 15 years

 $V_{SS5} = 0\text{V}$ **Table 10-1 Absolute maximum ratings currents for special conditions ( $\mu$ PD70F3427)**

| Parameter                              |          | Symbol    | Test Conditions                   |                           | Ratings average | Unit |
|--|----------|-----------|-----------------------------------|---------------------------|-----------------|------|
| Output current low                     | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 6, 7, 8 | $f_{SYS} = 48\text{ MHz}$ | 70              | mA   |
| Output current high                    |          | $I_{OHA}$ |                                   |                           | -70             | mA   |
| Number of active stepper motor drivers |          |           |                                   |                           | 4               |      |
| Output current low                     | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 6, 7, 8 | $f_{SYS} = 24\text{ MHz}$ | 250             | mA   |
| Output current high                    |          | $I_{OHA}$ |                                   |                           | -250            | mA   |
| Number of active stepper motor drivers |          |           |                                   |                           | 6               |      |

**(2)  $\mu$ PD70F3426A****Condition 1**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: RUN, HALT, IDLE

Power dissipation: &lt; 1.0 W

Duration: 15000 hours

 $V_{SS5} = 0\text{V}$ **Condition 2**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ ,

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation: &lt; 0.5W

Duration: 15 years

 $V_{SS5} = 0\text{V}$ **Table 10-2 Absolute maximum ratings currents for special conditions ( $\mu$ PD70F3426A)**

| Parameter                              |          | Symbol    | Test Conditions                |                           | Ratings average | Unit |
|--|----------|-----------|--------------------------------|---------------------------|-----------------|------|
| Output current low                     | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 48\text{ MHz}$ | 40              | mA   |
| Output current high                    |          | $I_{OHA}$ |                                |                           | -40             | mA   |
| Number of active stepper motor drivers |          |           |                                |                           | 6               |      |
| Output current low                     | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 24\text{ MHz}$ | 250             | mA   |
| Output current high                    |          | $I_{OHA}$ |                                |                           | -250            | mA   |
| Number of active stepper motor drivers |          |           |                                |                           | 6               |      |

**(3)  $\mu$ PD70F3425****Condition 1**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: RUN, HALT, IDLE

Power dissipation: &lt; 0.9 W

Duration: 15000 hours

 $V_{SS5} = 0\text{V}$ **Condition 2**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation: &lt; 0.5W

Duration: 15 years

 $V_{SS5} = 0\text{V}$ **Table 10-3 Absolute maximum ratings currents for special conditions ( $\mu$ PD70F3425)**

| Parameter                             |          | Symbol    | Test Conditions                |                           | Ratings average | Unit |
|---------------------------------------|----------|-----------|--------------------------------|---------------------------|-----------------|------|
| Output current low                    | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 48\text{ MHz}$ | 135             | mA   |
| Output current high                   |          | $I_{OHA}$ |                                |                           | -135            | mA   |
| Number of active stepper motor driver |          |           |                                |                           | 6               |      |
| Output current low                    | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 32\text{ MHz}$ | 250             | mA   |
| Output current high                   |          | $I_{OHA}$ |                                |                           | -250            | mA   |
| Number of active stepper motor driver |          |           |                                |                           | 6               |      |

**(4)  $\mu$ PD70F3424****Condition 1**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: RUN, HALT, IDLE

Power dissipation:  $< 0.88\text{ W}$ 

Duration: 15000 hours

 $V_{SS5} = 0\text{V}$ **Condition 2**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation:  $< 0.5\text{W}$ 

Duration: 15 years

 $V_{SS5} = 0\text{V}$ **Table 10-4 Absolute maximum ratings currents for special conditions ( $\mu$ PD70F3424)**

| Parameter                             |          | Symbol    | Test Conditions                |                           | Ratings average | Unit |
|---------------------------------------|----------|-----------|--------------------------------|---------------------------|-----------------|------|
| Output current low                    | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 48\text{ MHz}$ | 180             | mA   |
| Output current high                   |          | $I_{OHA}$ |                                |                           | -180            | mA   |
| Number of active stepper motor driver |          |           |                                |                           | 6               |      |
| Output current low                    | All pins | $I_{OLA}$ | Sum of Groups 1, 2, 3, 5, 7, 8 | $f_{SYS} = 32\text{ MHz}$ | 250             | mA   |
| Output current high                   |          | $I_{OHA}$ |                                |                           | -250            | mA   |
| Number of active stepper motor driver |          |           |                                |                           | 6               |      |

**(5)  $\mu$ PD70F3421,  $\mu$ PD70F3422,  $\mu$ PD70F3423****Condition 1**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: RUN, HALT, IDLE

Power dissipation:  $< 0.86\text{ W}$ 

Duration: 15000 hours

 $V_{SS5} = 0\text{V}$ **Condition 2**  $T_A = -40^\circ\text{C} \sim +105^\circ\text{C}$ 

Operation Modes: WATCH, Sub-WATCH, STOP, Sub-Clock CPU Operation

Power dissipation:  $< 0.5\text{W}$ 

Duration: 15 years

 $V_{SS5} = 0\text{V}$ **Note** No additional condition must be fulfilled.

# Chapter 11 Package

## 11.1 Package of $\mu$ PD70F3426AGJ, $\mu$ PD70F3425GJ, $\mu$ PD70F3424GJ, $\mu$ PD70F3423GJ, $\mu$ PD70F3422GJ, $\mu$ PD70F3421GJ

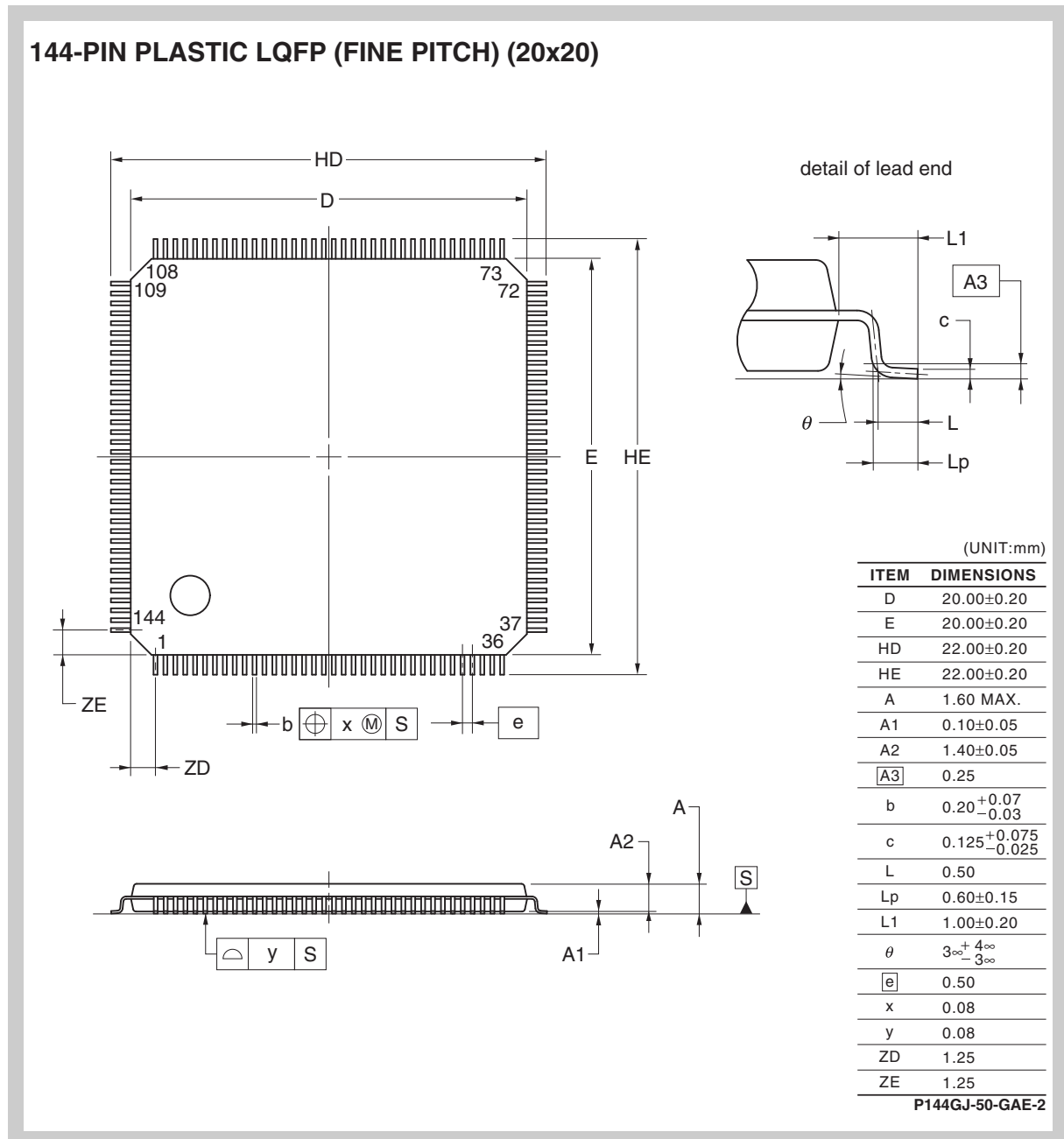


Figure 11-1 Package Drawing of  $\mu$ PD70F3426AGJ,  $\mu$ PD70F3425GJ,  $\mu$ PD70F3424GJ,  $\mu$ PD70F3423GJ,  $\mu$ PD70F3422GJ,  $\mu$ PD70F3421GJ

## 11.2 Package of $\mu$ PD70F3427GD

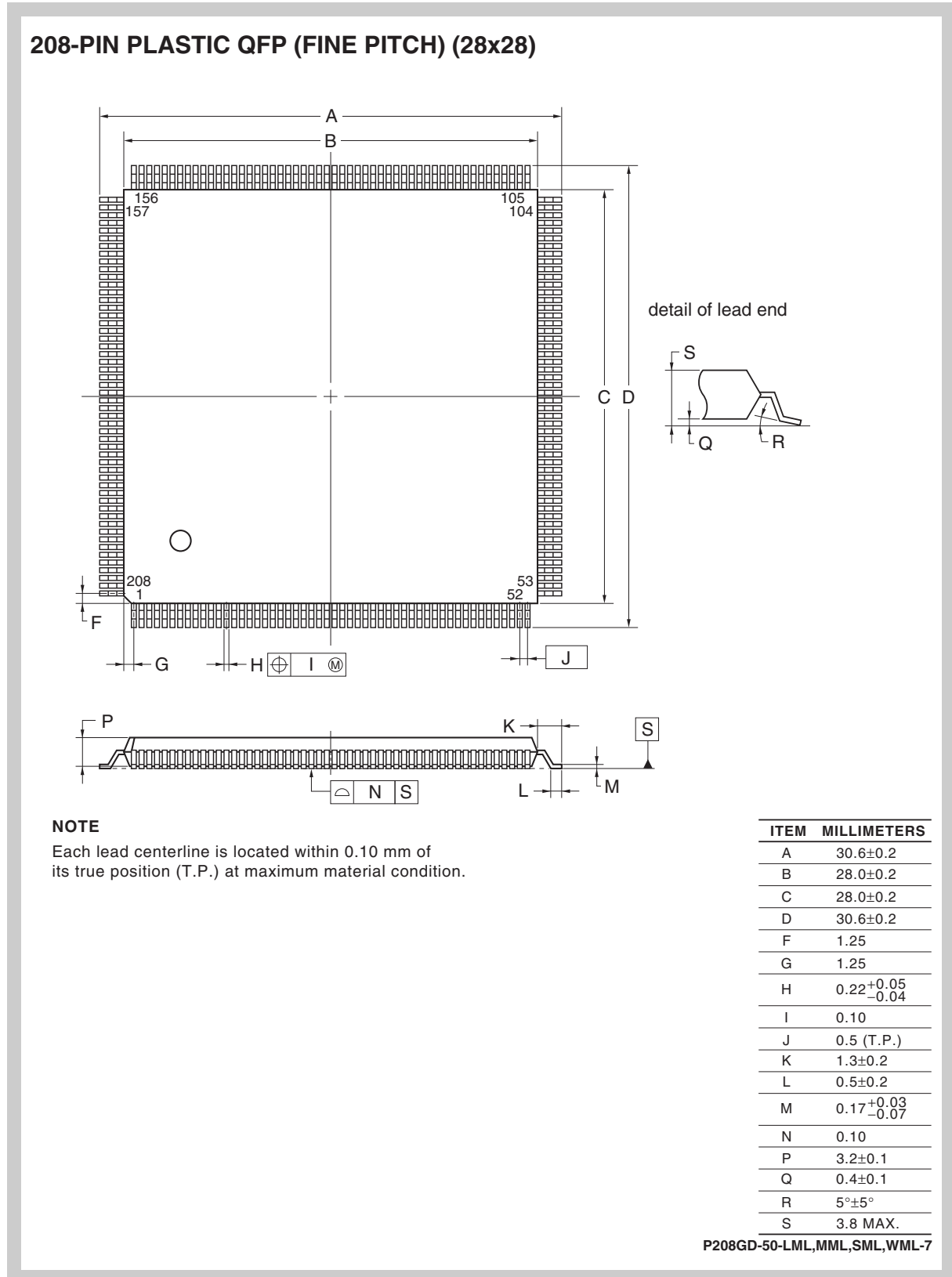


Figure 11-2 Package Drawing  $\mu$ PD70F3427GD

## 11.3 Thermal Resistance

Table 11-1 Thermal resistance of V850E/Dx3 products

| Product Code                    | Junction to Ambient            | Junction to Case | Junction to Lead | Lead       | Unit |
|---------------------------------|--------------------------------|------------------|------------------|------------|------|
|                                 | $R_{THJA}$ ,<br>Airflow = 0m/s | $R_{THJC}$       | $R_{THJL}$       | $R_{THLL}$ |      |
| $\mu$ PD70F3421GJ(A)-GAE-QS-AX  | 43.26                          | 7.53             | 22.49            | 0.22       | K/W  |
| $\mu$ PD70F3422GJ(A)-GAE-QS-AX  | 43.26                          | 7.53             | 22.49            | 0.22       | K/W  |
| $\mu$ PD70F3423GJ(A)-GAE-QS-AX  | 43.26                          | 7.53             | 22.49            | 0.22       | K/W  |
| $\mu$ PD70F3424GJ(A)-GAE-QS-AX  | 43.26                          | 7.53             | 22.49            | 0.22       | K/W  |
| $\mu$ PD70F3425GJ(A)-GAE-QS-AX  | 42.89                          | 6.68             | 21.08            | 0.21       | K/W  |
| $\mu$ PD70F3426AGJ(A)-GAE-QS-AX | 41.66                          | 5.33             | 19.77            | 0.19       | K/W  |
| $\mu$ PD70F3427GD(A)-LML-QS-AX  | 38.36                          | 10.39            | 22.99            | 0.43       | K/W  |

**Note** Maximum junction temperature  $T_{Jmax} = 150^{\circ}\text{C}$



# Chapter 12 Recommended Soldering Conditions

## 12.1 Description of Recommended Conditions

The recommended soldering conditions by item are indicated by a combination of the soldering process, peak temperature, baking time, and exposure limit all abbreviated as shown below.

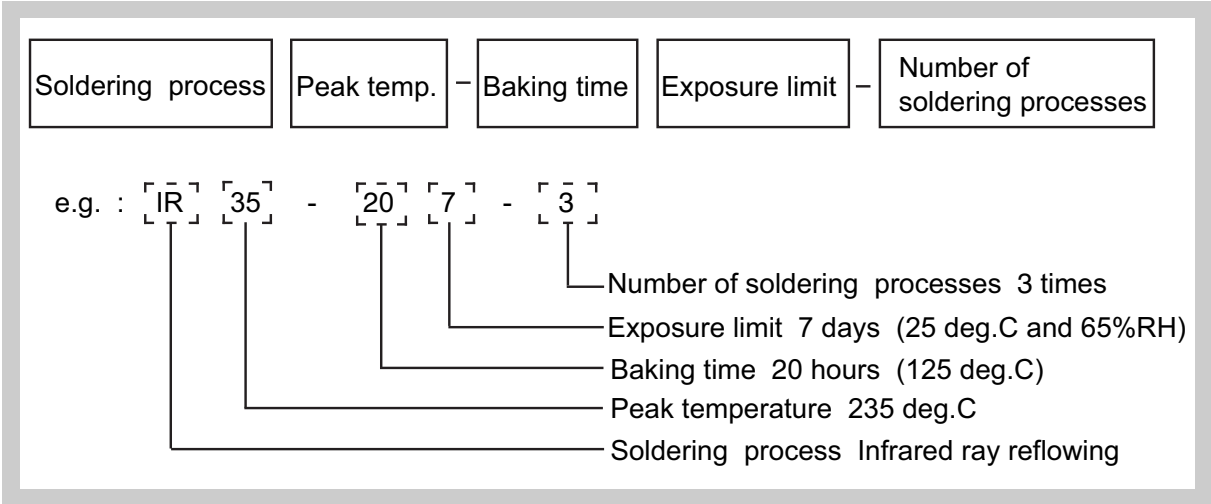


Figure 12-1 Soldering conditions indication

### 12.1.1 Soldering process

The soldering process is indicated by the following symbols:

| Soldering process         | Symbol |
|---------------------------|--------|
| Infrared Reflow Soldering | IR     |
| Vapour Phase Soldering    | VP     |
| Wave Soldering            | WS     |

### 12.1.2 Peak temperature

The peak temperature is indicated by the two least significant digits (two characters) of the peak value. The peak temperature of the VPS and the infrared ray reflowing process is indicated by the package surface temperature. The wave soldering is indicated by the solder temperature.

| Peak temperature | Symbol |
|------------------|--------|
| 215 deg.C        | 15     |
| 220 deg.C        | 20     |
| 230 deg.C        | 30     |
| 235 deg.C        | 35     |
| 260 deg.C        | 60     |

### 12.1.3 Baking time

The baking time is indicated by the following symbols:

| Baking time (stored at 125 deg.C) | Symbol |
|-----------------------------------|--------|
| No baking required (0 hours)      | 00     |
| 10 hours                          | 10     |
| 16 hours                          | 16     |
| 20 hours                          | 20     |
| 36 hours                          | 36     |

### 12.1.4 Exposure limit

Exposure limit means the maximum limit with which the device can be soldered without problem after unpack. The limit is indicated by the following symbols:

| Exposure limit<br>(Temperature 25 deg.C and<br>humidity 65%RH or less) | Symbol |
|--|--------|
| One day (24 hours)   | 1      |
| Two days (48 hours)  | 2      |
| Three days (72 hours)  | 3      |
| Seven days (168 hours)   | 7      |
| Eight hours  | B      |
| Twelve hours   | C      |

### 12.1.5 Number of soldering process

Number of soldering process is indicated by the following symbols:

| Number of soldering processes | Symbol |
|-------------------------------|--------|
| Once                          | 1      |
| Twice                         | 2      |

## 12.2 Recommended Conditions of IR60-207-3

The following is recommended soldering conditions. (Moisture sensitive device)

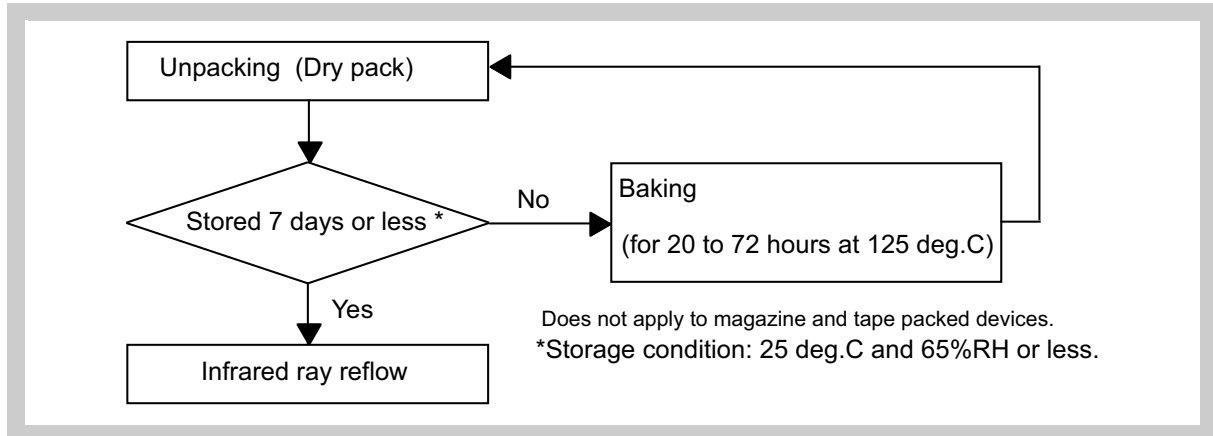


Figure 12-2 Recommended Handling of Unpacked Devices

|   |  |
|---|--|
| Peak temperature:   | 260 deg.C or below (Package's surface temperature)   |
| Reflow time:  | 60 seconds or less (at 220 deg.C)  |
| Maximum number of reflow processes:                           | 3 times  |
| Exposure limit (Store until the final reflow process starts): | 7 days or less   |
| Flux:   | Rosin flux containing small amount of chlorine (Flux with a maximum chlorine content of 0.2 Wt% is recommended.) |

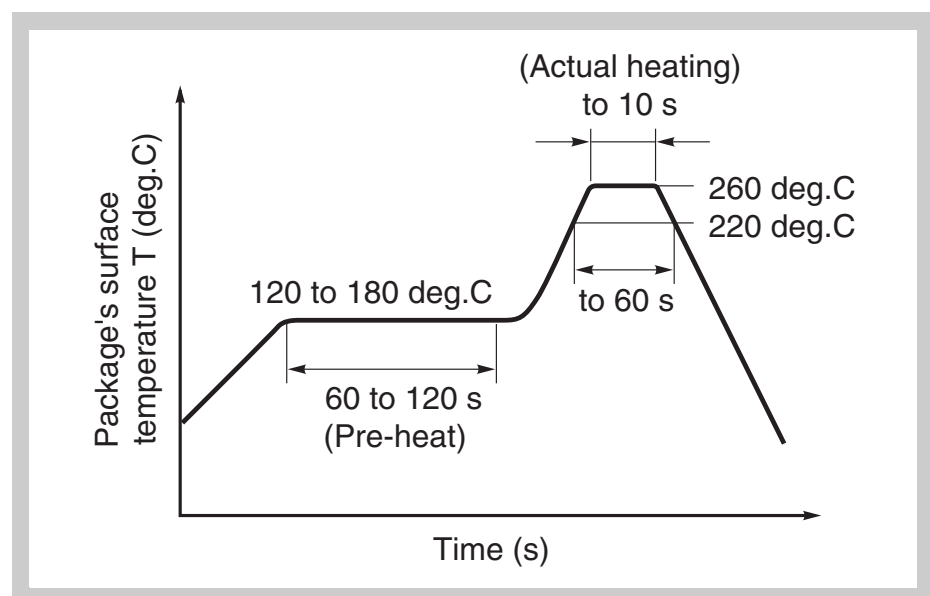


Figure 12-3 Infrared Ray Reflow Temperature Profile

## Appendix A Revision History

| Item | Date published | Document No.     | Comment   |
|------|----------------|------------------|---|
| 1    | Jul 5, 2005    | EASE-PL-8007-0V1 | First release of this document  |
| 2    | Aug 3, 2005    | EASE-PL-8007-0V2 | Second release of this document   |
| 3    | Dec 13, 2005   | EASE-PL-8007-0V3 | <p>Update of document</p> <p>Overview:</p> <ul style="list-style-type: none"> <li>- Included the derivatives <math>\mu</math>PD70F3427, <math>\mu</math>PD70F3426, <math>\mu</math>PD70F3422, <math>\mu</math>PD703422.</li> <li>- Included a note describing the expansion of flash and RAM for the derivative <math>\mu</math>PD70F3426.</li> <li>- Included the LCD I/F to the reduced peripheral set.</li> </ul> <p>DC characteristics:</p> <ul style="list-style-type: none"> <li>- Added typical operating current for 48MHz.</li> <li>- Changed VCOMP0/1 to VCMP0/1.</li> <li>- Corrected the table 6-15.</li> </ul> <p>Pinout Information:</p> <ul style="list-style-type: none"> <li>- Included the Pinconfiguration of the new derivatives <math>\mu</math>PD70F3427 and <math>\mu</math>PD70F3426.</li> <li>- Introduced the pin-group 6 representing the external memory-interface of the new derivative <math>\mu</math>PD70F3427.</li> <li>- Introduced the pin-group 8 representing the voltage comparator input pins.</li> </ul> <p>Absolute Maximum Ratings:</p> <ul style="list-style-type: none"> <li>- Included the DJ3 derivatives <math>\mu</math>PD70F3427, <math>\mu</math>PD70F3426, <math>\mu</math>PD70F3422, <math>\mu</math>PD703422.</li> <li>- Included the concerned parameters for the <math>\mu</math>PD70F3427's memory interface.</li> </ul> <p>General Characteristics:</p> <ul style="list-style-type: none"> <li>- Included the concerned information regarding the external memory interface of the derivative <math>\mu</math>PD70F3427.</li> </ul> <p>Operation Conditions:</p> <ul style="list-style-type: none"> <li>- Included the DJ3 derivatives <math>\mu</math>PD70F3427 and <math>\mu</math>PD70F3426 for the corresponding CPU clock frequencies 32 MHz and 48 MHz.</li> </ul> <p>DC-Characteristics:</p> <ul style="list-style-type: none"> <li>- Included the DJ3 derivatives <math>\mu</math>PD70F3427 and <math>\mu</math>PD70F3426.</li> <li>- Separated the characteristics of pin-group 3 for <math>\mu</math>PD70F3427 and the remaining devices.</li> <li>- Included the characteristics of pin-group 6 for the device <math>\mu</math>PD70F3427.</li> <li>- Included the supply-currents for added derivatives <math>\mu</math>PD70F3427 and <math>\mu</math>PD70F3426.</li> <li>- Added a note regarding current limit function of the derivative <math>\mu</math>PD70F3427.</li> <li>- Review of chapter "LCD Common and Segment Lines".</li> </ul> <p>AC-Characteristics:</p> <ul style="list-style-type: none"> <li>- Included the derivatives <math>\mu</math>PD70F3427 and <math>\mu</math>PD70F3426.</li> <li>- Included the external memory access specification for the derivative <math>\mu</math>PD70F3427.</li> </ul> <p>Analog Functions:</p> <ul style="list-style-type: none"> <li>- POC characteristics. Included a note.</li> </ul> |

| Item | Date published | Document No.     | Comment  |
|------|----------------|------------------|--|
| 3    | Dec 13, 2005   | EASE-PL-8007-0V3 | Flash Memory:<br>- Included the derivatives $\mu$ PD70F3427 and $\mu$ PD70F3426.   |
|      |                |                  | Package:<br>- Included the derivatives $\mu$ PD70F3427 and $\mu$ PD70F3426<br>- Added the package drawings for the derivatives $\mu$ PD70F3427 and $\mu$ PD70F3426.  |
| 4    | Sep 4, 2006    | EASE-PL-8007-1V0 | Redefinition of that document "Electrical Target Specification" to "Preliminary Data Sheet".   |
|      |                |                  | Family Overview:<br>- Updated operating clock.   |
|      |                |                  | Operation Conditions:<br>- Update the CPU clock frequencies.   |
|      |                |                  | DC-Characteristics:<br>- Updated the supply-currents for all derivatives.<br>- Completion of table 6-23.   |
|      |                |                  | AC-Characteristics:<br>- Updated the AC-Characteristics for the ext. mem. I/F ( $\mu$ PD70F3427).  |
| 5    | Jan 18, 2007   | EASE-PL-8007-1V1 | DC-Characteristics:<br>- Included the values for the LCD split voltages<br>- Updated the supply-currents for the derivatives $\mu$ PD70F3424, $\mu$ PD70F3426 and $\mu$ PD70F3427.   |
|      |                |                  | AC- Characteristics:<br>- CSIB updated and expanded characteristics.<br>- LCD Bus Interface updated.<br>- External memory access updated.  |
|      |                |                  | Analog Functions:<br>- Added the Voltage Comparator Characteristics stabilization time.  |
|      |                |                  | Flash Memory:<br>- Updated parameters for End-of-Line programming.<br>Included parameters for missing derivatives.   |
|      |                |                  | Special Conditions for Device Operation at extended Operating Temperature Range ( $T_A = -40^\circ\text{C} \dots +105^\circ\text{C}$ )<br>- Included a new chapter describing the operating conditions when device is operating within the extended operating temperature range. |
|      |                |                  |  |
| 6    | Oct. 29, 2009  | U20110EE1V0DS00  | Overview:<br>- Updated device list.  |
|      |                |                  | Peripherals:<br>- added Memory interface extension for $\mu$ PD70F3427GD<br>- added 3rd CAN channel for $\mu$ PD70F3421/22/23/24/25/27<br>- added Timer Y (TMY) for all devices<br>- corrected number of voltage comparators from 3 to 2   |
|      |                |                  | Internal RAM:<br>- Increased from 16kbytes to 20kbytes for $\mu$ PD70F3422GJ   |
|      |                |                  | General Characteristics:<br>- Updated the parameters regarding the SSCG modulation range and frequency.<br>- Added input leakage parameters for pin group 6.   |

| Item | Date published | Document No.    | Comment   |
|------|----------------|-----------------|---|
| 6    | Oct. 29, 2009  | U20110EE1V0DS00 | <p>DC-Characteristics:</p> <ul style="list-style-type: none"> <li>- Added injected current specification (Table 6-1)</li> <li>- Removed limitation "CMOS2 and SCHMITT2 are only available on Port P8" (Table 6-2, table 6-3)</li> <li>- Added Schmitt2 and CMOS2 (Table 6-6, table 6-7, table 6-8)</li> <li>- Added ADC Low Voltage Operating Range (Table 6-9)</li> <li>- Extended Schmitt 2 and CMOS2 to whole pingroup 3 (Table 6-10, table 6-11)</li> <li>- Added Definitions for VLCD (Table 6-15)</li> <li>- Added Schmitt2 and CMOS2 (Table 6-16 - DC Characteristics Stepper Motor Driver Input Normal Voltage Operation, table 6-17)</li> <li>- Added Stepper Motor Driver Zeropoint Detection</li> <li>- Reduced "Watch" and "Watch monitored" currents for <math>\mu</math>PD70F3421/22/23/24/25/26 (Table 6-23, table 6-26, table 6-27)</li> <li>- Added "Additional Supply Current (Operating) during Self-Flash-Programming" (Table 6-24)</li> <li>- Reduced supply currents for <math>\mu</math>PD70F3427 (Table 6-25)</li> <li>- Added table describing when bias current is flowing.</li> <li>- Added LCD common and segment lines operation current</li> <li>- Stepper motor driver output voltage deviation not tested, but specified by design</li> </ul> <p>AC Characteristics:</p> <ul style="list-style-type: none"> <li>- Corrected parameters for the serial clock high- and low-level width.</li> <li>- Corrected min. SIBn setup time in low voltage operation CSIB master mode</li> <li>- Corrected maximum I<sup>2</sup>C clock SCL0</li> <li>- Renamed LCD Bus I/F control modes</li> <li>- Corrected D<sub>VDD5</sub> range of LCD Bus I/F specification</li> <li>- Updated the characteristics for the ext. mem. I/F.</li> <li>- Added/corrected the characteristics for the mem. I/F's asynchronous synchronous operation.</li> <li>- Added "i" in calculation for T<sub>DWRA</sub> (Table 7-18)</li> </ul> <p>Analog Functions:</p> <ul style="list-style-type: none"> <li>- Updated A/D Converter parameters</li> <li>- Removed uncalibrated Voltage Comparator threshold: no user calibration required</li> <li>- Reduced POC Threshold Voltage Max. to 3.5V (Table 8-2)</li> <li>- Added TDETV1 for Voltage Comparator (Table 8-3)</li> </ul> <p>Flash Memory:</p> <ul style="list-style-type: none"> <li>- Modified parameters for Flash Memory Characteristics.</li> </ul> <p>Special Conditions for Device Operation at extended Operating Temperature Range (T<sub>A</sub> = -40°C ... +105°C):</p> <ul style="list-style-type: none"> <li>- Added the whole chapter.</li> </ul> <p>Package / Pin configuration:</p> <ul style="list-style-type: none"> <li>- thermal resistances specified</li> <li>- Corrected package code for <math>\mu</math>PD70F3427 to <math>\mu</math>PD70F3427GD (was <math>\mu</math>PD70F3427GJ, chapter 2.1)</li> <li>- Updated pin configuration drawings (chapters 2.1, 2.2, 2.3)</li> </ul> <p>Absolute maximum ratings</p> <ul style="list-style-type: none"> <li>- Increased Output currents low (Table 3-2)</li> <li>- Added Power Supply Restrictions (Table 3-3)</li> <li>- Updated parameter for the power dissipation and storage temperature</li> <li>- Corrected symbols of currents</li> </ul> |

| Item | Date published | Document No.    | Comment   |
|------|----------------|-----------------|---|
| 6    | Oct. 29, 2009  | U20110EE1V0DS00 | Operating Conditions<br>- Added SSCG for IICLK, SPCLK0-1 and SPCLK2-15 (Table 5-2)<br>- Added sub chapter "5.3 AC Load Condition - Single Pin Switching"<br>Naming: Changed $\mu$ PD70F3426 to $\mu$ PD70F3426A (64MHz)   |
| 7    | Dec 10, 2010   | R01DS0049ED0200 | Overview:<br>Replaced product names by product codes<br>Analog Functions:<br>- Added integral non linearity error (INL) to A/D converter characteristics<br>Package:<br>- Corrected/replaced package drawing of 144 pin plastic QFP (package code GAE instead of UEN) |
| 8    | Jun 1, 2011    | R01DS0049ED0210 | AC Characteristics of Flash Memory changed to more relaxed values ( $t_{MSET}$ , $t_{COUNT}$ )  |



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