

Datasheet

V850ES/FF3-L

32-bit Single-Chip Microcontroller

Hardware

μPD70F3615(A)

μPD70F3615(A1)

μPD70F3615(A2)

μPD70F3616(A)

μPD70F3616(A1)

μPD70F3616(A2)

μPD70F3617(A)

μPD70F3617(A1)

μPD70F3617(A2)

μPD70F3618(A)

μPD70F3618(A1)

μPD70F3618(A2)

μPD70F3619(A)

μPD70F3619(A1)

μPD70F3619(A2)

Notes for CMOS Devices

1. Precaution against ESD for semiconductors

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

2. Handling of unused input pins for CMOS

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

3. Status before initialization of MOS devices

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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1. Pin Group Information

1.1 Device package information

The V850ES/Fx3-L device series comprises several members. An overview with the pin and package information is given in the following table:

Series Member	# Pins	Device package information
μPD70F3610 μPD70F3611 μPD70F3612 μPD70F3613 μPD70F3614	64	FE3-L
μPD70F3615 μPD70F3616 μPD70F3617 μPD70F3618 μPD70F3619	80	FF3-L
μPD70F3620 μPD70F3621 μPD70F3622	100	FG3-L

This document describes the specification for the V850ES/FF3-L.

1.2 Pin Groups 1x: Pins supplied by EVDD

1B: (SHMT1)

- P04, P30-31, P34; P40, P91, P913-915 (FE3-L)
- P04, P30-31, P34; P38-39, P40, P91, P913-915 (FF3-L)
- P04, P30-31, P34; P36-39, P40, P91, P911, P913-915 (FG3-L)

1D: (SHMT3)

- P00-03, P05-P06, P32-33, P35, P41-42, P50-55, P90, P96-99 (FE3-L)
- P00-03, P05-P06, P32-33, P35, P41-42, P50-55, P90, P96-99 (FF3-L)
- P00-03, P05-P06, P10-11, P32-33, P35, P41-42, P50-55, P90, P92-910, P912 (FG3-L)

1.3 Pin Groups 2x: Pins supplied by EVDD

2A: (CMOS)

- PCM0-1 (FE3-L)
- PCM0-3, PCS0-1, PCT0-1, PCT4, PCT6 (FF3-L)

2D: (SHMT3)

- PDL0-7 (FE3-L)
- PDL0-11 (FF3-L)

1.4 Pin Groups 3x: Pins supplied by BVDD

3A: (CMOS)

- PCM0-3, PCS0-1, PCT0-1, PCT4, PCT6 (FG3-L)

3D: (SHMT3)

- PDL0-13 (FG3-L)

1.5 Pin Groups 4: Pins supplied by AVREF0

4: (CMOS)

- P70-79 (FE3-L)
- P70-711 (FF3-L)
- P70-715 (FG3-L)

1.6 Pin Groups 6: Pins supplied by EVDD

- RESET (SHMT2)
- IC, FLMD0

1.7 Pin Groups 7: Pins supplied by VRO

- X1, X2, XT1, XT2

2. Electrical Specifications

This product has to be used only under the conditions of VDD=EVDD. Operation is not ensured at the time of using this product except this condition.

The operating ambient temperature of each quality grade is as follows:

(A)-Grade: Ta = -40 to +85°C

(A1)-Grade: Ta = -40 to +110°C

(A2)-Grade: Ta = -40 to +125°C

2.1 Absolute Maximum Ratings

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Conditions	Rating	Unit		
Supply voltage	VDD	VDD=EVDD,	-0.5 to +6.5	V		
	EVDD	VDD=EVDD	-0.5 to +6.5			
	AVREF0		-0.5 to +6.5			
	VSS	VSS=EVSS=AVSS	-0.5 to +0.5			
	EVSS	VSS=EVSS=AVSS	-0.5 to +0.5			
	AVSS	VSS=EVSS=AVSS	-0.5 to +0.5			
Input voltage	VI1	Pin Group 1x, 2x, 6	-0.5 to EVDD+0.5 Note1	V		
	VI3	Pin Group 7	-0.5 to VRO+0.5 Note1			
Analog input voltage	VIAN	Pin Group 4	-0.5 to AVREF0+0.5 Note1	V		
High level output current	IOH	Pin Group 1x, 2x	1 pin	-4	mA	
			Total	(A)		-50
		Pin Group 4	Total	(A1)		-20
				(A2)		-20
	Pin Group 4	Total	1 pin	-4		
			(A) ^{Note2}	-20		
		(A1) ^{Note2}	-10			
		(A2) ^{Note3}	-10			
Low level output current	IOL	Pin Group 1x, 2x	1 pin	4	mA	
			Total	(A)		50
		Pin Group 4	Total	(A1)		20
				(A2)		20
	Pin Group 4	Total	1 pin	4		
			(A) ^{Note2}	20		
		(A1) ^{Note2}	10			
		(A2) ^{Note3}	10			
Operating ambient temperature	Ta	Normal operating mode	(A)	-40 to +85	°C	
		Flash programming mode				
		Normal operating mode	(A1)	-40 to +110		
		Flash programming mode				
		Normal operating mode	(A2)	-40 to +125		
		Flash programming mode				
Storage temperature	Tstg		-40 to +125	°C		

Remarks: 1. The characteristics of the dual-function pins are the same as those of the port pins unless otherwise specified

Notes: 1. Be sure not to exceed the absolute maximum ratings (Max. value) of each supply voltage.
 2. Excluding ADC IAREF0 current.
 3. Including ADC IAREF0 current.

2.2 Capacities

(Ta = 25°C, VDD = EVDD = AVREF0 = VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input/output capacitance	CIO	f=1MHz, Not measured pins is 0V.			10	pF

2.3 Operating condition

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Internal System clock frequency (f _{VBLK})	Supply voltage	Operating Condition
$4.0 \leq f_{xx} \leq 20\text{MHz}$ Note1	$3.5\text{V} \leq \text{VDD} \leq 5.5\text{V}$ ^{Note1}	Operation of functions is enabled
	$3.3\text{V} \leq \text{VDD} < 3.5\text{V}$	The following functions are operable: <ul style="list-style-type: none"> • CPU • Flash (including programming) • RAM • IO Buffer • Port • WT • WDT • INT • CLM • POC • LVI
	$3.3\text{V} \leq \text{AVRF0} \leq 5.5\text{V}$	<ul style="list-style-type: none"> • A/D Converter <ul style="list-style-type: none"> • stop ADC for AVREF0 < 4.0V (ADA0CE bit =0) • Refer to chapter '2.8 A/D Converter' for details.
$32\text{kHz} \leq f_{XT} \leq 35\text{kHz}$ (Crystal)	$3.3\text{V} \leq \text{VDD} < 5.5\text{V}$ Note1	-
$12.5\text{kHz} \leq f_{XT} \leq 27.5\text{kHz}$ ^{Note2} (RC)		
f _{RL} (240kHz Internal-OSC)	$3.3\text{V} \leq \text{VDD} < 5.5\text{V}$ ^{Note1}	-

Notes: 1. VDD = EVDD

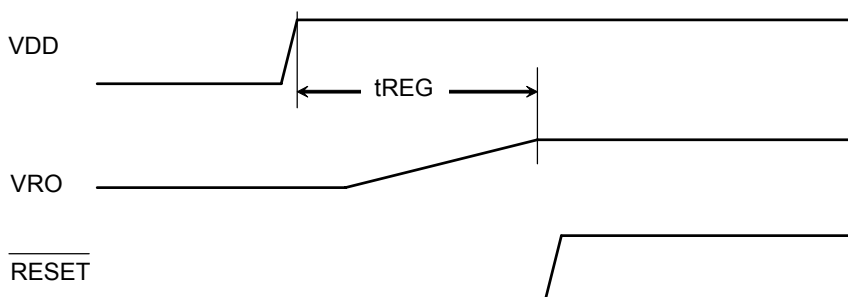
2. RC Oscillation frequency is min. 25kHz max. 55kHz. This clock is divided by 2 internally.

2.4 Voltage Regulator Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD, VSS = EVSS = AVSS = 0V))

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input voltage	VDD		3.5		5.5	V
		Limited function see '2.3 Operating condition'	3.3			V
Output voltage	VRO			2.5		V
Output voltage stabilization time	t _{REG} ^{Note}	After VDD reaches voltage range min. 3.3V To connect C=4.7uF on REGC terminal			1	ms

Note: In case of non-POC device, be sure to start VDD in the state of $\overline{\text{RESET}}=\text{VSS}=0\text{V}$.
For POC devices there is no need to control external $\overline{\text{RESET}}$ terminal. For decives with POC function the internal $\overline{\text{RESET}}$ signal will automatically controlled until VRO is stable.



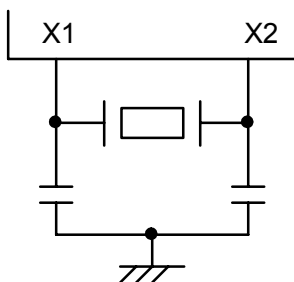
2.5 Clock Generator Circuit

2.5.1 Main System Clock Oscillation Circuit Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Crystal / Ceramic resonator	Refer to figure below	Oscillator frequency (fx) ^{Note1}		4		16	MHz
		Oscillation stabilization time ^{Note2}	After STOP mode	54 ^{Note4}	Note3		μs
			After IDLE2 mode	54 ^{Note4}	Note3		μs

- Notes:**
1. Indicates only oscillation circuit characteristics. Refer to '2.7 AC Characteristics' for CPU operation clock.
 2. Time required to stabilize oscillation after VDD reaches oscillator voltage range MIN. 3.3V
 3. Depends on the setting of the oscillation stabilization time select register (OSTS)
 4. Minimum time required to stabilize flash. Time has to be secured by setting the oscillation stabilization time select register (OSTS)



2.5.2 Sub System Clock Oscillation Circuit Characteristics

(Ta = -40 to +85°C, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
Crystal resonator	Refer to Figure 1	Oscillator frequency (fxt) ^{Note1}		32	32.768	35	kHz
		Oscillation stabilization time ^{Note2}				10	s

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Resonator	Recommended Circuit	Parameter	Conditions	MIN.	TYP.	MAX.	Unit
RC resonator	Refer to Figure 2	Oscillator frequency ^{Note1,4}	R=390KΩ ±5% ^{Note3} , C=47pF ±10% ^{Note3}	25	40	55	kHz
		Oscillation stabilization time ^{Note2}				100	μs

- Notes:**
1. Indicates only oscillation circuit characteristics. Refer to "AC Characteristic" for cpu operation clock.
 2. Time required to stabilize oscillation after VDD reaches oscillator voltage range min. 3.3V
 3. In order to avoid the influence of wiring capacity, shorten wiring as much as possible.
 4. RC Oscillation frequency is typ. 40kHz. This clock is divided (1/2) internally. In case of RC Oscillator, internal system clock frequency (fxt) is min. 12.5kHz, typ. 20kHz, max. 27.5kHz.



2.5.3 Internal-OSC Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Output frequency	f _{RL}	240kHz Internal-OSC	204	240	276	kHz
	f _{RH}	8MHz Internal-OSC	7.2	8.0	8.8	MHz
Oscillation stabilization time		240kHz Internal-OSC		10	36	μs
		8MHz Internal-OSC	51	92	256	μs

2.5.4 PLL Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input frequency	f_x		4		16	MHz
	f_{PLL1}	Note1	3		6	MHz
Output frequency	f_{xx}		10		20	MHz
Lock time	tPLL	After VDD reaches voltage range min. 3.3V			800	μs
Output period jitter Note2	tpj	Peak to peak			2.0	ns

- Notes:**
1. The input of the PLL (f_{PLL1}) can be set to f_x , $f_x/2$, or $f_x/4$. The divider is set through an option byte in the code flash memory.
 2. Not tested in production.

2.6 DC Characteristics

2.6.1 Input/Output Level

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
High level input voltage	VIH1	Pin Group 1B	0.7·EVDD		EVDD	V
	VIH2	Pin Group 1D	0.8·EVDD		EVDD	V
		Pin Group 2D	0.8·EVDD		EVDD	V
	VIH3	Pin Group 2A	0.7·EVDD		EVDD	V
	VIH4	Pin Group 4	0.7·AVREF0		AVREF0	V
Low level input voltage	VIH5	Pin Group 6	0.8·EVDD		EVDD	V
	VIL1	Pin Group 1B	EVSS		0.3·EVDD	V
	VIL2	Pin Group 1D	EVSS		0.4·EVDD	V
		Pin Group 2D	EVSS		0.4·EVDD	V
	VIL3	Pin Group 2A	EVSS		0.3·EVDD	V
Input hysteresis	VIL4	Pin Group 4	AVSS		0.3·AVREF0	V
	VIL5	Pin Group 6	EVSS		0.2·EVDD	V
	VHYS1	Pin Group 1B	Center point at 0.5·EVDD ^{Note3}		0.267·EVDD - 0.51V	V
	VHYS2	Pin Group 1D	Center point at 0.6·EVDD ^{Note3}		0.192·EVDD - 0.31V	V
		Pin Group 2D	Center point at 0.6·EVDD ^{Note3}		0.192·EVDD - 0.31V	V
VHYS5	Pin Group 6	Center point at 0.5·EVDD ^{Note3}		0.535·EVDD - 0.9V	V	
High level output voltage ^{Note2}	VOH1	Pin Group 1x, 2x	IOH=-1.0mA	EVDD-1.0	EVDD	V
			IOH=-100μA	EVDD-0.5	EVDD	V
	VOH3	Pin Group 4	IOH=-1.0mA	AVREF0-1.0	AVREF0	V
			IOH=-100μA	AVREF0-0.5	AVREF0	V
Low level output voltage ^{Note2}	VOL1	Pin Group 1x, 2x	IOL=1.0mA	0	0.4	V
		P914, 915	IOL=3.0mA			
	VOL3	Pin Group 4	IOL=1.0mA	0	0.4	V
Software pull-up resistor	R1	VI=0V	10	30	100	kΩ
Software ^{Note1} pull-down resistor	R2	VI=VDD	10	30	100	kΩ

Remark: The characteristics of the dual-function pins are the same as those of the port pins unless otherwise specified.

- Notes:**
1. $\overline{\text{DRST}}$ terminal only. (Control register is OCDM)
 2. Total IOH/IOL for each power supply line (EVDD and AVREF0).
 - (A-Grade) :max 20mA/-20mA
 - (A1-/A2-Grade): max. 10mA/-10mA
 AVREF0 IOH/IOL current is excluding ADC0 current IAREF0.
 3. Typical value. Not tested and guaranteed

2.6.2 PIN leakage current

(C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.			Unit
					(A)	(A1)	(A2)	
High level input leakage current	ILIH1	VI=VDD			0.2	0.4	0.5	μA
					Other pins ^{Note1}	0.5	0.8	
Low level input leakage current	ILIL1	VI=0V			-0.2	-0.4	-0.5	
					Other pins ^{Note1}	-0.5	-0.8	
High level output leakage current	ILOH1	VO=VDD			0.2	0.4	0.5	
					Other pins	0.5	0.8	
Low level output leakage current	ILOL1	VO=0V			-0.2	-0.4	-0.5	
					Other pins	-0.5	-0.8	

Notes: 1. The input leakage current of FLMD0 is as follows:

High level input leakage current :

- (A)-Grade 2.0μA
- (A1)-Grade 4.0μA
- (A2)-Grade 5.0μA

Low level input leakage current:

- (A)-Grade -2.0μA
- (A1)-Grade -4.0μA
- (A2)-Grade 5.0μA

2.6.3 Power supply current

2.6.3.1 FF3-L μ PD70F3615, μ PD70F3616, μ PD70F3617, μ PD70F3618, μ PD70F3619

(a) Absolute values

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
C=4.7 μ F, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V^{Note1})

Mode	Symbol	Condition			TYP.	MAX.			Unit	
						(A)	(A1)	(A2)		
Operating mode Note2	IDD1	All peripherals running	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =10MHz f _x =5MHz	16	24			mA
					f _{xx} =20MHz f _x =10MHz	25	35			mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	f _{xx} =8MHz 8MHz Internal-OSC ^{Note3}	12	19			mA
					f _{xx} =16MHz f _x =16MHz	20	28			mA
				Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =20MHz f _x =10MHz	22	32		
		All peripherals stopped	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =10MHz f _x =5MHz	13	-			mA
					f _{xx} =20MHz f _x =10MHz	21				mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	f _{xx} =8MHz 8MHz Internal-OSC ^{Note3}	11				mA
					f _{xx} =16MHz f _x =16MHz	18				mA
				Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =20MHz f _x =10MHz				21

Mode	Symbol	Condition				TYP.	MAX.			Unit	
							(A)	(A1)	(A2)		
HALT mode	IDD2	All peripherals running	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =10MHz f _x =5MHz	10	15			mA	
					f _{xx} =20MHz f _x =10MHz	17	25			mA	
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	f _{xx} =8MHz 8MHz Internal-OSC <small>Note3</small>	7	11			mA	
					f _{xx} =16MHz f _x =16MHz	12	18			mA	
				Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =20MHz f _x =10MHz	14	21			mA
		All peripherals stopped	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =10MHz f _x =5MHz	7	-			mA	
					f _{xx} =20MHz f _x =10MHz	12				mA	
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	f _{xx} =8MHz 8MHz Internal-OSC <small>Note3</small>	5				mA	
					f _{xx} =16MHz f _x =16MHz	9				mA	
				Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	f _{xx} =20MHz f _x =10MHz				11	mA

Mode	Symbol	Condition			TYP.	MAX.			Unit
						(A)	(A1)	(A2)	
IDLE1 mode	IDD3	Peripheral (TAA, UARTD) running	PLL: OFF 4MHz≤f _{xx} ≤16MHz Note7	f _{xx} =5MHz f _x =5MHz	1.4	2.2	2.5	2.8	mA
				f _{xx} =12MHz f _x =12MHz	2.0	3.1	3.4	3.7	mA
				f _{xx} =16MHz f _x =16MHz	2.4	3.6	3.9	4.2	mA
		f _{xx} =8MHz, 8MHz Internal-OSC ^{Note3}			1.5	2.3	2.6	2.9	mA
	All peripherals stopped	PLL: OFF 4MHz≤f _{xx} ≤16MHz Note7		f _{xx} =5MHz f _x =5MHz	1.2	-			mA
				f _{xx} =12MHz f _x =12MHz	1.4				mA
				f _{xx} =16MHz f _x =16MHz	1.6				mA
				f _{xx} =8MHz, 8MHz Internal-OSC ^{Note3}					1.1
IDLE2 mode	IDD4	PLL: OFF 4MHz≤f _{xx} ≤16MHz Note7		f _{xx} =5MHz f _x =5MHz	0.4	0.7	0.9	1.1	mA
				f _{xx} =12MHz f _x =12MHz	0.7	1.0	1.2	1.5	mA
				f _{xx} =16MHz f _x =16MHz	0.8	1.2	1.4	1.7	mA
				f _{xx} =8MHz, 8MHz Internal-OSC ^{Note3}			0.2	0.5	0.7
SUB operating mode ^{Note5}	IDD5	Crystal resonator (f _{xt} = 32,768kHz)			80	400	-	-	μA
		RC resonator (f _{xt} =20kHz) ^{Note6}			80	400	600	850	μA
		240 kHz Internal-OSC (SubOSC stopped)			220	1000	1200	1450	μA
SubIDLE mode ^{Note3,5}	IDD6	Crystal resonator (f _{xt} = 32,768kHz)			20	190	-	-	μA
		RC resonator (f _{xt} =20kHz) ^{Note6}			40	220	420	670	μA
		240kHz Internal-OSC (SubOSC stopped)			25	180	380	630	μA
STOP mode ^{Note3,4}	IDD7	POC stop	240kHz Internal-OSC stop		7.5	80	280	530	μA
			240kHz Internal-OSC working		15.5	95	295	545	μA
		POC work	240kHz Internal-OSC stop		10.5	85	285	535	μA
			240kHz Internal-OSC working		18.5	100	300	550	μA

(b) Calculation formulas

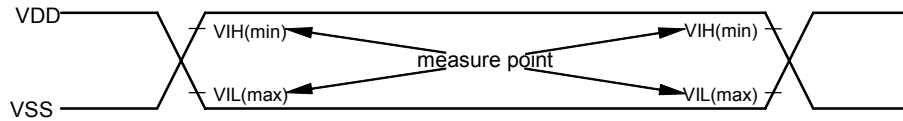
(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V^{Note1)})

Mode	Symbol	Condition		TYP. Note8	MAX. Note8			Unit	
					(A)	(A1)	(A2)		
Operating mode Note2	IDD1	All peripherals running	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	0.93·f _{xx} +6.3	1.12·f _{xx} +12.6			mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	0.93·f _{xx} +4.7	1.12·f _{xx} +9.7			mA
			Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	0.85·f _{xx} +5.2	1.03·f _{xx} +11.3			mA
		All peripherals stopped	Peripheral: ff _{xx} - PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	0.78·f _{xx} +5.4	-			mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	0.80·f _{xx} +4.9				mA
			Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	0.76·f _{xx} +5.4				mA
HALT mode	IDD2	All peripherals running	Peripheral: ff _{xx} - PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	0.70·f _{xx} +3.0	0.97·f _{xx} +5.2			mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	0.65·f _{xx} +1.9	0.90·f _{xx} +3.6			mA
			Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	0.54·f _{xx} +2.8	0.63·f _{xx} +8.60			mA
		All peripherals stopped	Peripheral: f _{xx} PRSI option: 0	PLL: ON 16MHz ≤ f _{xx} ≤ 20MHz	0.46·f _{xx} +2.8	-			mA
				PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	0.44·f _{xx} +1.6				mA
			Peripheral: f _{xx} /2 PRSI option: 1	PLL: ON 10MHz ≤ f _{xx} ≤ 20MHz	0.46·f _{xx} +1.8				mA
IDLE1 mode	IDD3	Peripheral (TAA, UARTD) running	PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz	0.092·f _{xx} +0.90	0.128·f _{xx} + 1.52	0.128·f _{xx} + 1.82	0.128·f _{xx} + 2.12	mA	
		All peripherals stopped		0.035·f _{xx} +1.01	-			mA	
IDLE2 mode	IDD4	PLL: OFF 4MHz ≤ f _{xx} ≤ 16MHz Note7		0.037·f _{xx} +0.21	0.049·f _{xx} + 0.43	0.049·f _{xx} + 0.63	0.049·f _{xx} + 0.88	mA	

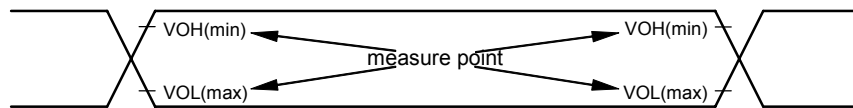
- Notes:**
1. VDD and EVDD total current. (Ports are stopped).
AVREF0 current, port buffer current (including a current flowing in the on-chip pull-up/pull-down resistor) are not included.
 2. The code flash is in read mode.
When the device is in programming mode (Self-programming mode) the current value (MAX. value) adds by the following value:
 - Self-programming mode:
 - + In case of PLL OFF: $7-(0.33*f_{xx}+0.1)$ [mA]
 - + In case of PLL ON: $7-(0.18*f_{xx}+3.0)$ [mA]
 3. Main OSC is stopped.
 4. Do not use SubOSC.
 5. POC is working. 240kHz Internal-OSC is working. 8MHz Internal-OSC is stopped.
 6. RC Oscillation frequency is typ.40kHz. This clock is divided by 1/2 internally.
 7. 8MHz Internal-OSC is stopped
 8. The formulas are for reference only. Not all possible values for f_{xx} are tested in the outgoing device inspection.

2.7 AC Characteristics

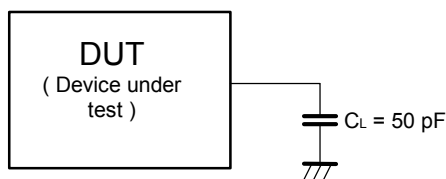
AC test Input measurement points (VDD, AVREF0, EVDD)



AC test output measurement points



Load conditions



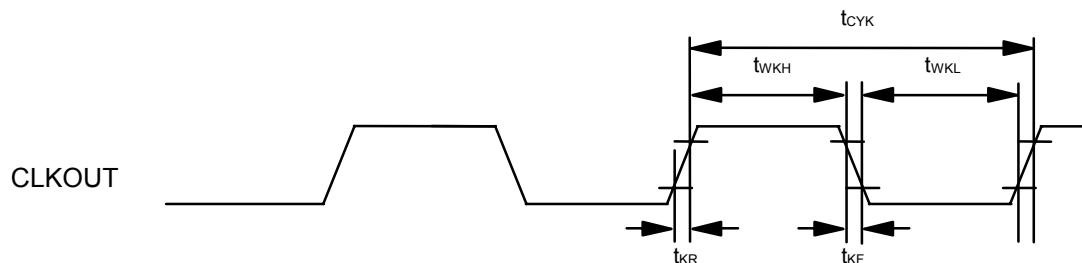
Caution: If the load capacitance exceeds 50pF due to the circuit configuration, reduce the load capacitance of the device to 50pF or less by inserting a buffer or by some other means.

2.7.1 CLKOUT Output Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
Output cycle	t _{CYK}		50ns	80μs	
High level width	t _{WKH}	VDD = EVDD = 4.0V ~ 5.5V	t _{CYK} /2-13		ns
		VDD = EVDD = 3.5V ~ 5.5V	t _{CYK} /2-15		
Low level width	t _{WKL}	VDD = EVDD = 4.0V ~ 5.5V	t _{CYK} /2-13		ns
		VDD = EVDD = 3.5V ~ 5.5V	t _{CYK} /2-15		
Rise time	t _{KR}	VDD = EVDD = 4.0V ~ 5.5V		13	ns
		VDD = EVDD = 3.5V ~ 5.5V		15	
Fall time	t _{KF}	VDD = EVDD = 4.0V ~ 5.5V		13	ns
		VDD = EVDD = 3.5V ~ 5.5V		15	

CLKOUT output timing



2.7.2 RESET, Interrupt, ADTRG Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
RESET input low level width	tWRSL	analog filter	250			ns
NMI input high level width	tWNIH	analog filter	250			ns
NMI input low level width	tWNIL	analog filter	250			ns
INTPn ^{Note1} input high level width	tWITH	analog filter ,n=0-8	250			ns
		digital filter ,n=3	Note2			ns
INTPn ^{Note1} input low level width	tWITL	analog filter ,n=0-8	250			ns
		digital filter ,n=3	Note2			ns

- Notes:** 1. ADTRG is same spec (P03/INTP0/ADTRG). $\overline{\text{DRST}}$ is same spec (P05/INTP2/ $\overline{\text{DRST}}$)
2. 2Tsamp+20 or 3Tsamp+20 ("Tsamp" is Noise reject sampling clock (NF macro))

- Remarks:** 1. The above minimum values show pulse widths that are surely detected as an effective edge. An effective may also be detected even if the input pulse width is less than the above minimum specification.
2. RESET, NMI, INTPn, ADTRG and $\overline{\text{DRST}}$ have analog noise filter. The typical filter time is typ=60ns.

2.7.3 Key Return Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
KRn input high level width	tWKRH	analog filter ,n=0-7	250			ns
KRn input low level width	tWKRL	analog filter ,n=0-7	250			ns

- Remarks:** 1. The above minimum values show pulse widths that are surely detected as an effective edge. An effective may also be detected even if the input pulse width is less than the above minimum specification.
2. KRn inputs have analog noise filter. The typical filter time is typ=60ns.

2.7.4 Timer Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Tl input high level width	tTIH	TIAA00-01,10-11,20-21,30-31,40-41 ^{Note1}	250			ns
Tl input low level width	tTIL	TIAA00-01,10-11,20-21,30-31,40-41 ^{Note1}	250			ns
TO output cycle	tTCYK	TIAA00-01,10-11,20-21,30-31, 40-41 ^{Note1}			10	MHz

- Notes:** 1. Except for the external trigger and external event function.

- Remarks:** 1. The above minimum values show pulse widths that are surely detected as an effective edge. An effective may also be detected even if the input pulse width is less than the above minimum specification.
2. TIAAn inputs have analog noise filter. The typical filter time is typ=60ns.

2.7.5 CSI Timing

(a) Master mode

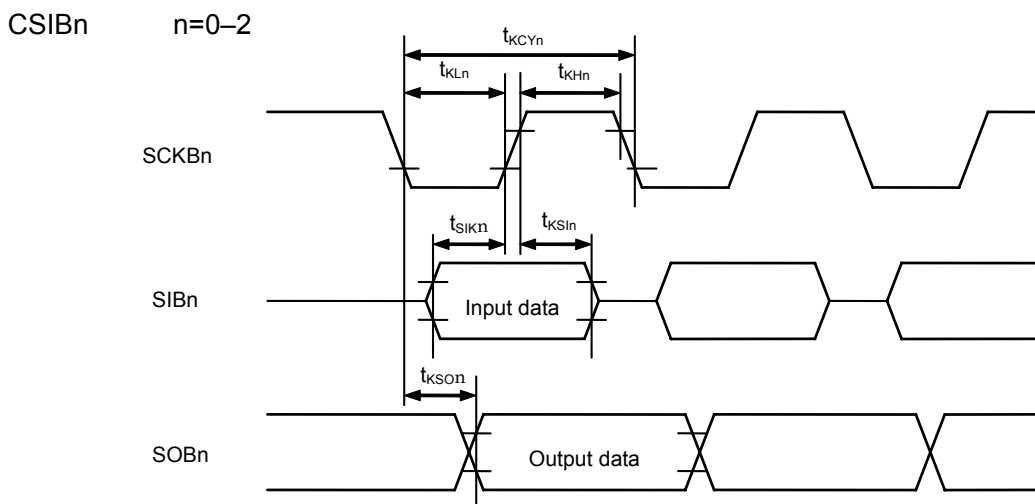
(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
SCKBn cycle time	tKCY1		125		ns
SCKBn high level width	tKH1		tKCY1/2-15		ns
SCKBn low level width	tKL1		tKCY1/2-15		ns
SIBn setup time (to SCKBn)	tSIK1		30		ns
SIBn hold time (from SCKBn)	tKSI1		25		ns
Delay time from SCKBn to SOBn	tKSO1			25	ns

(b) Slave mode

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	MAX.	Unit
SCKBn cycle time	tKCY1		200		ns
SCKBn high level width	tKH1		90		ns
SCKBn low level width	tKL1		90		ns
SIBn setup time (to SCKBn)	tSIK1		50		ns
SIBn hold time (from SCKBn)	tKSI1		50		ns
Delay time from SCKBn to SOBn	tKSO1			50	ns



2.7.6 UART Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate					1.5	Mbps
ASCK0 frequency					10	MHz

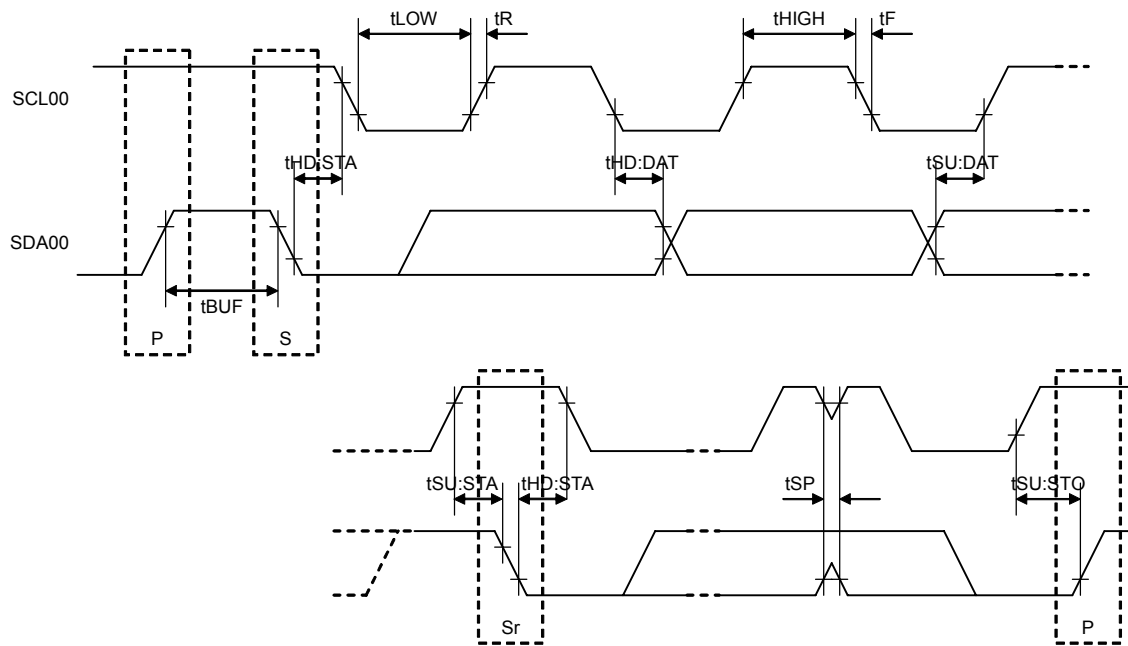
2.7.7 IIC Timing

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade,
VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter		Symbol	Normal mode		High-speed mode		Unit
			min.	max.	min.	max.	
SCL00 clock frequency		fCLK	0	100	0	400	kHz
Bus-free time (between stop/start conditions)		tBUF	4.7		1.3		μs
Hold time ^{Note1}		tHD:STA	4.0		0.6		μs
SCL00 clock low-level width		tLOW	4.7		1.3		μs
SCL00 clock high-level width		tHIGH	4.0		0.6		μs
Setup time for start/restart conditions		tSU:STA	4.7		0.6		μs
Data hold time	CBUS compatible master	tHD:DAT	5.0				μs
	IIC mode		0 ^{Note2}		0 ^{Note2}	0.9 ^{Note3}	μs
Data setup time		tSU:DAT	250		100 ^{Note4}		ns
SDA00 and SCL00 signal rise time		tR		1000	20+0.1Cb	300	ns
SDA00 and SCL00 signal fall time		tF		300	20+0.1Cb	300	ns
Stop condition setup time		tSU:STO	4.0		0.6		μs
Pulse width with spike suppressed by input filter		tSP			0	50	ns
Capacitance load of each bus line		Cb		400		400	pF

- Notes:**
- At the start condition, the first clock pulse is generated after the hold time
 - The system requires a minimum of 300ns hold time Internally for the SDA signal (at VIH-min. of SCL00 signal)
In order to occupy the undefined area at the falling edge of SCL00.
 - If the system does not extend the SCL00 signal low hold time (tLOW), only the maximum data hold time (tHD:DAT) needs to be satisfied.
 - The high-speed-mode IIC bus can be used In a normal-mode IIC bus system.
In this case, set the high-speed-mode IIC bus so that It meets the following conditions.
- If the system does not extend the SCL00 signal's low state hold time:
SU:DAT?250ns
- If the system extends the SCL00 signal's low state hold time:
Transmit the following data bit to the SDA00 line prior to releasing the SCL00 line
(tRmax.+tSU:DAT=1000+250=1250ns: Normal mode IIC bus specification).
 - Cb: Total capacitance of one bus line (unit: pF)

IIC bus interface timing

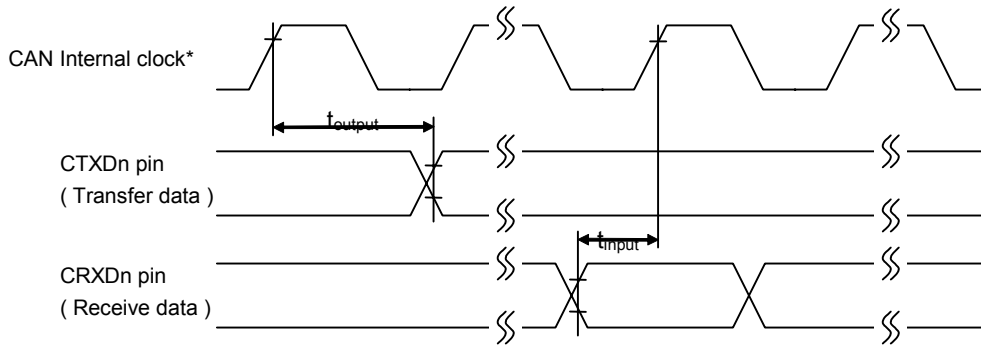


Remark: P: Stop condition
 S: Start condition
 Sr: Restart condition

2.7.8 CAN Timing

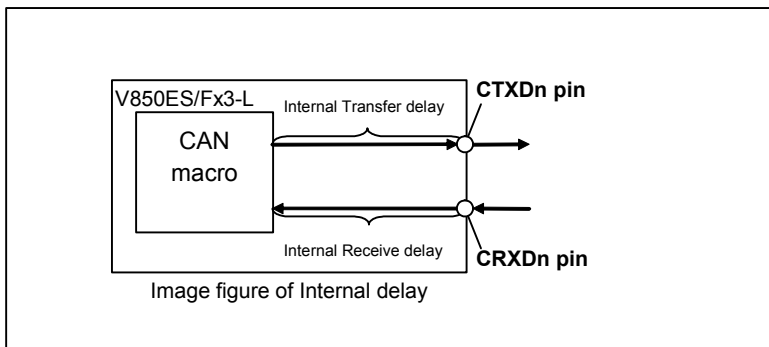
(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Transfer rate					1	Mbps
Internal delay time					100	ns



Internal delay time (t_{NODE})= Internal Transfer Delay(t_{output}) + Internal Receive Delay(t_{input})

*) CAN Internal clock (f_{CAN}) :CAN baud rate clock



2.8 A/D Converter

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.5 to 5.5V, AVREF0 = 4.0 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.		Unit
					(A),(A1)	(A2)	
Resolution					10		bit
Overall error ^{Note1}		4.0V ≤ AVREF0 < 5.5V		±0.15	±0.3	±0.35	%FSR
Conversion time	tCONV		3.10		16		µs
Stabilization time	tSTA	After ADA0PS bit = 0 -> 1	2				µs
Recovery time for power down mode	tDPU		1				µs
Zero-scale error ^{Note1}	ZSE				±0.3	±0.35	%FSR
Full-scale error ^{Note1}	FSE				±0.3	±0.35	%FSR
Integral non-linearity error ^{Note2}	INL				±2.5		LSB
Differential non-linearity error ^{Note2}	DNL				±1.5		LSB
Analog input voltage	VIAN		AVSS		AVREF0		V
Analog input equivalent circuit capacitance ^{Note3,4}	CINA				6.19		pF
Analog input equivalent circuit resistance ^{Note3}	RINA				2.55		kΩ
AVREF0 current	IAREF0	A/D operating		4	7		mA
		A/D operation stop		1	10		µA
Conversion result when using Diagnostic function		AVREF0 conversion	3FC		3FF		HEX
		AVSS conversion	000		003		HEX

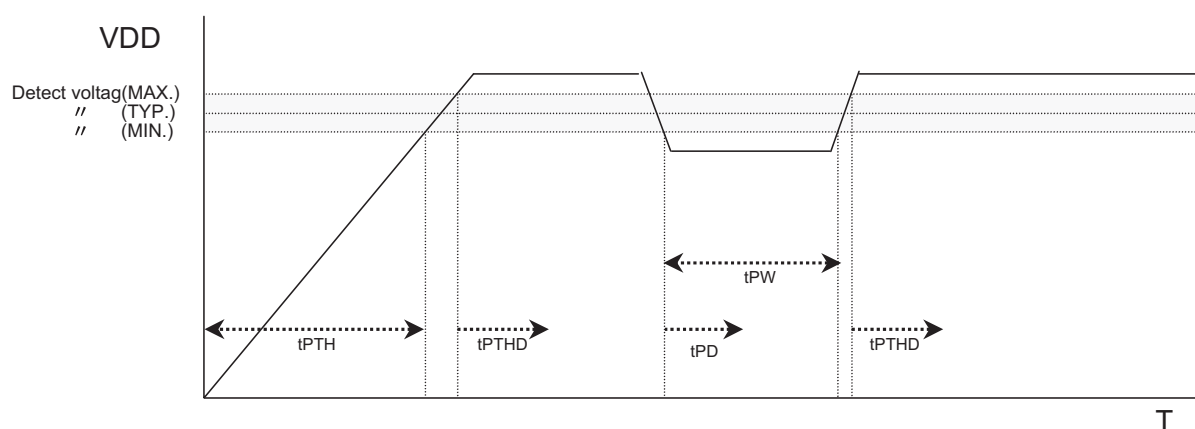
- Notes:**
1. Overall error excluding quantization error (±0.05%FSE). It is indicated as a ratio to the full-scale value.
 2. Excluding quantization error (±1/2 LSB)
 3. Reference value. Not tested in production.
 4. Does not include input/output capacitance CIO

2.9 POC

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detect voltage	VPOC0		3.3	3.5	3.7	V
Supply voltage rise time	tPTH	From VDD=0V to VDD=3.3V	0.002			ms
Response time1 ^{Note1}	tPTHd	In case of power on. After VDD reaches 3.7V.			2.0	ms
Response time2 ^{Note2}	tPD	In case of power off. After VDD drop 3.3V.		0.2	1.0	ms
VDD minimum width	tPW		0.2			ms

- Notes:** 1. From detect voltage to release reset signal
 2. From detect voltage to occurrence of reset signal



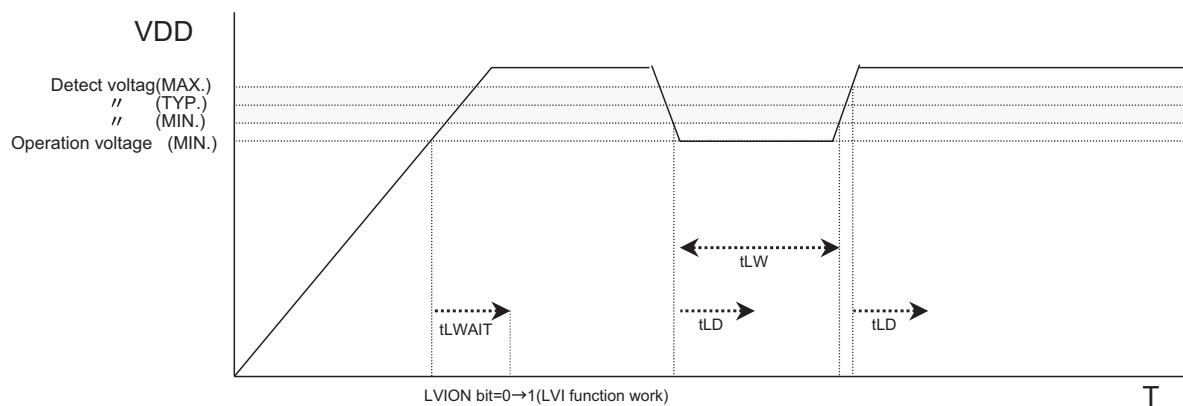
Note: POC is available only in M2 devices. Refer to 'Ordering information' in the V850ES/Fx3-L User'sManual.

2.10 LVI

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 3.3 to 5.5V, AVREF0 = 3.3 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detect voltage	VLVI0		3.8	4.0	4.2	V
	VLVI1		3.5	3.7	3.9	V
Response time ^{Note1}	tLD	After VDD reaches VLVI0/1(max). After VDD drop VLVI0/1(min).		0.2	2.0	ms
VDD minimum width	tLW		0.2			ms
Reference voltage stabilization wait time ^{Note2}	tLWAIT	After VDD reaches 3.3V. After LVION bit (LVIM.bit7) = 0->1		0.1	0.2	ms

- Notes:** 1. From detect voltage to occurrence interrupt/reset signal
 2. If POC functionality is available, the wait time is not needed.

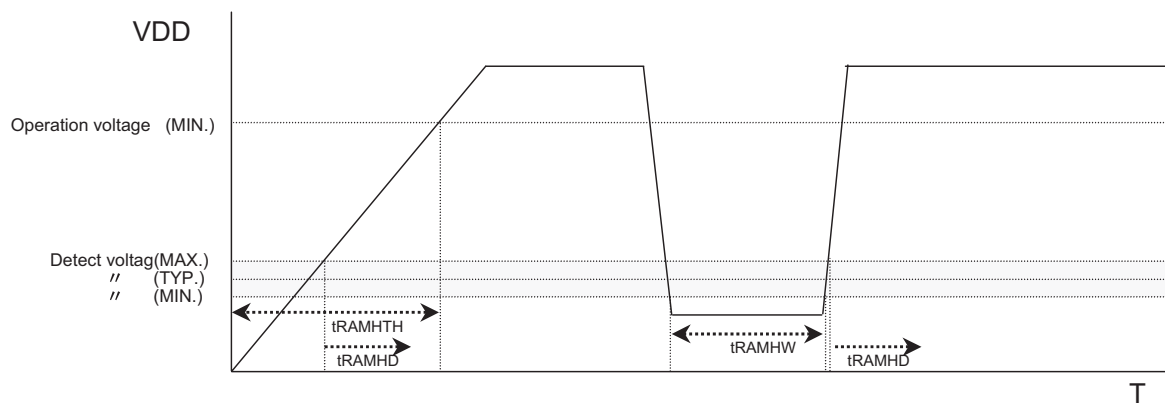


2.11 RAM Retention Flag

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 1.9 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detect voltage	VRAMH		1.9	2.0	2.1	V
Supply voltage rise time	tRAMHTH	From VDD=0V to VDD=3.3V	0.002		1800	ms
Response time ^{Note1}	tRAMHD	After VDD reaches 2.1V.		0.2	2.0	ms
VDD minimum width	tRAMHW		0.2			ms

- Notes:** 1. From detect voltage to set RAMFbit (RAMS.bit0)

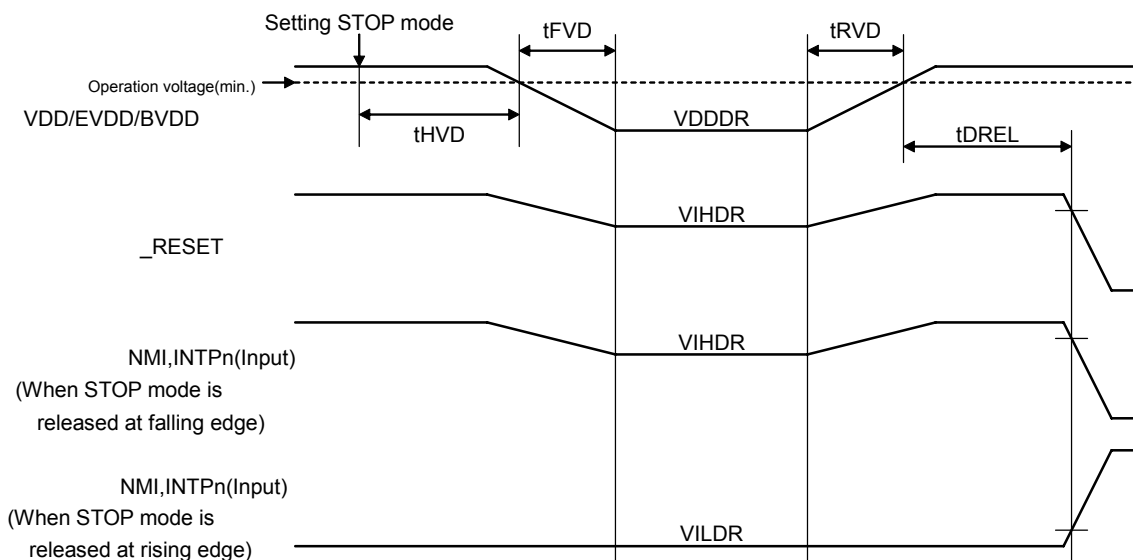


2.12 Data Retention Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD = 1.9 to 5.5V, VSS = EVSS = AVSS = 0V) (

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Data retention power supply voltage	VDDDR	STOP mode (All function is stopped)	1.9		5.5	V
Data retention power supply current	IDDDR	VDDDR=2.0V(All function is stopped)		6.5	70	μA
Supply voltage rise time	tRVD		1			μs
Supply voltage fall time	tFVD		1			μs
Supply voltage hold time	tHVD	After STOP mode	0			ms
STOP release signal input time	tDREL	After VDD reaches operating voltage range MIN. 3.3V	0			ms
Data retention high-level input voltage	VIHDR	All input port	0.9·VDDDR		VDDDR	V
Data retention low-level input voltage	VILDR	All input port	0		0.1·VDDDR	V

Remark: When STOP mode is entered/released operation voltage range must be controlled.



2.13 Flash Memory Programming Characteristics

(a) Basic Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.			Unit
					(A)	(A1)	(A2)	
Operation frequency	fCPU		4		20			MHz
Supply voltage	VDD		3.3		5.5			V
Number of rewrites	CWRT	Code Flash			1000			count
High level input voltage	VIH	FLMD0	0.8·EVDD		EVDD			V
Low level input voltage	VIL	FLMD0	EVSS		0.2·EVDD			V
Programming temperature	tPRG		-40		+85	+110	+125	°C
Data retention		Code Flash	15					year

Remark: The initial write when the product is shipped, any erase → write set of operations, or any programming operation is counted as one rewrite.

Example: P: Program(write) E: Erase

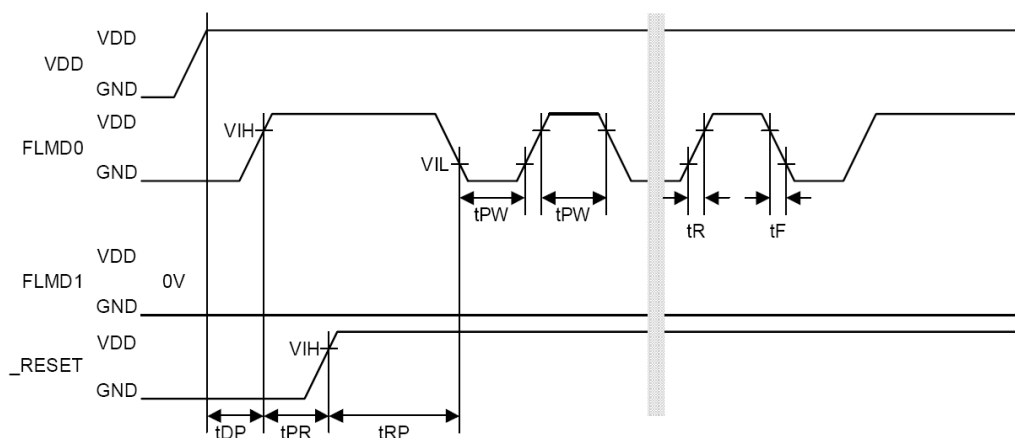
Product is shipped → P → E → P → E → P : Rewrite count: 3

Product is shipped → E → P → E → P → E → P : Rewrite count: 3

(b) Serial Writing Operation Characteristics

(Ta = -40 to +85°C for (A)-Grade, Ta = -40 to +110°C for (A1)-Grade, Ta = -40 to +125°C for (A2)-Grade, C=4.7uF, VDD = EVDD, AVREF0 = 3.5 to 5.5V, VSS = EVSS = AVSS = 0V, CL=50pF)

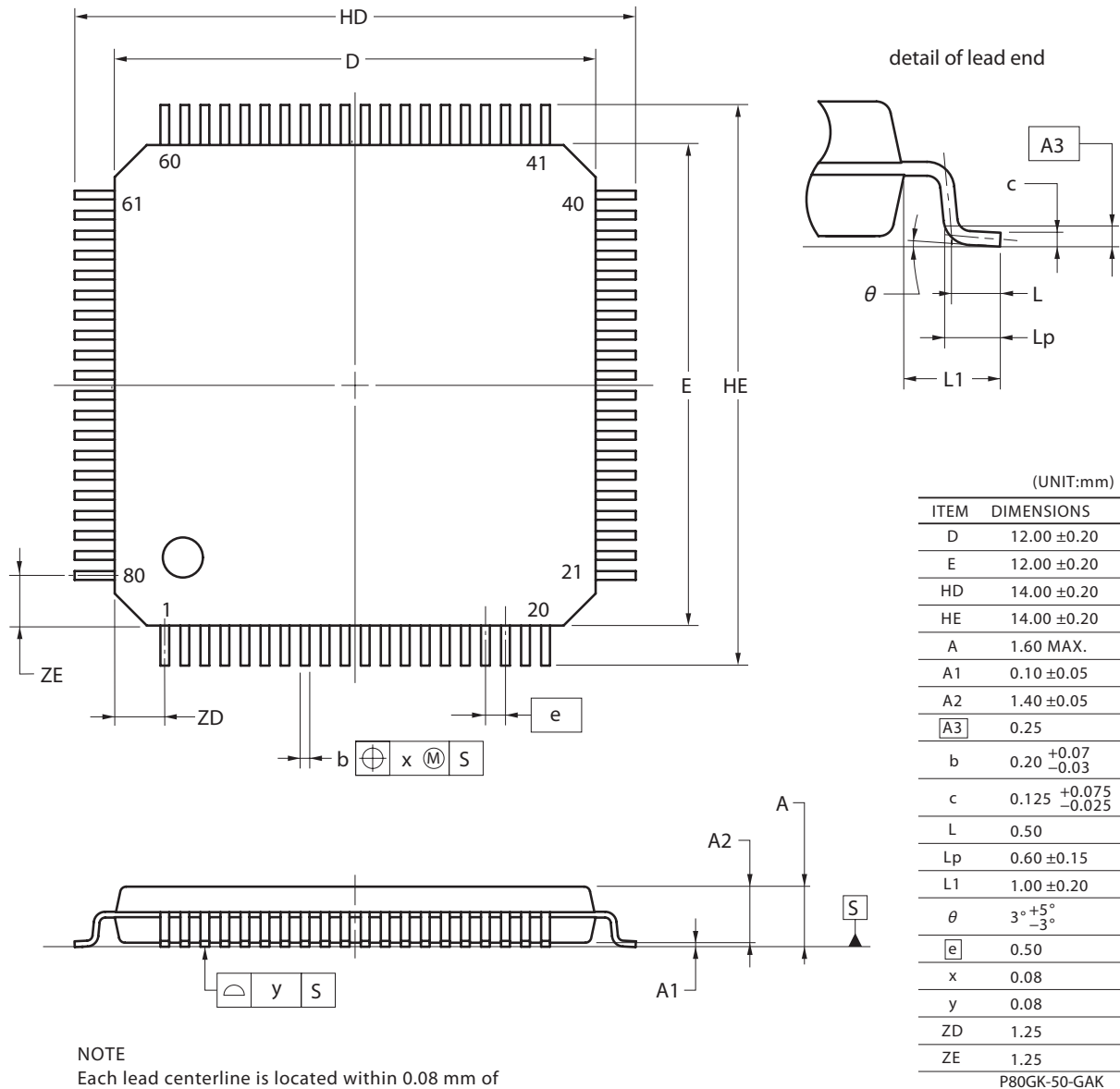
Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
FLMD0 setup time (from VDD)	tDP		1			ms
RESET release (from FLMD0)	tPR		2			ms
FLMD0 pulse input start (from raise edge of _RESET)	tRP		800			µs
FLMD0 high level width / low level width	tPW		10		100	µs
FLMD0 raise time	tR				50	ns
FLMD0 fall time	tF				50	ns



3. Package

3.1 Package Dimension

80-PIN PLASTIC LQFP (FINE PITCH) (12x12)

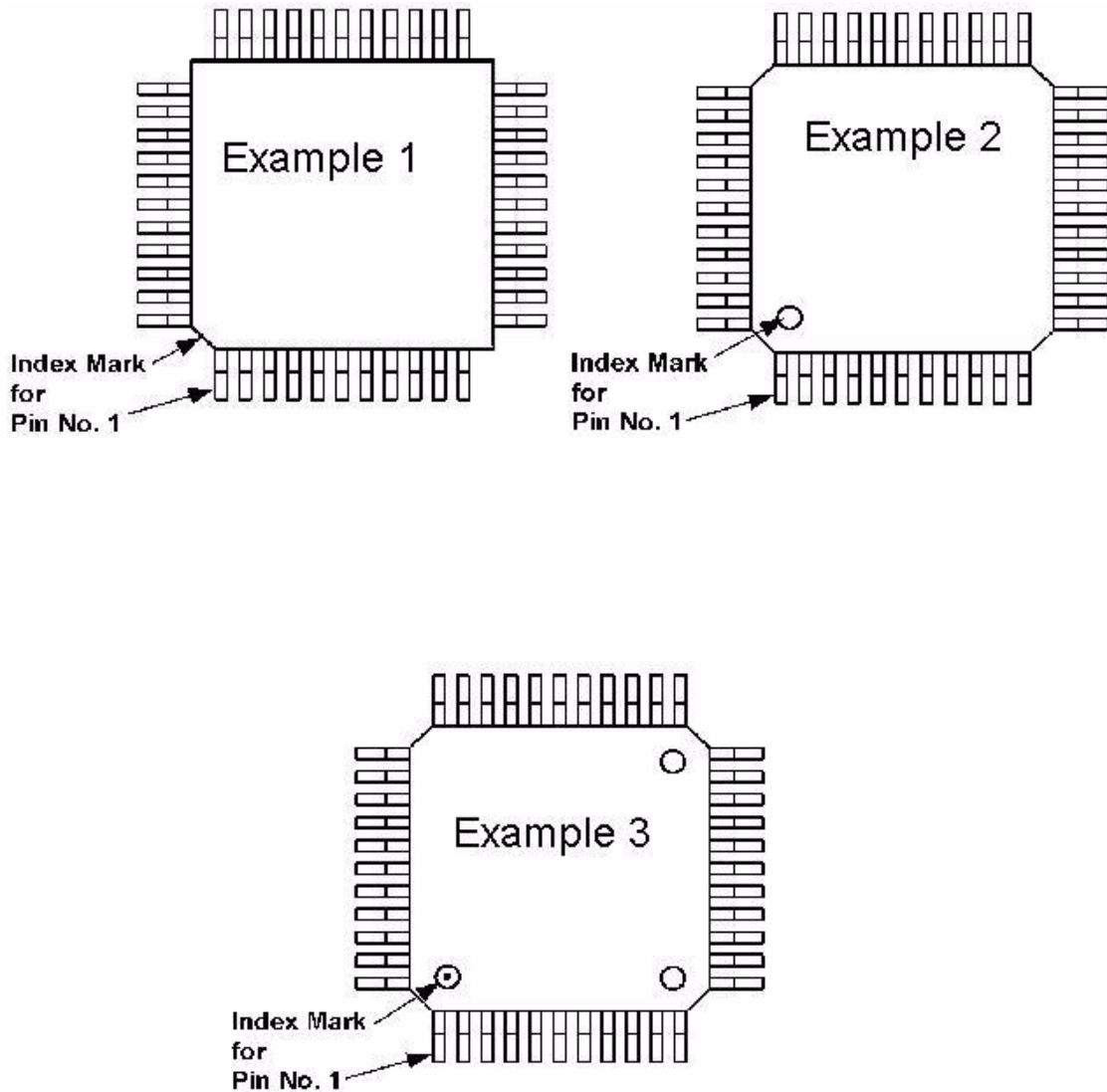


NOTE
Each lead centerline is located within 0.08 mm of its true position at maximum material condition.

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3.2 Product Marking

3.2.1 Marking of pin 1 at a QFP (Quad Flat Package)



Example 1: The index mark for pin 1 is the beveled edge of the package

Example 2: The index mark for pin 1 is a round notch at one of the 4 edges. In this case, the shape of all edges is identical (usually beveled).

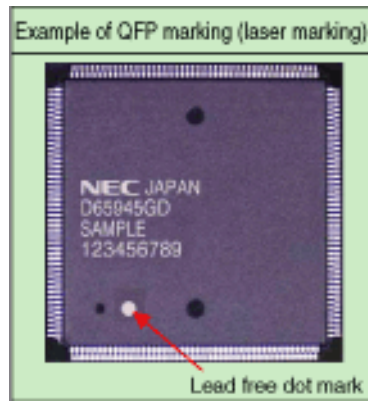
Example 3: For production reasons, two or more similar notches may be located at the top of the package. In such a case the index marker for pin 1 is a round notch with an additional mark in it.

Note: RoHS compliant devices have an additional dot at the top side. Do not mix it up with the marking for pin 1. For details see 3.2.2 "Identification of Lead-Free Products" on page 34.

3.2.2 Identification of Lead-Free Products

Lead-Free products are marked with a dot "•". The marking methods are the paint or the laser (It doesn't sink in). The shape of lead-free marks is a circle.

Example:



4. Change History

Version	Chapter	Comment
V1.0		Initial release

Facsimile Message

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Name

Company

Tel.

FAX

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[MEMO]