Customer Notification

RL78/F12 Family

16-bit Single-Chip Microcontroller

Injected Current Specification

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1. Related Products

Series	Pin Count	Package Type	Product Name	Temperature Grades
RL78/F12	20-pins	SSOP	R5F10968 /A /B /C /D /E	J, K
	30-pins	SSOP	R5F109AA /B /C /D /E	
	32-pins	QFN	R5F109BA /B /C /D /E	
	48-pins	QFP	R5F109GA /B /C /D /E	
	64-pins	QFP	R5F109LA /B /C /D /E	

2. Electrical Specification for Injected Current

(Ta = -40 to +125 °C, 2.7V ≤ V_{DD} ≤ EV_{DD0} ≤ 5.5V, V_{SS} = EV_{SS0} = 0V) (Notes 1)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Pos. Injected Current $V_{IN} > V_{DD}$ (Peak value) (Note 5)	I_{INJP}	Per input pin (Group A) (Notes 2, 3)			5	mA
		Per input pin (Group B) (Note 2)			2	mA
		Per input pin (Group C) (Note 2)			2	mA
Neg. Injected Current $V_{IN} < V_{SS}$ (Peak value) (Note 5)	I_{INJN}	Per input pin (Group A) (Note 2)			-5	mA
		Per input pin (Group B) (Note 2)			-0.5	mA
		Per input pin (Group C) (Note 2)			-0.5	mA
Sum of all Positive Injected Currents (Peak value) (Note 6)	ΣI_{INJP}	Sum for all input pins (Group A) (Notes 2, 3)			40	mA
		Sum for all input pins (Group B + C) (Note 2)			10	mA
Sum of all Negative Injected Currents (Peak value) (Note 6)	ΣI_{INJN}	Sum for all input pins (Group A) (Note 2)			-40	mA
		Sum for all input pins (Group B + C) (Note 2)			-2.0	mA
Total Sum of all Injected Currents (Positve and Negative) (Peak value) (Note 6)	$\Sigma \lvert I_{INJP} \rvert + \Sigma \lvert I_{INJN} \rvert$	Total Sum for all input pins (Group A) (Notes 2, 3)			40	mA
		Total Sum for all input pins (Group B + C) (Note 2)			10	mA
Pos. Injected Current $V_{IN} > V_{DD}$ (Average value) (Note 7, 8)	$I_{INJP\ AVG}$	Per input pin (Group A) (Notes 2, 3)			0.4	mA
		Per input pin (Group B) (Note 2)			0.15	mA
		Per input pin (Group C) (Note 2)			0.15	mA
		Sum for all input pins (Group A) (Notes 2, 3)			4	mA
		Sum for all input pins (Group B + C) (Note 2)			1	mA

Note 1: 64 pins products have EV_{DD0}, EV_{SS0}. For all other products EV_{DD0} is V_{DD} and EV_{SS0} is V_{SS}

Note 2: Depending on products the corresponding input ports are split in three groups:

Series	Products	Input pins (Group A)	Input pins (Group B)	Input pins (Group C)
RL78/F12	20pins	P10-P12,P16,P17,P31,P50,P51	P01	P22
	30pins	P10-P17,P30,P31,P50,P51,P60, P61	P00,P01,P120,P147	P22-P23
	32pins	P10-P17,P30,P31,P50,P51,P60-P62, P70	P00,P01,P120,P147	P22-P24
	48pins	P10-P17,P30,P31,P41,P50,P51, P60-P63, P70-P75,P140,P146	P00,P01,P120,P147	P22-P27
	64pins	P04,P10-P17,P30,P31,P41-P43,P50-P55,P60-P63, P70-77,P140,P141,P146	P00-P03,P120,P147	P22-P27

Note 3: The injected current specification ($V_{IN} > V_{DD} = I_{INJP}$ & $I_{INJP\ AVG}$) is not valid for the N-CH O/D ports (P60 to P63) and P137/INTP0 because, these port pins don't have the protection diode to V_{DD}.

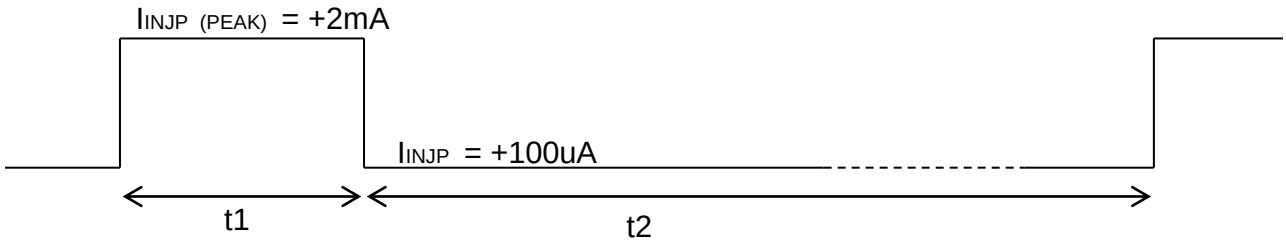
Note 5: If any of the Injected Current specifications (Peak values) are exceeded even momentarily, there is a possibility to destroy the device.

Note 6: If the Sum of the Injected Current specifications (Peak values) are exceeded even momentarily, there is a possibility to destroy the device.

Note 7: When the Injected Current value exceeds the allowed Injected Current value (Average value), the electrical characteristics can't be specified.

Note 8: If the allowed Injected Current value (Average value) is exceeded permanently, the product life time could be influenced.
However, when the injected current exceed the Average value but is **still below** the Peak value the product life time will not be influenced if the injected current will follow the example as given here:

Example for an input belonging to Group C:



Requirement :

$I_{INJP\ AVG} \leq (I_{INJP\ (PEAK)} \times t1) + (I_{INJ\ P\ A} \times t2) / (t1 + t2) \leq 150uA$

$I_{INJP\ AVG} \leq (2mA \times t1) + (100uA \times t2) / (t1 + t2) \leq 150uA$

Remark :

The above mentioned example could also be used for the input pins belonging to Group A with:
$I_{INJP\ AVG} \leq 400uA$

General Cautions:

1. An Injected Current conditions occur, if the standard operating conditions are exceeded.
   Example: The input voltage on any pin exceeds the specified range:
   $V_{IN} > EV_{DD} / V_{DD} / AV_{REF} + 0.3\ V \rightarrow (I_{INJP} > 0)$ or
   $V_{IN} < EV_{SS} / V_{SS} / AV_{SS} - 0.3\ V \rightarrow (I_{INJN} < 0)$.
   I_{INJP}, I_{INJN} = Injected current value that doesn't influence to the operation of the device.

2. The supply voltages must always remain within the specified limits.

3. A proper operation is not specified if an Injected Current occurs on the functional pins such as:
   P121/X1, P122/X2/EXCLK, P123/XT1, P124/XT2/EXCLKS, P20/ANI0/AVREFP, P21/ANI1/AVREFM, P40/TOOL0, P137/INTP0, /RESET.

4. The above specifications are not tested in the outgoing inspection, but they are specified based on the design rules and the device characterization.

3. The influence on an adjacent pin caused by the Injected Current

(Ta = -40 to +125 °C, 2.7V ≤ V_{DD} ≤ EV_{DD0} ≤ 5.5V, V_{SS} = EV_{SS0} = 0V) (Note 1)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Leakage current coupling factor for a Positive Injected Current	K_{INJP}	Input pins (Group A + B) (Notes 2, 3)			5×10^{-3}	-
		Input pins (Group C) (Note 2)			1×10^{-4}	-
Leakage current coupling factor for a Negative Injected Current	K_{INJN}	Input pins (Group A + B) (Note 2)			1×10^{-2}	-
		Input pins (Group C) (Note 2)			3.2×10^{-3}	-

Note 1: 64 pins products have EV_{DD0}, EV_{SS0}. For all other products EV_{DD0} is V_{DD} and EV_{SS0} is V_{SS}

Note 2: Depending on products the corresponding input ports are split in three groups:

Series	**Products**	**Input pins (Group A)**	**Input pins (Group B)**	**Input pins (Group C)**
RL78/F12	20pins	P10-P12,P16,P17,P31,P50,P51	P01	P22
	30pins	P10-P17,P30,P31,P50,P51,P60, P61	P00,P01,P120,P147	P22-P23
	32pins	P10-P17,P30,P31,P50,P51,P60-P62, P70	P00,P01,P120,P147	P22-P24
	48pins	P10-P17,P30,P31,P41,P50,P51, P60-P63, P70-P75,P140,P146	P00,P01,P120,P147	P22-P27
	64pins	P04,P10-P17,P30,P31,P41-P43,P50-P55,P60-P63, P70-77,P140,P141,P146	P00-P03,P120,P147	P22-P27

Note 3: The injected current specification (V_{IN} > V_{DD} = I_{INJP} & $I_{INJP\ AVG}$) is not valid for the N-CH O/D ports (P60 to P63) and P137/INTP0 because, these port pins don't have the protection diode to V_{DD}

General Cautions:

1. An Injected Current through a pin will cause a certain error current in the adjacent pins. This error current must be added to the respective leakage current (I_{LIH} / I_{LIL}) of the adjacent pins.
2. The amount of error leakage current depends on the Injected Current and it is defined by the coupling factor K_{INJ}.
3. The total leakage current through a pin is $| I_{Ltotal} | = | I_{LIH} / I_{LIL} | + (| I_{INJn} | \times K_{INJn})$
4. The additional error current may affect the input voltage on the analog inputs.
5. These specifications are not tested in the outgoing inspection, but it is specified based on the design rules and the device characterization.

4. Valid Specification

Item	Date published	Document No.	Document Title
1	Jan, 2014	R01UH0231EJ0111(or later)	RL78/F12 User's Manual: Hardware 16-Bit Single-Chip Microcontrollers

5. Revision History

Item	Date published	Document No.	Comment
1	January 31, 2013	R01TU0043ED0100	1st Release
2	April 24, 2014	R01TU0043ED0101	1st Update - Add “Related Product” Table - Removed P40, P20, P21 from the Input pins (Group A & C) on pages 4 & 6 - Added the P40, P20, P21 to ‘Caution 3’ on page 5 - Removed completely the ‘Note 4’