Customer Notification

RL78/F13 Family

16-bit Single-Chip Microcontroller

Injected Current Specification

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Table of Contents

1. Related Products 4

2. Port Pin Groups 5

3. Electrical Specification for Injected Current 6

4. The influence on an adjacent pin caused by the Injected Current 8

5. Valid Specification 10

6. Revision History 11

1. Related Products

Series	Pin Count	Package Type	Product Name	Temperature Grades
RL78/F13	20-pins	SSOP	R5F10A6A /C /D /E	L, K, Y
	30-pins	SSOP	R5F10AAA /C /D /E, R5F10BAC /D /E /F /G	
	32-pins	QFN	R5F10ABA /C /D /E, R5F10BBC /D /E /F /G	
	48-pins	QFP	R5F10AGA /C /D /E /F /G,	
		QFN	R5F10BGC /D /E /F /G	
	64-pins	QFP	R5F10ALC /D /E /F /G, R5F10BLC /D /E /F /G	
	80-pins	QFP	R5F10AME /F /G, R5F10BME /F /G	

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2. Port Pin Groups

Depending on the products the corresponding ports are split into four groups:

Products		Port Group A	Port Group B	Port Group C	Port Group D
20 pin	R5F10A6A, R5F10A6C R5F10A6D, R5F10A6E	P13-P17, P30, P120, P125		P80-P81	
30 pin	R5F10AAA, R5F10AAC, R5F10AAD, R5F10AAE	P10-P17, P30, P41, P120, P125		P80-P87	
	R5F10BAC, R5F10BAD, R5F10BAE, R5F10BAF, R5F10BAG	P10-P17, P30, P41,	P120, P125	P80, P85-P87	P81-P84
32 pin	R5F10ABA, R5F10ABC, R5F10ABD, R5F10ABE	P10-P17, P30, P41, P60-P63, P120, P125		P80-P85	
	R5F10BBC, R5F10BBD, R5F10BBE, R5F10BBF, R5F10BBG	P10-P17, P30, P41, P60-P63	P120, P125	P80, P85	P81-P84
48 pin	R5F10AGA, R5F10AGC, R5F10AGD, R5F10AGE	P00, P10-P17, P30-P32, P41 P60-P63, P70-P73, P92, P120, P125, P140		P80-P87, P90-P91	
	R5F10AGF, R5F10AGG, R5F10BGC, R5F10BGD, R5F10BGE, R5F10BGF, R5F10BGG	P00, P10-P17, P30-P32, P41, P60-P63, P70-P73, P140	P120, P125	P80, P85-P87, P90-P92	P81-P84
64 pin	R5F10ALC, R5F10ALD, R5F10ALE	P00, P10-P17, P30-P32, P41-P43, P50-P53, P60-P63, P70-P77, P92-P96, P120, P125, P140		P80-P87, P90-P91	
	R5F10ALF, R5F10ALG, R5F10BLC, R5F10BLD, R5F10BLE, R5F10BLF, R5F10BLG	P00, P10-P17, P30-P32, P41-P43, P50-P53, P60-P63, P70-P77, P140	P96, P120, P125	P80, P85-P87, P90-P95	P81-P84
80 pin	R5F10AME, R5F10AMF, R5F10AMG, R5F10BME, R5F10BMF, R5F10BMG	P00-P02, P10-P17, P30-P32, P41-P47, P50-P57, P60-P67, P70-P77, P126, P140	P96-P97, P120, P125	P80, P85-P87, P90-P95	P81-P84

3. Electrical Specification for Injected Current

(Ta = -40 to +150 °C, 2.7V ≤ $V_{DD} = EV_{DD0}$ ≤ 5.5V, $V_{SS} = EV_{SS0}$ = 0V) (Note 1)

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

Note 1: 64-pin and 80-pin products have EV_{DD0}, EV_{SS0}. For all other products EV_{DD0} is V_{DD} and EV_{SS0} is V_{SS}

Note 2: If any of the Injected Current specifications (Peak values) are exceeded even momentarily, there is a possibility to destroy the device.

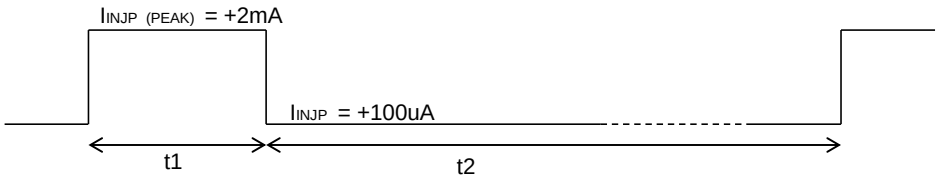
Note 3: If the Sum of the Injected Current specifications (Peak values) are exceeded even momentarily, there is a possibility to destroy the device.

Note 4: The injected current specification ($V_{IN} > V_{DD} = I_{INJP}$ & $I_{INJP\ AVG}$) is not valid for P137/INTP0, because this port pin doesn't have the protection diode to V_{DD}.

Note 5: When the Injected Current value exceeds the allowed Injected Current value (Average value), the electrical characteristics can't be specified.

Note 6: 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 on the next page:

Example for an input belonging to Group B, C or D:



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, P137/INTP0, /RESET,
   P33/ANI0/AVREFP, P34/ANI1/AVREFM, P40/TOOL0

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

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

(Ta = -40 to +150 °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)			5×10^{-3}	-
		Input pins (Group C)			1×10^{-4}	-
		Input pins (Group D)			(Note 2)	
Leakage current coupling factor for a Negative Injected Current	K_{INJN}	Input pins (Group A + B)			1×10^{-2}	-
		Input pins (Group C)			3.2×10^{-3}	-
		Input pins (Group D)			(Note 2)	

Note 1: 64-pin and 80-pin products have EV_{DD0}, EV_{SS0}. For all other products EV_{DD0} is V_{DD} and EV_{SS0} is V_{SS}

Note 2: The following leakage current (I_{LINJP} or I_{LINJN}) could be generated on any pin of Group D when an injected current is input to another pin of Group D:

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Leakage current of adjacent pins caused by a Positive Injected Current (Note 3)	I_{LINJP}	I_{INJP}=2mA			-14	uA
		I_{INJP}=0.15mA			-1.5	uA
Leakage current of adjacent pins caused by a Negative Injected Current (Note 3)	I_{LINJN}	I_{INJN}=-0.5mA			3.5	uA

Note 3: A leakage current (I_{LINJP}, I_{LINJN}) is generated on the remaining pins of Group D when a current is injected to a pin of Group D.

Injected Current Specification for RL78/F13 Family

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. 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, P137/INTP0, /RESET, P33/ANI0/AVREFP, P34/ANI1/AVREFM, P40/TOOL0

6. These specifications are not tested in the outgoing inspection, but it is specified based on the design rules and the device characterization.

5. Valid Specification

Item	Date published	Document No.	Document Title
1	May, 2014	R01UH0368EJ0200	RL78/F13, F14 User's Manual: Hardware 16-Bit Single-Chip Microcontrollers

6. Revision History

Item	Date published	Document No.	Comment
1	December, 2013	R01TU0058ED0100	1st Release
2	April 2014	R01TU0058ED0101	1st Update - page 5: move P120 and P125 of 30 and 32 pin device to Port Goup B - page 5: remove P130 from the table because this is output only. - Correct some typos
3	October, 2015	R01TU0058ED0102	2nd Update - page 4: add “Y” to Temperature Grades - pages 6 & 8: Expand the temperature range specification (Ta = -40°C to +150°C)