Customer Notification

RL78/F15 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/F15	48-pins	QFP	R5F113GK /L	L, K
		QFN		
	64-pins	QFP	R5F113LK /L	
	80-pins	QFP	R5F113MK /L	
	100-pins	QFP	R5F113PG /H /J /K /L	
	144-pins	QFP	R5F113TG /H /J /K /L	

2. Port Pin Groups

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

Products		Port Group A	Port Group B	Port Group C	Port Group D
48 pin	R5F113GK, R5F113GL	P00, P10-P17, P30-P32, P41, P60-P63, P140	P70-P73 P120, P125	P80, P85-P87, P90-P92	P81-P84
64 pin	R5F113LK, R5F113LL	P00, P10-P17, P30-P32, P41-P43, P50-P53, P60-P63, P75-P77, P140	P70-P74, P120, P125	P80, P85-P87, P90-P96	P81-P84
80 pin	R5F113MK, R5F113ML	P00-P02, P10-P17, P30-P32, P41-P47, P50-P57, P60-P67, P75-P77, P126, P140	P70-P74, P120, P125	P80, P85-P87, P90-P97	P81-P84
100 pin	R5F113PG, R5F113PH, R5F113PJ, R5F113PK, R5F113PL	P00-P03, P10-P17, P30-P32, P41-P47, P50-P57, P60-P67, P75-P77, P106-P107, P126-P127, P140, P150-P157	P70-P74, P120, P125	P80, P85-P87, P90-P97, P100-P105	P81-P84
144 pin	R5F113TG, R5F113TH, R5F113TJ, R5F113TK, R5F113TL	P00-P03, P10-P17, P30-P32, P41-P47, P50-P57, P60-P67, P75-P77, P106-P107, P110-P117, P126-P127, P131-P136, P140-P147, P150-P157, P160-P167	P70-P74, P120, P125	P80, P85-P87, P90-P97, P100-P105	P81-P84

3. Electrical Specification for Injected Current

(Ta = -40 to +125 °C, 2.7V ≤ V_{DD} = $EV_{DD0,1}$ = AV_{REF}(+) ≤ 5.5V, V_{SS} = $EV_{SS0,1}$ = AV_{REF}(-) = 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 (Positive 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) (Note 7)			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: $EV_{DD0,1}$ and $EV_{SS0,1}$ pins do not exist in the 48pin products.

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.

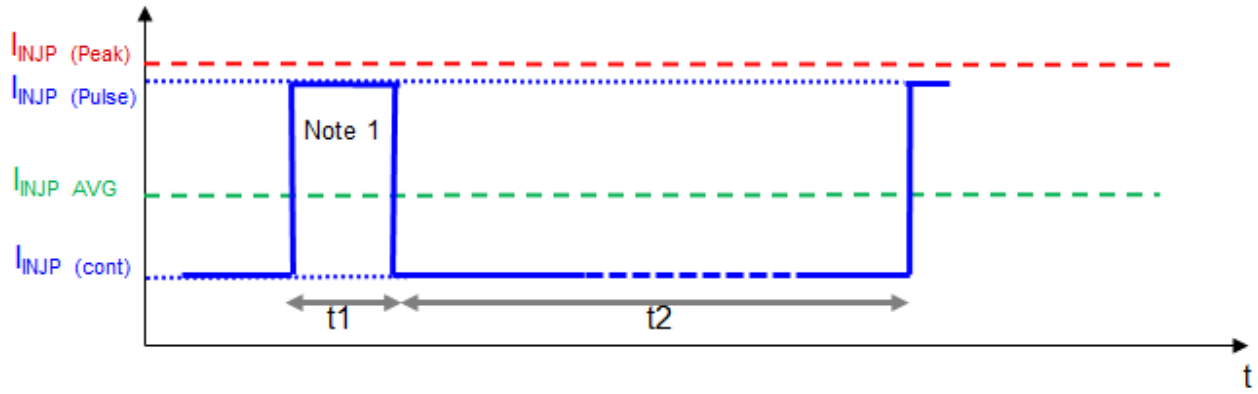
Note 4: The injected current specification ($V_{IN} > V_{DD} = I_{INJP}$ & $I_{INJP\ AVG}$) is not valid for P137/INTP0, because this port pin doesn't have the protection diode to V_{DD}.

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

Note 6: **Average current:** If the average value (effective value) of the injected current exceeds the specified value, the product quality could be degraded.
However, when the injected current exceeds the Average value but will be **still below** the Peak value the product quality will not be degraded if the injected current will follow the example as given on the next page:

Note 7: The positive injected current specifications (Average values) are not valid for P85/ANI07/IVREF0. Even if the injected current does not exceed the Average value, the electrical characteristics are not specified.

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



Note 1: During t1 the electrical characteristics can't be specified.

Requirement :

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

Remark :

The before 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 condition occurs, 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

5. If the pin P80/ANI2/ANO0 is used as DA converter output ANO0 there is no injected current allowed on this pin.

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

(Ta = -40 to +125 °C, 2.7V ≤ V_{DD} = $EV_{DD0,1}$ = AV_{REF}(+) ≤ 5.5V, V_{SS} = $EV_{SS0,1}$ = AV_{REF}(-) = 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: $EV_{DD0,1}$ and $EV_{SS0,1}$ pins do not exist in the 48pin products.
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}	Comparator is enabled (HCMPON =1)	I_{INJP}=2mA			-43	uA
			I_{INJP}=0.15mA			-10	uA
		Comparator is disabled (HCMPON =0)	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}	Comparator is enabled (HCMPON =1)	I_{INJN}=-0.5mA			25	uA
		Comparator is disabled (HCMPON =0)	I_{INJN}=-0.5mA			3.5	uA

Note 3: When a current is injected to a pin of Group D, a leakage current (I_{LINJP}, I_{LINJN}) will be generated on the remaining pins of Group D. When the current is injected onto more than two pins, the values of (I_{LINJP}, I_{LINJN}) will be added.

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

7. If the pin P80/ANI2/ANO0 is used as DA converter output ANO0 there is no injected current allowed on this pin.

5. Valid Specification

Item	Date published	Document No.	Document Title
1	Jan 29, 2016	R01UH0559EJ0100	RL78/F15 User's Manual: Hardware 16-Bit Single-Chip Microcontrollers

6. Revision History

Item	Date published	Document No.	Comment
1	May, 2018	R01AN4286ED0100	1st Release