Description

The 9FGV0841 is a member of Renesas' SOC-friendly 1.8V very low-power PCIe clock family. It has integrated output terminations providing Zo = 100Ω for direction connection to 100Ω transmission lines. The device has 8 output enables for clock management, 2 different spread spectrum levels in addition to spread off, and 2 selectable SMBus addresses.

Typical Applications

- PCIe Gen1–4 clock generation for Riser Cards
- Storage
- Networking
- JBOD
- Communications
- Access Points

Output Features

- Eight 100MHz Low-Power HCSL (LP-HCSL) DIF pairs with Zo = 100Ω
- One 1.8V LVCMOS REF output with Wake-On-LAN (WOL) support

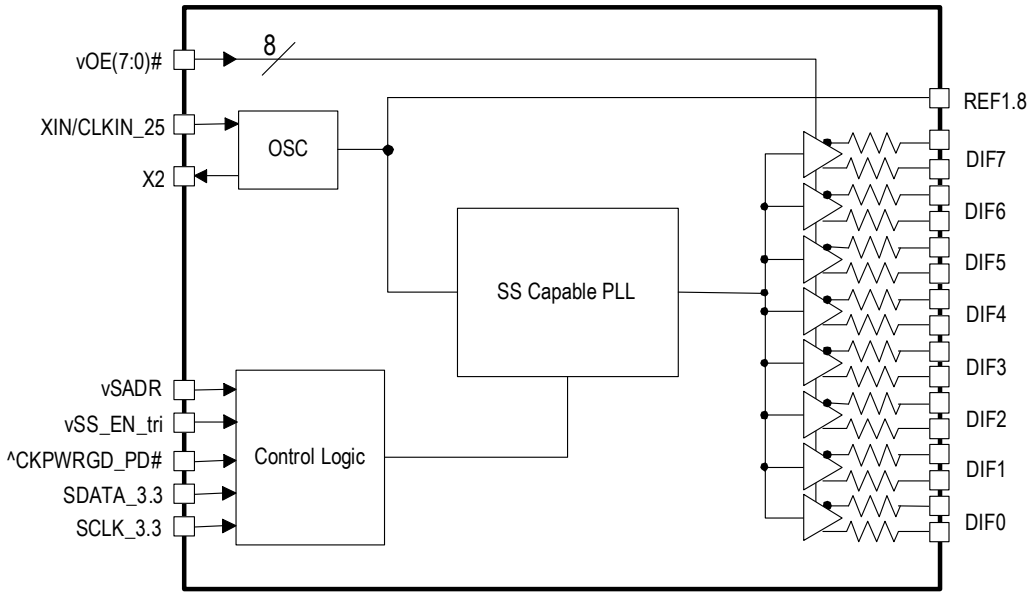
Key Specifications

- DIF cycle-to-cycle jitter < 50ps
- DIF output-to-output skew < 50ps
- DIF phase jitter is PCIe Gen1–4 compliant
- REF phase jitter is < 1.5ps RMS

Features

- Direct connection to 100Ω transmission lines; saves 32 resistors compared to standard PCIe devices
- 62mW typical power consumption; reduced thermal concerns
- Outputs can optionally be supplied from any voltage between 1.05V and 1.8V; maximum power savings
- OE# pins; support DIF power management
- LP-HCSL differential clock outputs; reduced power and board space
- Programmable slew rate for each output; allows tuning for various line lengths
- Programmable output amplitude; allows tuning for various application environments
- DIF outputs blocked until PLL is locked; clean system start-up
- Selectable 0%, -0.25% or -0.5% spread on DIF outputs; reduces EMI
- External 25MHz crystal; supports tight ppm with 0 ppm synthesis error
- Configuration can be accomplished with strapping pins; SMBus interface not required for device control
- 3.3V tolerant SMBus interface works with legacy controllers
- Selectable SMBus addresses; multiple devices can easily share an SMBus segment
- Space saving 6 × 6 mm 48-VFQFPN; minimal board space
- Available in Commercial (0° to +70°C), Industrial (-40°C to +85°C) and Automotive Grade 2 (-40°C to +105°C) temperature ranges

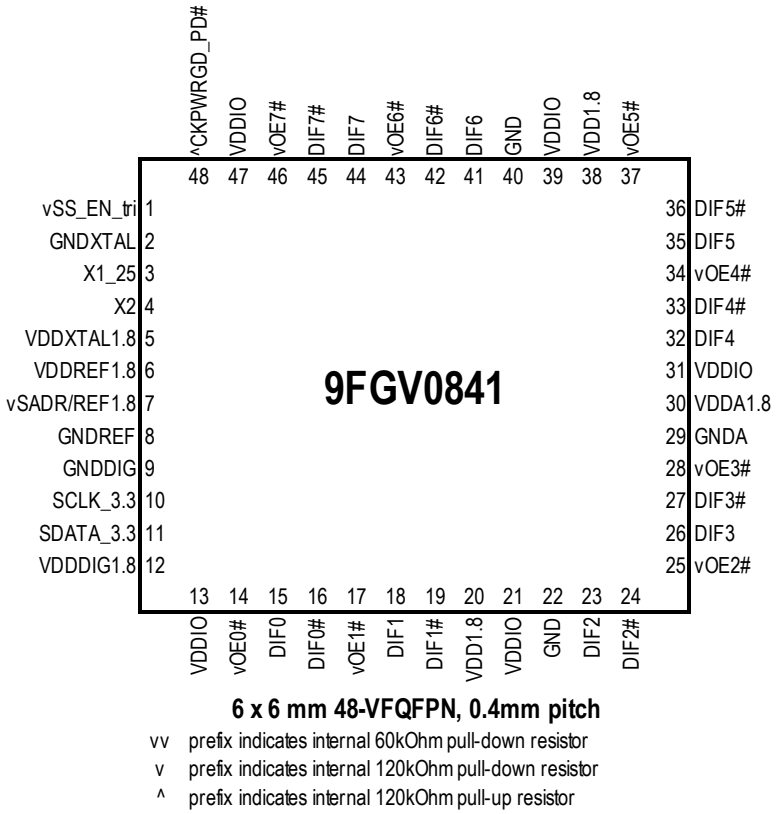
Block Diagram



Contents

Pin Assignments

Figure 1. Pin Assignments for 6 × 6 mm 48-VFQFPN Package – Top View



6 x 6 mm 48-VFQFPN, 0.4mm pitch

vv prefix indicates internal 60kOhm pull-down resistor
v prefix indicates internal 120kOhm pull-down resistor
^ prefix indicates internal 120kOhm pull-up resistor

Pin Descriptions

Table 1. Pin Descriptions

Number	Name	Type	Description
1	vSS_EN_tri	Latched In	Latched select input to select spread spectrum amount at initial power-up: 1 = -0.5% spread, M = -0.25%, 0 = spread off
2	GNDXTAL	GND	Ground for XTAL.
3	X1_25	Input	Crystal input, nominally 25.00MHz.
4	X2	Output	Crystal output.
5	VDDXTAL1.8	Power	Power supply for XTAL, nominal 1.8V.
6	VDDREF1.8	Power	VDD for REF output, nominal 1.8V.
7	vSADR/REF1.8	Latched I/O	Latch to select SMBus address/1.8V LVCMOS copy of X1/REFIN pin.
8	GNDREF	GND	Ground pin for the REF outputs.
9	GNDDIG	GND	Ground pin for digital circuitry.
10	SCLK_3.3	Input	Clock pin of SMBus circuitry, 3.3V tolerant.
11	SDATA_3.3	I/O	Data pin for SMBus circuitry, 3.3V tolerant.
12	VDDDIG1.8	Power	1.8V digital power (dirty power).
13	VDDIO	Power	Power supply for differential outputs.

Table 1. Pin Descriptions (Cont.)

Number	Name	Type	Description
14	vOE0#	Input	Active low input for enabling DIF pair 0. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
15	DIF0	Output	Differential true clock output.
16	DIF0#	Output	Differential complementary clock output.
17	vOE1#	Input	Active low input for enabling DIF pair 1. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
18	DIF1	Output	Differential true clock output.
19	DIF1#	Output	Differential complementary clock output.
20	VDD1.8	Power	Power supply, nominal 1.8V.
21	VDDIO	Power	Power supply for differential outputs.
22	GND	GND	Ground pin.
23	DIF2	Output	Differential true clock output.
24	DIF2#	Output	Differential complementary clock output.
25	vOE2#	Input	Active low input for enabling DIF pair 2. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
26	DIF3	OUT	Differential true clock output.
27	DIF3#	OUT	Differential complementary clock output.
28	vOE3#	Input	Active low input for enabling DIF pair 3. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
29	GNDA	GND	Ground pin for the PLL core.
30	VDDA1.8	Power	1.8V power for the PLL core.
31	VDDIO	Power	Power supply for differential outputs.
32	DIF4	Output	Differential true clock output.
33	DIF4#	Output	Differential complementary clock output.
34	vOE4#	Input	Active low input for enabling DIF pair 4. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
35	DIF5	Output	Differential true clock output.
36	DIF5#	Output	Differential complementary clock output.
37	vOE5#	Input	Active low input for enabling DIF pair 5. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
38	VDD1.8	Power	Power supply, nominal 1.8V.
39	VDDIO	Power	Power supply for differential outputs.
40	GND	GND	Ground pin.
41	DIF6	Output	Differential true clock output.
42	DIF6#	Output	Differential complementary clock output.
43	vOE6#	Input	Active low input for enabling DIF pair 6. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
44	DIF7	Output	Differential true clock output.

Table 1. Pin Descriptions (Cont.)

Number	Name	Type	Description
45	DIF7#	Output	Differential complementary clock output.
46	vOE7#	Input	Active low input for enabling DIF pair 7. This pin has an internal pull-down. 1 =disable outputs, 0 = enable outputs
47	VDDIO	Power	Power supply for differential outputs.
48	^CKPWRGD_PD#	Input	Input notifies device to sample latched inputs and start up on first high assertion. Low enters Power Down Mode, subsequent high assertions exit Power Down Mode. This pin has internal pull-up resistor.

Power Management

Table 2. Power Management

CKPWRGD_PD#	SMBus OE bit	DIFx			REF
		OEx#	True Output	Complementary Output	
0	X	X	Low	Low	Hi-Z[a]
1	1	0	Running	Running	Running
1	0	1	Low	Low	Low

[a] REF is Hi-Z until the 1st assertion of CKPWRGD_PD# high. After this, when CKPWRG_PD# is low, REF is Low.

Table 3. SMBus Address Selection

	SADR	Address	+ Read/Write Bit
State of SADR on first application of CKPWRGD_PD#	0	1101000	X
	1	1101010	X

Table 4. Power Connections

Pin Number			Description
VDD	VDDIO	GND	
5		2	XTAL OSC
6		8	REF Power
12		9	Digital (dirty) Power
20, 38	13, 21, 31, 39, 47	22, 29, 40	DIF Outputs
30		29	PLL Analog

Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed below can cause permanent damage to the device. Functional operation of the 9FGV0841 at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 5. Absolute Maximum Ratings[a][b][c]

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Supply Voltage	VDDxx	Applies to all V_{DD} pins.	-0.5		2.5	V
Input Voltage	V_{IN}		-0.5		V_{DD} + 0.5V	V
Input High Voltage, SMBus	V_{IHSMB}	SMBus clock and data pins.			3.6V	V
Storage Temperature	Ts		-65		150	°C
Junction Temperature	Tj				125	°C
Input ESD protection	ESD prot	Human Body Model.	2000			V

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] Operation under these conditions is neither implied nor guaranteed.

[c] Not to exceed 2.5V.

Thermal Characteristics

Table 6. Thermal Characteristics[a]

Parameter	Symbol	Conditions	Package	Typical Values	Unit
Thermal Resistance	θ_{JC}	Junction to case.	NDG48	33	°C/W
	θ_{Jb}	Junction to base.		2.1	°C/W
	θ_{JA0}	Junction to air, still air.		37	°C/W
	θ_{JA1}	Junction to air, 1 m/s air flow.		30	°C/W
	θ_{JA3}	Junction to air, 3 m/s air flow.		27	°C/W
	θ_{JA5}	Junction to air, 5 m/s air flow.		26	°C/W

[a] EPAD soldered to board.

Electrical Characteristics

$T_A = T_{AMB}$; supply voltages per normal operation conditions. See Test Loads for loading conditions

Table 7. Common Electrical Characteristics

Parameter	Symbol	Conditions		Minimum	Typical	Maximum	Unit
Supply Voltage	VDDxx	Supply voltage for core, analog and single-ended LVCMOS outputs.		1.7	1.8	1.9	V
Output Supply Voltage	VDDIO	Supply voltage for differential Low Power outputs.		0.9975	1.05–1.8	1.9	V
Ambient Operating Temperature	T_{AMB}	Commercial range.		0	25	70	°C
		Industrial range.		-40	25	85	°C
Input High Voltage	V_{IH}	Single-ended inputs, except SMBus.		0.75 V_{DD}		V_{DD} + 0.3	V
Input Mid Voltage	V_{IM}	Single-ended tri-level inputs ('_tri' suffix).		0.4 V_{DD}	0.5 V_{DD}	0.6 V_{DD}	V
Input Low Voltage	V_{IL}	Single-ended inputs, except SMBus.		-0.3		0.25 V_{DD}	V
Output High Voltage	V_{OH}	Single-ended outputs, except SMBus. I_{OH} = -2mA		V_{DD}-0.45			V
Output Low Voltage	V_{OL}	Single-ended outputs, except SMBus. I_{OL} = -2mA				0.45	V
Input Current	I_{IN}	Single-ended inputs, V_{IN} = GND, V_{IN} = VDD.	Industrial[a]	-5		5	µA
	I_{INP}	Single-ended inputs. V_{IN} = 0 V; Inputs with internal pull-up resistors. V_{IN} = VDD; Inputs with internal pull-down resistors.	Industrial[a]	-20		20	µA
	I_{IN}	Single-ended inputs, V_{IN} = GND, V_{IN} = VDD.	Automotive[b]	-5		5	µA
	I_{INP}	Single-ended inputs. V_{IN} = 0 V; Inputs with internal pull-up resistors. V_{IN} = VDD; Inputs with internal pull-down resistors.	Automotive[b]	-25		25	µA
Input Frequency	F_{in}	XTAL, or X1 input.		23	25	27	MHz
Pin Inductance[c]	L_{pin}					7	nH
Capacitance[c]	C_{IN}	Logic Inputs, except DIF_IN.7		1.5		5	pF
	C_{OUT}	Output pin capacitance.				6	pF
Clk Stabilization[c][d]	T_{STAB}	From V_{DD} Power-Up and after input clock stabilization or de-assertion of PD# to 1st clock.			0.6	1.8	ms
SS Modulation Frequency[c]	f_{MOD}	Allowable Frequency. (Triangular Modulation)		30	31.6	33	kHz
OE# Latency[c][e]	$t_{LATOE\#}$	DIF start after OE# assertion. DIF stop after OE# deassertion		1	3	3	clocks
Tdrive_PD#[c][e]	t_{DRVPD}	DIF output enable after PD# de-assertion.			20	300	us

Table 7. Common Electrical Characteristics (Cont.)

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Tfall[d]	t_F	Fall time of single-ended control inputs.			5	ns
Trise[d]	t_R	Rise time of single-ended control inputs.			5	ns
SMBus Input Low Voltage	V_{ILSMB}	V_{DDSMB} = 3.3V, see note 4 for V_{DDSMB} < 3.3V.			0.6	V
SMBus Input High Voltage[f]	V_{IHSMB}	V_{DDSMB} = 3.3V, see note 5 for V_{DDSMB} < 3.3V.	2.1		3.6	V
SMBus Output Low Voltage	V_{OLSMB}	At I_{PULLUP}.			0.4	V
SMBus Sink Current	I_{PULLUP}	At V_{OL}.	4			mA
Nominal Bus Voltage	V_{DDSMB}		1.7		3.6	V
SCLK/SDATA Rise Time[c]	t_{RSMB}	(Max V_{IL} - 0.15V) to (Min V_{IH} + 0.15V).			1000	ns
SCLK/SDATA Fall Time[c]	t_{FSMB}	(Min V_{IH} + 0.15V) to (Max V_{IL} - 0.15V).			300	ns
SMBus Operating Frequency[c]	f_{MAXSMB}	Maximum SMBus operating frequency.			400	kHz

[a] 9FGV0841AKLF, 9FGV0841AKLFT, 9FGV0841AKILF, and 9FGV0841AKILFT.

[b] 9FGV0841ANDG2 and 9FGV0841ANDG28.

[c] Guaranteed by design and characterization, not 100% tested in production.

[d] Control input must be monotonic from 20% to 80% of input swing.

[e] Time from deassertion until outputs are > 200mV.

[f] For V_{DDSMB} < 3.3V, V_{IHSMB} > = 0.65 x V_{DDSMB}.

Table 8. DIF Low-Power HCSL (LP-HCSL) Outputs

Parameter	Symbol	Conditions		Minimum	Typical	Maximum	Unit
Slew Rate[a][b][c]	Trf	Scope averaging on fast setting.	Industrial[d]	1.6	2.3	3.5	V/ns
			Automotive[e]	2.4	3.2	4.2	
		Scope averaging on slow setting.		1.3	1.9	2.9	V/ns
Slew Rate Matching[a][b][f]	ΔTrf	Slew rate matching, scope averaging on.			7	20	%
Voltage High[g]	V_{HIGH}	Statistical measurement on single-ended signal using oscilloscope math function (scope averaging on).		660	784	850	mV
Voltage Low[g]	V_{LOW}			-150	-33	150	
Max Voltage[g]	Vmax	Measurement on single-ended signal using absolute value (scope averaging off).			816	1150	mV
Min Voltage[g]	Vmin			-300	-42		
Vswing[a][b][g]	Vswing	Scope averaging off.		300	1634		mV
Crossing Voltage (abs)[a][g][h]	Vcross_abs	Scope averaging off.		250	427	550	mV
Crossing Voltage (var)[a][g][i]	Δ-Vcross	Scope averaging off.			12	140	mV

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] Measured from differential waveform.

[c] Slew rate is measured through the Vswing voltage range centered around differential 0V. This results in a ±150mV window around differential 0V.

[d] 9FGV0841AKLF, 9FGV0841AKLFT, 9FGV0841AKILF, and 9FGV0841AKILFT.

[e] 9FGV0841ANDG2 and 9FGV0841ANDG28.

[f] Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a ±75mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations.

[g] At default SMBus amplitude settings.

[h] V_{CROSS} is defined as voltage where Clock = Clock# measured on a component test board and only applies to the differential rising edge (i.e. Clock rising and Clock# falling).

[i] The total variation of all Vcross measurements in any particular system. Note that this is a subset of VCROSS_min/max (VCROSS absolute) allowed. The intent is to limit VCROSS induced modulation by setting Δ-VCROSS to be smaller than VCROSS absolute

Table 9. Current Consumption[a]

Parameter	Symbol	Conditions		Minimum	Typical	Maximum	Unit
Operating Supply Current	I_{DDAOP}	VDDA, All outputs active at100MHz.			6	9	mA
	I_{DDOP}	All VDD, except VDDA and VDDIO, All outputs active at100MHz.	Industrial[b]		12	16	mA
			Automotive[c]		12	20	
	I_{DDIOOP}	VDDIO, All outputs active at100MHz.			28	35	mA
Wake-on-LAN Current (CKPWRGD_PD# = '0' Byte 3, bit 5 = '1')[d]	I_{DDAPD}	VDDA, DIF outputs off, REF output running.			0.4	1	mA
	I_{DDPD}	All VDD, except VDDA and VDDIO, DIF outputs off, REF output running.	Industrial[b]		5.3	8	mA
			Automotive[c]		5.3	12	
	I_{DDIOPD}	VDDIO, DIF outputs off, REF output running.			0.04	0.1	mA
Powerdown Current (CKPWRGD_PD# = '0' Byte 3, bit 5 = '0')	I_{DDAPD}	VDDA, all outputs off.			0.4	1	mA
	I_{DDPD}	All VDD, except VDDA and VDDIO, all outputs off.			0.6	1	mA
	I_{DDIOPD}	VDDIO, all outputs off.			0.0005	0.1	mA

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] 9FGV0841AKLF, 9FGV0841AKLFT, 9FGV0841AKILF, and 9FGV0841AKILFT.

[c] 9FGV0841ANDG2 and 9FGV0841ANDG28.

[d] This is the current required to have the REF output running in Wake-on-LAN mode (Byte 3, bit 5 = 1).

Table 10. DIF Output Duty Cycle, Jitter, and Skew Characteristics

Parameter	Symbol	Conditions		Minimum	Typical	Maximum	Unit
Duty Cycle[a][b]	t_{DC}	Measured differentially, PLL Mode.		45	50	55	%
Skew, Output to Output[a][b]	t_{sk3}	Averaging on, V_T = 50%.	Industrial[c]		43	50	ps
			Automotive[d]		43	67	
Jitter, Cycle to Cycle[a][b]	$t_{jcyc-cyc}$				14	50	ps

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] Measured from differential waveform.

[c] 9FGV0841AKLF, 9FGV0841AKLFT, 9FGV0841AKILF, and 9FGV0841AKILFT.

[d] 9FGV0841ANDG2 and 9FGV0841ANDG28.

Table 11. Filtered Phase Jitter Parameters – PCIe Common Clocked (CC) Architectures

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Specification Limits	Unit	Notes
Phase Jitter, PLL Mode	$t_{jphPCIeG1-CC}$	PCIe Gen1.	21	25	35	86	ps (p-p)	1,2,3
	$t_{jphPCIeG2-CC}$	PCIe Gen2 Low Band 10kHz < f < 1.5MHz (PLL BW of 5–16MHz, 8–16MHz, CDR = 5MHz).	0.9	0.9	1.1	3	ps (rms)	1,2
		PCIe Gen2 High Band 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5–16MHz, 8–16MHz, CDR = 5MHz).	1.5	1.6	1.9	3.1	ps (rms)	1,2
	$t_{jphPCIeG3-CC}$	PCIe Gen3 (PLL BW of 2–4MHz, 2–5MHz, CDR = 10MHz).	0.3	0.37	0.44	1	ps (rms)	1,2
	$t_{jphPCIeG4-CC}$	PCIe Gen4 (PLL BW of 2–4MHz, 2–5MHz, CDR = 10MHz).	0.3	0.37	0.44	0.5	ps (rms)	1,2

Table 12. REF

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Long Accuracy[a][b]	ppm	See Tperiod min–max values.	0			ppm
Clock Period[b]	T_{period}	25MHz output.		40		ns
Rise/Fall Slew Rate[a]	t_{rf1}	Byte 3 = 1F, 20% to 80% of V_{DDREF}.	0.6	1	1.6	V/ns
Rise/Fall Slew Rate[a][c]	t_{rf1}	Byte 3 = 5F, 20% to 80% of V_{DDREF}.	0.9	1.4	2.2	V/ns
Rise/Fall Slew Rate[a]	t_{rf1}	Byte 3 = 9F, 20% to 80% of V_{DDREF}.	1.1	1.7	2.7	V/ns
Rise/Fall Slew Rate[a]	t_{rf1}	Byte 3 = DF, 20% to 80% of V_{DDREF}.	1.1	1.8	2.9	V/ns
Duty Cycle[a][d]	d_{t1X}	$V_T = V_{DD}/2$ V.	45	49.1	55	%
Duty Cycle Distortion[a][e]	d_{tcd}	$V_T = V_{DD}/2$ V.	0	2	4	%
Jitter, Cycle to Cycle[a][d]	$t_{jcyc-cyc}$	$V_T = V_{DD}/2$ V.		19.1	250	ps
Noise Floor[a][d]	t_{jdBc1k}	1kHz offset.		-129.8	-105	dBc
Noise Floor[a][d]	$t_{jdBc10k}$	10kHz offset to Nyquist.		-143.6	-115	dBc
Jitter, Phase[a][d]	t_{jphREF}	12kHz to 5MHz.		0.63	1.5	ps (rms)

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is trimmed to 25.00MHz.

[c] Default SMBus value.

[d] When driven by a crystal.

[e] When driven by an external oscillator via the X1 pin, X2 should be floating.

Clock Periods

Table 13. Clock Periods - Differential Outputs with Spread Spectrum Disabled

SSC OFF	Center Frequency (MHz)	Measurement Window							Unit
		1 Clock	1µs	0.1s	0.1s	0.1s	1µs	1 Clock	
		-c2cjitter AbsPer Min	-SSC Short-Term Average Min	-ppm Long-Term Average Min	0 ppm Period Nominal	+ppm Long-Term Average Max	+SSC Short-Term Average Max	+c2cjitter AbsPer Max	
DIF[a] [b]	100.00	9.94900	—	9.99900	10.00000	10.00100	—	10.05100	ns

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is trimmed to 0ppm.

Table 14. Clock Periods - Differential Outputs with Spread Spectrum Enabled

SSC ON	Center Frequency (MHz)	Measurement Window							Unit
		1 Clock	1µs	0.1s	0.1s	0.1s	1µs	1 Clock	
		-c2cjitter AbsPer Min	-SSC Short-Term Average Min	-ppm Long-Term Average Min	0 ppm Period Nominal	+ppm Long-Term Average Max	+SSC Short-Term Average Max	+c2cjitter AbsPer Max	
DIF[a][b]	99.75	9.94906	9.99906	10.02406	10.02506	10.02607	10.05107	10.10107	ns

[a] Guaranteed by design and characterization, not 100% tested in production.

[b] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is trimmed to 0ppm.

Crystal Characteristics

Table 15. Recommended Crystal Characteristics

Parameter	Value	Unit
Frequency	25	MHz
Resonance Mode	Fundamental	–
Frequency Tolerance at 25°C	±20	ppm maximum
Frequency Stability, REF at 25°C Over Operating Temperature Range	±20	ppm maximum
Temperature Range (commercial)	0–70	°C
Temperature Range (industrial)	-40–85	°C
Equivalent Series Resistance (ESR)	50	Ω maximum
Shunt Capacitance (C_O)	7	pF maximum
Load Capacitance (C_L)	8	pF maximum
Drive Level	0.1	mW maximum
Aging Per Year	±5	ppm maximum

Test Loads

Figure 2. Low-Power HCSL (LP-HCSL) Differential Output Test Load

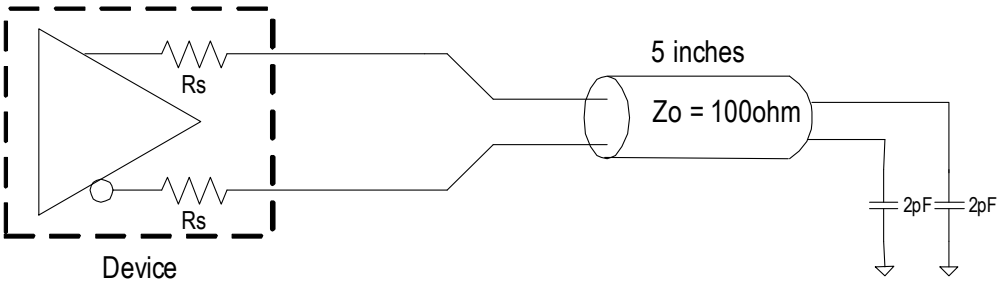
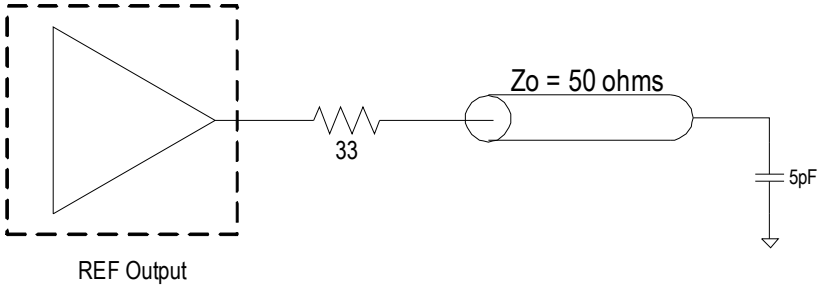


Figure 3. REF Output Test Load



Alternate Terminations

The output can easily drive other logic families. See “AN-891 Driving LVPECL, LVDS, CML, and SSTL Logic with Universal Low-Power HCSL Outputs” for LVPECL, LVDS, CML, and SSTL.

General SMBus Serial Interface Information

How to Write

- Controller (host) sends a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) sends the byte count = X
- Renesas clock will **acknowledge**
- Controller (host) starts sending Byte **N through Byte N+X-1**
- Renesas clock will **acknowledg**e each byte **one at a time**
- Controller (host) sends a stop bit

Index Block Write Operation			
Controller (Host)			**Renesas (Slave/Receiver)**
T	starT bit		
Slave Address			
WR	WRite		
			ACK
Beginning Byte = N			
			ACK
Data Byte Count = X			
			ACK
Beginning Byte N		X Byte	
			ACK
O			
O			O
O			O
			O
Byte N + X - 1			
			ACK
P	stoP bit		

Note: SMBus address is latched on SADR pin.

How to Read

- Controller (host) will send a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) will send a separate start bit
- Controller (host) sends the read address
- Renesas clock will **acknowledge**
- Renesas clock will send the data byte count = X
- Renesas clock sends Byte **N+X-1**
- Renesas clock sends **Byte 0 through Byte X (if $X_{(H)}$ was written to Byte 8)**
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

Index Block Read Operation			
Controller (Host)			**Renesas**
T	starT bit		
Slave Address			
WR	WRite		
			ACK
Beginning Byte = N			
			ACK
RT	Repeat starT		
Slave Address			
RD	ReaD		
			ACK
			Data Byte Count=X
ACK			
		X Byte	Beginning Byte N
ACK			
			O
O			O
O			O
O			
			Byte N + X - 1
N	Not acknowledge		
P	stoP bit		

SMBus Table: Output Enable Register

Byte 0	Name[a]	Control Function	Type	0	1	Default
Bit 7	DIF OE7	Output Enable	RW	Low/Low	Enabled	1
Bit 6	DIF OE6	Output Enable	RW	Low/Low	Enabled	1
Bit 5	DIF OE5	Output Enable	RW	Low/Low	Enabled	1
Bit 4	DIF OE4	Output Enable	RW	Low/Low	Enabled	1
Bit 3	DIF OE3	Output Enable	RW	Low/Low	Enabled	1
Bit 2	DIF OE2	Output Enable	RW	Low/Low	Enabled	1
Bit 1	DIF OE1	Output Enable	RW	Low/Low	Enabled	1
Bit 0	DIF OE0	Output Enable	RW	Low/Low	Enabled	1

[a] A low on these bits will override the OE# pin and force the differential output Low/Low.

SMBus Table: SS Readback and Control Register

Byte 1	Name	Control Function	Type	0	1	Default
Bit 7	SSENRB1	SS Enable Readback Bit1	R	00' for SS_EN_tri = 0, '01' for SS_EN_tri = 'M', '11 for SS_EN_tri = '1'		Latch
Bit 6	SSENRB1	SS Enable Readback Bit0	R			Latch
Bit 5	SSEN_SWCNTRL	Enable SW control of SS	RW	Values in B1[7:6] control SS amount	Values in B1[4:3] control SS amount.	0
Bit 4	SSENSW1	SS Enable Software Ctl Bit1	RW[a]	00' = SS Off, '01' = -0.25% SS, '10' = Reserved, '11'= -0.5% SS		0
Bit 3	SSENSW0	SS Enable Software Ctl Bit0	RW[a]			0
Bit 2	Reserved					1
Bit 1	AMPLITUDE 1	Controls Output Amplitude	RW	00 = 0.6V	01 = 0.7V	1
Bit 0	AMPLITUDE 0		RW	10= 0.8V	11 = 0.9V	0

[a] B1[5] must be set to a 1 for these bits to have any effect on the part.

SMBus Table: DIF Slew Rate Control Register

Byte 2	Name	Control Function	Type	0	1	Default
Bit 7	SLEWRATESEL DIF7	Adjust Slew Rate of DIF7	RW	Slow Setting	Fast Setting	1
Bit 6	SLEWRATESEL DIF6	Adjust Slew Rate of DIF6	RW	Slow Setting	Fast Setting	1
Bit 5	SLEWRATESEL DIF5	Adjust Slew Rate of DIF5	RW	Slow Setting	Fast Setting	1
Bit 4	SLEWRATESEL DIF4	Adjust Slew Rate of DIF4	RW	Slow Setting	Fast Setting	1
Bit 3	SLEWRATESEL DIF3	Adjust Slew Rate of DIF3	RW	Slow Setting	Fast Setting	1
Bit 2	SLEWRATESEL DIF2	Adjust Slew Rate of DIF2	RW	Slow Setting	Fast Setting	1
Bit 1	SLEWRATESEL DIF1	Adjust Slew Rate of DIF1	RW	Slow Setting	Fast Setting	1
Bit 0	SLEWRATESEL DIF0	Adjust Slew Rate of DIF0	RW	Slow Setting	Fast Setting	1

SMBus Table: Nominal V_{HIGH} Amplitude Control / REF Control Register

Byte 3	Name	Control Function	Type	0	1	Default
Bit 7	REF	Slew Rate Control	RW	00 = Slowest	01 = Slow	0
Bit 6			RW	10 = Fast	11 = Faster	1
Bit 5	REF Power Down Function	Wake-on-Lan Enable for REF	RW	REF does not run in Power Down	REF runs in Power Down	0
Bit 4	REF OE	REF Output Enable	RW	Low	Enabled	1
Bit 3	Reserved					1
Bit 2	Reserved					1
Bit 1	Reserved					1
Bit 0	Reserved					1

Byte 4 is Reserved.

SMBus Table: Revision and Vendor ID Register

Byte 5	Name	Control Function	Type	0	1	Default
Bit 7	RID3	Revision ID	R	Industrial: 0001 (revision A) Automotive; 1000 (revision A)		0
Bit 6	RID2		R			0
Bit 5	RID1		R			0
Bit 4	RID0		R			1
Bit 3	VID3	VENDOR ID	R	0001 = Renesas		0
Bit 2	VID2		R			0
Bit 1	VID1		R			0
Bit 0	VID0		R			1

SMBus Table: Device Type/Device ID Register

Byte 6	Name	Control Function	Type	0	1	Default
Bit 7	Device Type1	Device Type	R	00 = FGx, 01 = DBx ZDB/FOB, 10 = DMx, 11= DBx FOB		0
Bit 6	Device Type0		R			0
Bit 5	Device ID5	Device ID	R	001000 binary or 08 hex		0
Bit 4	Device ID4		R			0
Bit 3	Device ID3		R			1
Bit 2	Device ID2		R			0
Bit 1	Device ID1		R			0
Bit 0	Device ID0		R			0

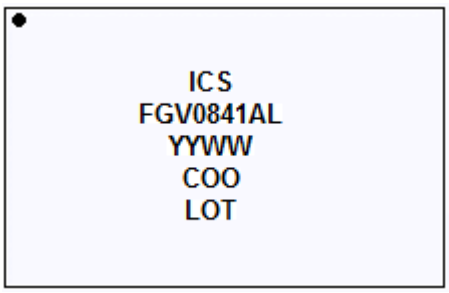
SMBus Table: Revision and Vendor ID Register

Byte 7	Name	Control Function	Type	0	1	Default
Bit 7	Reserved					0
Bit 6	Reserved					0
Bit 5	Reserved					0
Bit 4	BC4	Byte Count Programming	RW	Writing to this register will configure how many bytes will be read back, default is = 8 bytes.		0
Bit 3	BC3		RW			1
Bit 2	BC2		RW			0
Bit 1	BC1		RW			0
Bit 0	BC0		RW			0

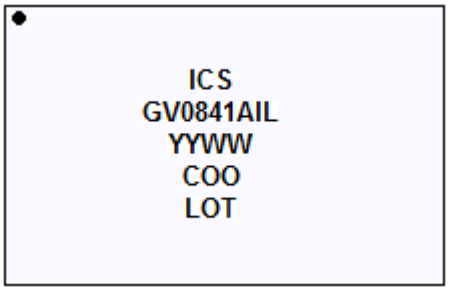
Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website (see Ordering Information for POD links). The package information is the most current data available and is subject to change without revision of this document.

Marking Diagrams



Commercial



Industrial

Automotive

- Lines 1 and 2: truncated part number
- “YYWW” denotes the last digits of the year and work week the part was assembled.
- “#” denotes the stepping sequence.
- “$” denotes mark code.
- “COO” denotes country of origin/
- “LOT” denotes the lot number.

Ordering Information

Orderable Part Number[a][b]	Package	Carrier Type	Temperature Range
9FGV0841AKLF	6 × 6 mm, 0.4mm pitch 48-VFQFPN	Tray	0 to +70°C
9FGV0841AKLFT	6 × 6 mm, 0.4mm pitch 48-VFQFPN	Reel	0 to +70°C
9FGV0841AKILF	6 × 6 mm, 0.4mm pitch 48-VFQFPN	Tray	-40 to +85°C
9FGV0841AKILFT	6 × 6 mm, 0.4mm pitch 48-VFQFPN	Reel	-40 to +85°C
9FGV0841ANDG2	6 × 6 mm, 0.4mm pitch 48-VFQFPN (wettable flank)	Tray	-40 to +105°C[c]
9FGV0841ANDG28	6 × 6 mm, 0.4mm pitch 48-VFQFPN (wettable flank)	Reel	-40 to +105°C[c]

[a] “LF” indicates Pb-free, RoHS compliant.

[b] “A” is the device revision designator (will not correlate to with the datasheet revision).

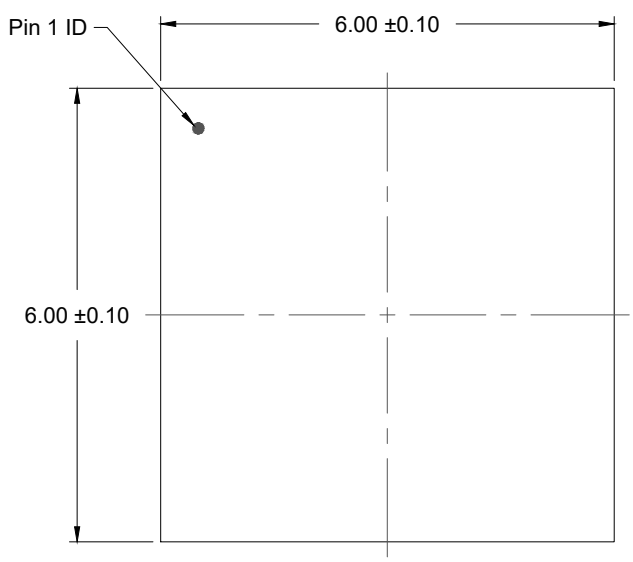
[c] AEC-Q100 Grade 2.

Revision History

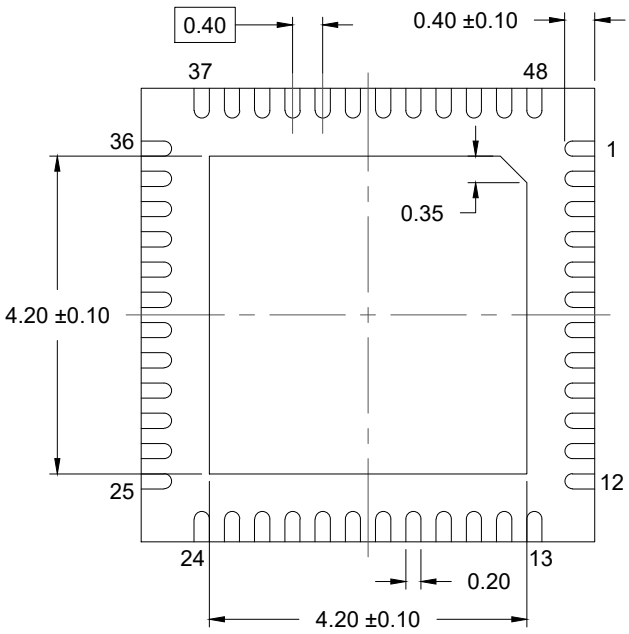
Revision Date	Description of Change
December 2, 2025	Updated Alternate Terminations section. Updated Package Outline Drawings section. Updated package outline drawings (POD) links and moved them to Ordering Information.
August 20, 2021	Rebranded to Renesas.
November 26, 2019	Initial release of production datasheet. Key changes include the addition of automotive electrical characteristics to Table 7 to Table 10; however, no changes were made to industrial-grade parameters.

Package Outline Drawing

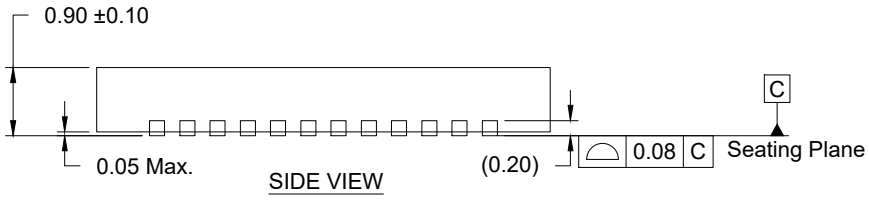
Package Code:NDG48P2
48-VFQFPN 6.0 x 6.0 x 0.9 mm Body, 0.4mm Pitch
PSC-4212-02, Revision: 04, Date Created: Sep 28, 2022



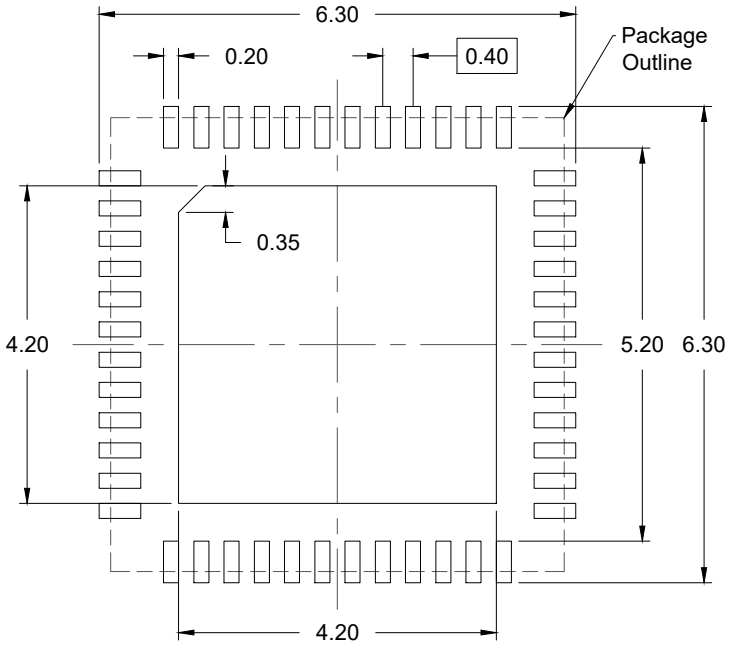
TOP VIEW



BOTTOM VIEW



SIDE VIEW



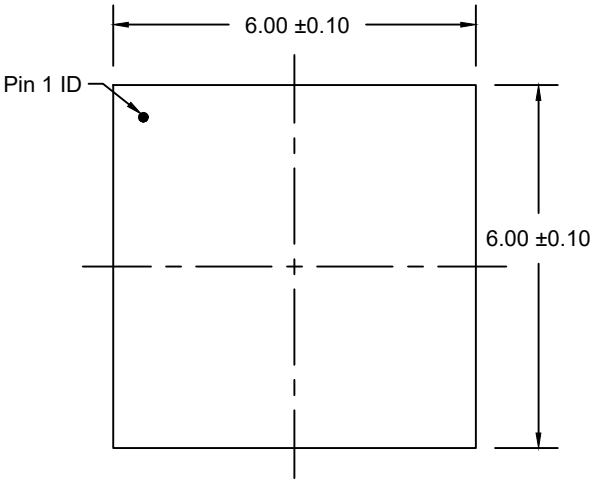
RECOMMENDED LAND PATTERN
(PCB Top View, NSMD Design)

NOTES:

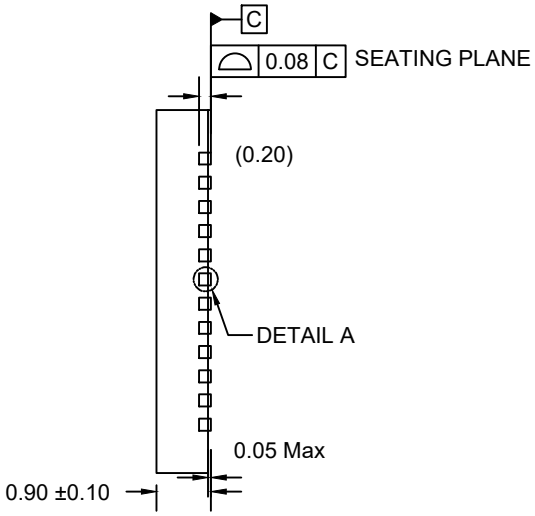
1. JEDEC compatible.
2. All dimensions are in mm and angles are in degrees.
3. Use ±0.05 mm for the non-toleranced dimensions.
4. Numbers in ( ) are for references only.

Package Outline Drawing

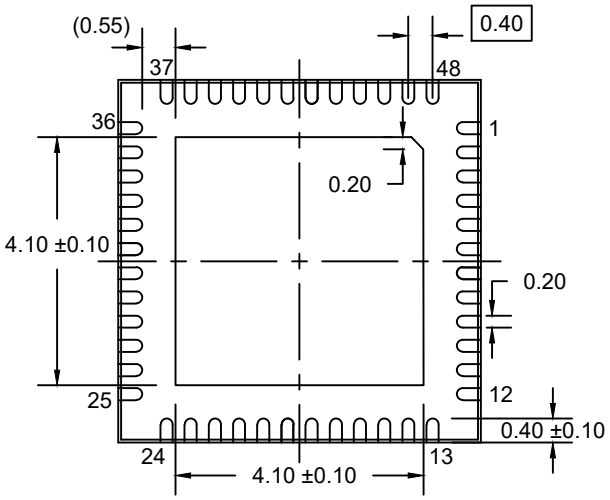
PSC-4212-04
NDG48S1
48-VFQFPN 6.0 x 6.0 x 0.9 mm Body, 0.40mm Pitch
Rev.04, Jun 26, 2025



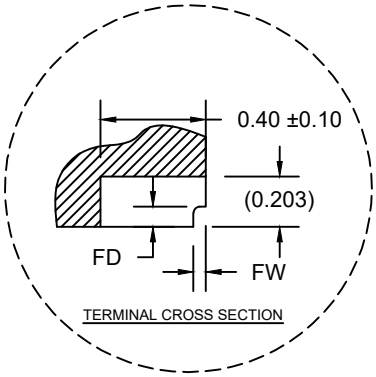
TOP VIEW



SIDE VIEW



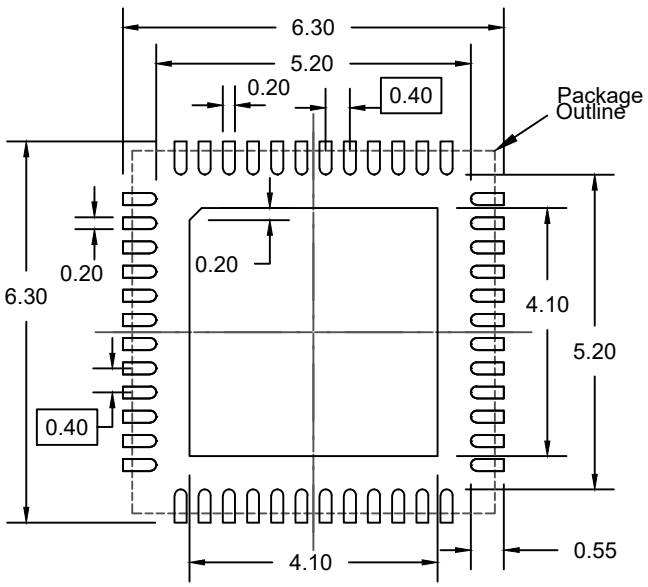
BOTTOM VIEW



DETAIL A

Table 1: Dimensions of wettable flank (DETAIL A)

Symbol	Unit (mm)	
	MIN	MAX
FD	0.100	-
FW	0.010	0.075



RECOMMENDED LAND PATTERN
(PCB Top View, NSMD Design)

NOTES:

1. JEDEC compatible.
2. All dimensions are in mm and angles are in degrees.
3. Use ±0.05 mm for the non-toleranced dimensions.
4. Numbers in ( ) are for references only.
5. Wettable flank (step cut).

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.