Description

The 9DMV0131B/9DMV0141B are 1.8V members of IDT's full-featured PCIe clock family. The 9DMV0131B uses external series resistors for maximum flexibility, while the 9DMV0141B integrates output terminations for direct connection to 100Ω transmission lines. An OE# pin provides optimal system control and power management. The parts provide asynchronous or glitch-free switching modes.

PCIe Clocking Architectures

- Common Clocked (CC)
- Independent Reference (IR) with and without spread spectrum

Typical Applications

- Servers
- nVME drives
- Embedded systems/Industrial control
- High-performance computing
- Accelerators

Key Specifications

- Additive cycle-to-cycle jitter < 5ps
- Additive PCIe Gen5 phase jitter < 38fs RMS
- 156.25MHz additive phase jitter 130fs RMS typical (12kHz to 20MHz)

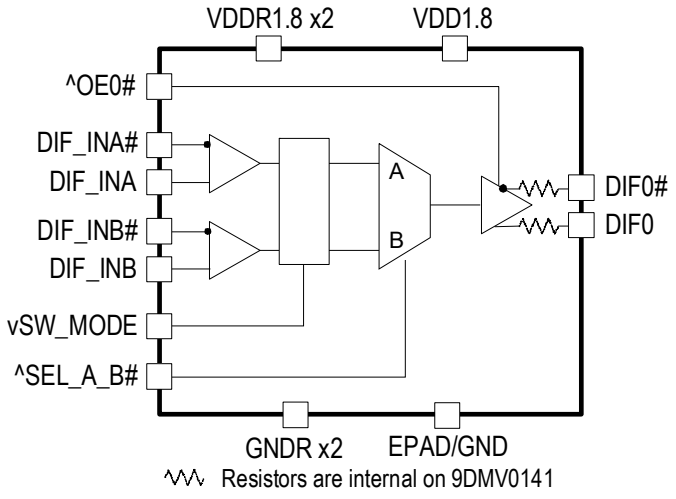
Features

- Direct connection to 100Ω loads saves 4 resistors (9DMV0141B)
- External series resistors allow use in 85Ω or 100Ω systems (9DMV0131B)
- 1.8V operation; 12mW typical power consumption
- Selectable asynchronous or glitch-free switching; allows the mux to be selected at power up even if both inputs are not running, then transition to glitch-free switching mode
- OE# pin for flexible power sequencing
- HCSL differential inputs
- Spread spectrum tolerant; allows reduction of EMI
- 1MHz to 200MHz operating frequency
- Configuration accomplished with strapping pins, no SMBus needed
- Space-saving 3 × 3 mm 16-VFQFPN; minimal board space

Output Features

- 1 Low-Power HCSL (LP-HCSL) DIF pair

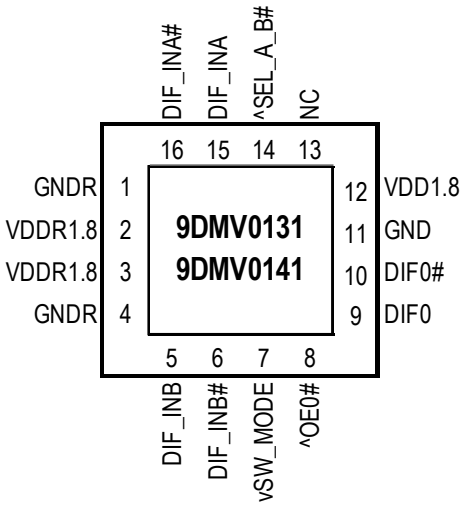
Block Diagram



Contents

Pin Assignments

Figure 1. Pin Assignments for 3 × 3 mm 16-VFQFPN Package – Top View



16-VFQFPN, 3 x 3 mm, 0.5mm pitch

^ prefix indicates internal 120kOhm pull-up resistor

v prefix indicates internal 120kOhm pull-down resistor

Note: Paddle may be connected to ground for thermal purposes. It is not required electrically.

Pin Descriptions

Table 1. Pin Descriptions

Number	Name	Type	Description
1	GNDR	GND	Analog ground pin for the differential input (receiver).
2	VDDR1.8	Power	Power supply for differential input clock (receiver). This V_{DD} should be treated as an analog power rail and filtered appropriately. Nominally 1.8V.
3	VDDR1.8	Power	Power supply for differential input clock (receiver). This V_{DD} should be treated as an analog power rail and filtered appropriately. Nominally 1.8V.
4	GNDR	GND	Analog ground pin for the differential input (receiver).
5	DIF_INB	Input	True input of differential clock.
6	DIF_INB#	Input	Complement input of differential clock.
7	vSW_MODE	Input	Switch Mode. This pin selects either asynchronous or glitch-free switching of the mux. Use asynchronous mode if 0 or 1 of the input clocks is running. Use glitch-free mode if both input clocks are running. This pin has an internal pull down resistor of ~s. 0 = asynchronous mode, 1 = glitch-free mode.
8	^OE0#	Input	Active low input for enabling output 0. This pin has an internal pull-up resistor. 1 = disable output, 0 = enable output.
9	DIF0	Output	Differential true clock output.
10	DIF0#	Output	Differential complementary clock output.
11	GND	GND	Ground pin.

Table 1. Pin Descriptions (Cont.)

Number	Name	Type	Description
12	VDD1.8	Power	Power supply, nominally 1.8V.
13	NC	—	No connection.
14	^SEL_A_B#	Input	Input to select differential input clock A or differential input clock B. This input has an internal pull-up resistor. 0 = Input B selected, 1 = Input A selected.
15	DIF_INA	Input	True input of differential clock.
16	DIF_INA#	Input	Complement input of differential clock.

Table 2. Power Management

OEx# Pin	DIF_IN	DIFx	
		True O/P	Complementary O/P
0	Running	Running	Running
1	Running	Low	Low

Table 3. Power Connections

Pin Number		Description
V_{DD}	GND	
2	1	Input A receiver analog.
3	4	Input B receiver analog.
12	11	DIF outputs,

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 9DMV0131B/9DMV0141B at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Table 4. Absolute Maximum Ratings

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
V_{DDxx}	Supply Voltage	Applies to all V_{DD} pins.	-0.5		2.5	V	1,2
V_{IN}	Input Voltage		-0.5		V_{DD} + 0.5V	V	1,3
Ts	Storage Temperature		-65		150	°C	1
Tj	Junction Temperature				125	°C	1
ESD prot	Input ESD protection	Human Body Model.	2000			V	1

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

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

[3] Not to exceed 2.5V.

Thermal Characteristics

Table 5. Thermal Characteristics

Symbol	Parameter	Conditions	Package	Value	Units	Notes
θ_{JC}	Thermal Resistance	Junction to case.	NLG16	66	°C/W	1
θ_{JB}		Junction to board.		5	°C/W	1
θ_{JA0}		Junction to air, still air.		63	°C/W	1
θ_{JA1}		Junction to air, 1m/s air flow.		56	°C/W	1
θ_{JA2}		Junction to air, 3m/s air flow.		51	°C/W	1
θ_{JA3}		Junction to air, 5m/s air flow.		49	°C/W	1

[1] EPAD soldered to board.

Electrical Characteristics

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

Table 6. Electrical Characteristics–Input/Supply/Common Parameters – Normal Operating Condition

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
V_{DDxx}	Supply Voltage	Applies to all V_{DD} pins.	1.7	1.8	1.9	V	
T_{AMB}	Ambient Operating Temperature	Industrial range.	-40	25	85	°C	1
V_{IH}	Input High Voltage	Single-ended inputs, except SMBus.	0.75 V_{DD}		V_{DD} + 0.3	V	
V_{IL}	Input Low Voltage	Single-ended inputs, except SMBus.	-0.3		0.25 V_{DD}	V	
I_{IN}	Input Current	Single-ended inputs, V_{IN} = GND, V_{IN} = V_{DD}.	-5		5	µA	
I_{INP}		Single-ended inputs. V_{IN} = 0 V; Inputs with internal pull-up resistors. V_{IN} = V_{DD}; Inputs with internal pull-down resistors.	-100		100	µA	
F_{ibyp}	Input Frequency		1		200	MHz	2
L_{pin}	Pin Inductance				7	nH	1
C_{IN}	Capacitance	Logic Inputs, except DIF_IN.	1.5		5	pF	1
C_{INDIF_IN}		DIF_IN differential clock inputs.	1.5		2.7	pF	1,4
C_{OUT}		Output pin capacitance.			6	pF	1
T_{STAB}	Clk Stabilization	From V_{DD} power-up and after input clock stabilization or de-assertion of PD# to 1st clock.			1	ms	1,2
$f_{MODINPCIe}$	Input SS Modulation Frequency PCIe	Allowable frequency for PCIe applications (triangular modulation).	30		33	kHz	
f_{MODIN}	Input SS Modulation Frequency non-PCIe	Allowable frequency for non-PCIe applications (triangular modulation).	0		66	kHz	
$t_{LATOE\#}$	OE# Latency	DIF start after OE# assertion. DIF stop after OE# deassertion.	1	2	3	clocks	1,3
t_F	Tfall	Fall time of single-ended control inputs.			5	ns	1,2
t_R	Trise	Rise time of single-ended control inputs.			5	ns	1,2

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

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

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

[4] DIF_IN input.

Table 7. Clock Input Parameters

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
V_{CROSS}	Input Crossover Voltage – DIF_IN	Crossover voltage (common mode voltage).	200		725		
V_{SWING}	Input Swing–DIF_IN	Differential value.	300			mV	1
dv/dt	Input Slew Rate–DIF_IN	Measured differentially.	0.6			V/ns	1,2
I_{IN}	Input Leakage Current	V_{IN} = 0.8V , V_{IN} = GND.	-5		5	µA	
d_{tin}	Input Duty Cycle	Measurement from differential waveform.	45		55	%	1

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

[2] Slew rate measured through ±75mV window centered around differential zero.

Table 8. DIF Low-Power HCSL Outputs

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
T_{RF}	Slew Rate	Scope averaging on, 9DMV0141B	2	2.9	4.0	V/ns	1,2,3
ΔT_{RF}	Slew Rate Matching	Slew rate matching, scope averaging on.		3	20	%	1,4
V_{HIGH}	Voltage High	Statistical measurement on single-ended signal using oscilloscope math function (scope averaging on).	660	783	850	mV	
V_{LOW}	Voltage Low		-150	26	150		
V_{MAX}	Max Voltage	Measurement on single ended signal using absolute value (scope averaging off).		790	1150	mV	
V_{MIN}	Min Voltage		-300	9			
V_{CROSS_ABS}	Crossing Voltage (abs)	Scope averaging off.	250	393	550	mV	1,5
Δ-V_{CROSS}	Crossing Voltage (var)	Scope averaging off.		12	140	mV	1,6

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

[2] Measured from differential waveform.

[3] Slew rate is measured through the V_{SWING} voltage range centered around differential 0V. This results in a ±150mV window around differential 0V.

[4] 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.

[5] 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).

[6] The total variation of all V_{CROSS} measurements in any particular system. Note that this is a subset of $V_{CROSS\_MIN/MAX}$ (V_{CROSS} absolute) allowed. The intent is to limit V_{CROSS} induced modulation by setting Δ-V_{CROSS} to be smaller than V_{CROSS} absolute.

Table 9. Current Consumption

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
I_{DDOP}	Operating Supply Current	V_{DD} rails, all outputs active at 100MHz.		7.9	12	mA	
I_{DDDIS}	Disable Current	V_{DD} rails, all outputs disabled Low/Low.		1.5	2.5	mA	2

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

[2] Input clock stopped after outputs have parked Low/Low.

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

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units	Notes
t_{DCD}	Duty Cycle Distortion	Measured differentially, at 100MHz.	-0.5	-0.12	0.5	%	1,3
t_{pdBYP}	Skew, Input to Output	V_T = 50%.	1800	2409	3000	ps	1
$t_{jcyc-cyc}$	Jitter, Cycle to Cycle	*Additive* Jitter.			5	ps	1,2

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

[2] Measured from differential waveform.

[3] Duty cycle distortion is the difference in duty cycle between the output and the input clock.

Table 11. PCIe Refclk Phase Jitter [1] [2]

T_{AMB} = over the specified operating range. Supply Voltages per normal operation conditions. See Test Loads for loading conditions

Symbol	Parameter	Conditions	Typical	Maximum	PCIe Specification	Units
$t_{jphPCIeG1-CC}$	Additive PCIe Phase Jitter in Fan-out Buffer Mode (Common Clocked Architecture) SSC ≦ -0.5%	PCIe Gen1 (2.5 GT/s)	1.7	3.0	[5]	ps pk-pk
$t_{jphPCIeG2-CC}$		PCIe Gen2 Hi Band (5 GT/s)	0.122	0.199		ps RMS
		PCIe Gen2 Lo Band (5 GT/s)	0.033	0.049		
$t_{jphPCIeG3-CC}$		PCIe Gen3 (8 GT/s)	0.059	0.098		
$t_{jphPCIeG4-CC}$		PCIe Gen4 (16 GT/s) [3] [6]	0.059	0.098		
$t_{jphPCIeG5-CC}$		PCIe Gen5 (32 GT/s) [3] [7]	0.023	0.038		
$t_{jphPCIeG1-SRIS}$	Additive PCIe Phase Jitter in Fan-out Buffer Mode (SRIS Architecture) [4] SSC ≤ -0.3%	PCIe Gen1 (2.5 GT/s)	0.175	0.275	N/A	ps RMS
$t_{jphPCIeG2-SRIS}$		PCIe Gen2 (5 GT/s)	0.156	0.247		
$t_{jphPCIeG3-SRIS}$		PCIe Gen3 (8 GT/s)	0.041	0.064		
$t_{jphPCIeG4-SRIS}$		PCIe Gen4 (16 GT/s)	0.043	0.066		
$t_{jphPCIeG5-SRIS}$		PCIe Gen5 (32 GT/s)	0.036	0.059		

[1] The Refclk jitter is measured after applying the filter functions found in PCI Express Base Specification 5.0, Revision 1.0. See the Test Loads section of the data sheet for the exact measurement setup. The worst case results for each data rate are summarized in this table. Equipment noise is removed from all measurements.

[2] Jitter measurements shall be made with a capture of at least 100,000 clock cycles captured by a real-time oscilloscope (RTO) with a sample rate of 20 GS/s or greater. Broadband oscilloscope noise must be minimized in the measurement. The measured PP jitter is used (no extrapolation) for RTO measurements. Alternately - Jitter measurements may be used with a Phase Noise Analyzer (PNA) extending (flat) and integrating and folding the frequency content up to an offset from the carrier frequency of at least 200 MHz (at 300 MHz absolute frequency) below the Nyquist frequency. For PNA measurements for the 2.5 GT/s data rate, the RMS jitter is converted to peak-to-peak jitter using a multiplication factor of 8.83.

[3] SSC spurs from the fundamental and harmonics are removed up to a cutoff frequency of 2 MHz taking care to minimize removal of any non-SSC content.

[4] The PCI Express Base Specification 5.0, Revision 1.0 provides the filters necessary to calculate SRIS jitter values; it does not provide specification limits, hence the n/a in the Limit column. SRIS values are informative only. A common practice is to split the common clock budget in half. For 16GT/s data rates and above, the user must choose whether to use the output jitter specification, or the input jitter specification, which includes an allocation for the jitter added by the channel. Using 32GT/s, the Refclk jitter budget is 150fs RMS. One half of the Refclk jitter budget is 106fs RMS. At the clock input, the system must deliver 250fs RMS. One half of this value is 177fs RMS. If the clock is placed next to the PCIe device in an SRIS system, the channel is very short and the user may choose to use this more relaxed value as the jitter limit.

[5] The RMS sum of the source jitter and the additive jitter must be less than the jitter specification listed for the clock generator operating mode.

[6] Note that 0.7 ps RMS is to be used in channel simulations to account for additional noise in a real system.

[7] Note that 0.25 ps RMS is to be used in channel simulations to account for additional noise in a real system.

Table 12. Non-PCIe Additive Phase Jitter

T_{AMB} = over the specified operating range. Supply Voltages per normal operation conditions. See Test Loads for loading conditions

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Units
Additive Phase Jitter [1]	$t_{jph12k-20Madd}$	12kHz to 20MHz integration range, 156.25MHz carrier.[2]	—	130	—	fs RMS

[1] Additive jitter for RMS values is calculated by solving for b, where [$b = sqrt(c^2 - a^2)$], "a" is rms input jitter and "c" is rms total jitter.

[2] Driven by SMA100B source.

Test Loads

Figure 2. Low-Power HCSL Output Test Load (standard PCIe source-terminated test load with high impedance receiver)

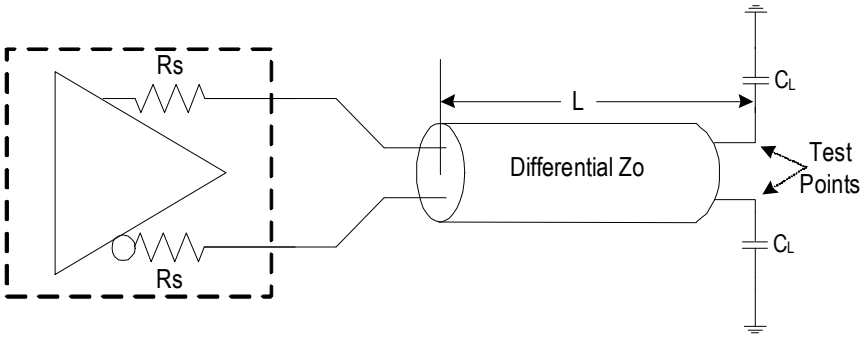


Table 13. Parameters for Low-Power HCSL Output Test Load

Device	Rs (Ω)	Zo (Ω)	L (inches)	C_L (pF)
9DMV0131	24	85	5	2
	33	100	5	2
9DMV0141	Internal	100	5	2

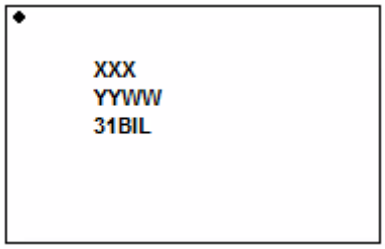
Alternate Terminations

The LP-HCSL output can easily drive other logic families. See application note "AN-891 for termination schemes for LVPECL, LVDS, CML, and SSTL.

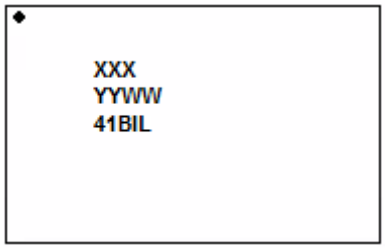
Package Outline Drawings

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



- Line 1: "XXX" is the Asm lot number.
- Line 2 indicates the following:
  - "YY" is the last two digits of the year; "WW" is the work week number when the part was assembled.
- Line 3: truncated part number.



Ordering Information

Orderable Part Number	Description	Package	Carrier Type	Temperature
9DMV0131BKILF	85Ω or 100Ω systems	3 × 3 × 0.9 mm, 16-VFQFPN	Tray	-40° to +85°C
9DMV0131BKILFT	85Ω or 100Ω systems		Tape and Reel	-40° to +85°C
9DMV0141BKILF	100Ω systems		Tray	-40° to +85°C
9DMV0141BKILFT	100Ω systems		Tape and Reel	-40° to +85°C

Revision History

Revision Date	Description of Change
May 25, 2021	▪ Updated Additive Phase Jitter bullet in Key Specifications for Gen5. ▪ Updated document title to "...PCIe Gen1–5..." ▪ Replaced Filtered Phase Jitter tables with PCIe Refclk Phase Jitter table. ▪ Replaced Unfiltered Phase Jitter table with Non-PCIe Additive Phase Jitter table. ▪ Updated Package Outline Drawings section, Marking Diagrams, and added POD link in the "Package" column in Ordering Information.
December 12, 2019	Added 9DMV0131B information to datasheet.
February 25, 2019	Initial release.

16-VFQFPN Package Outline Drawing

3.0 x 3.0 x 0.9 mm, 0.5mm Pitch, 1.70 x 1.70 mm Epad

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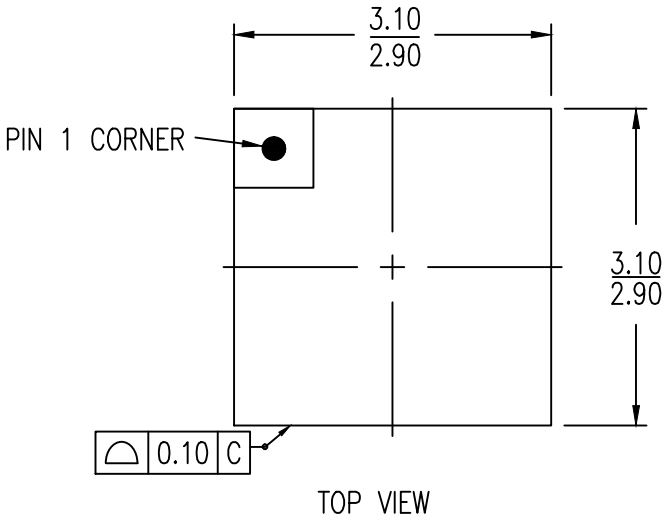
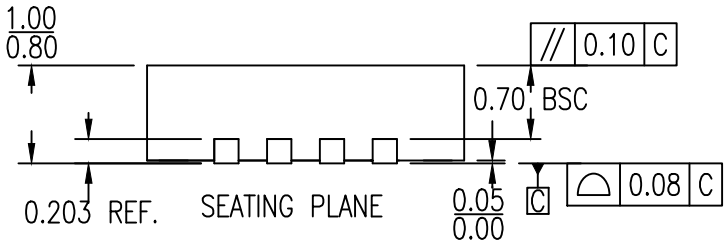
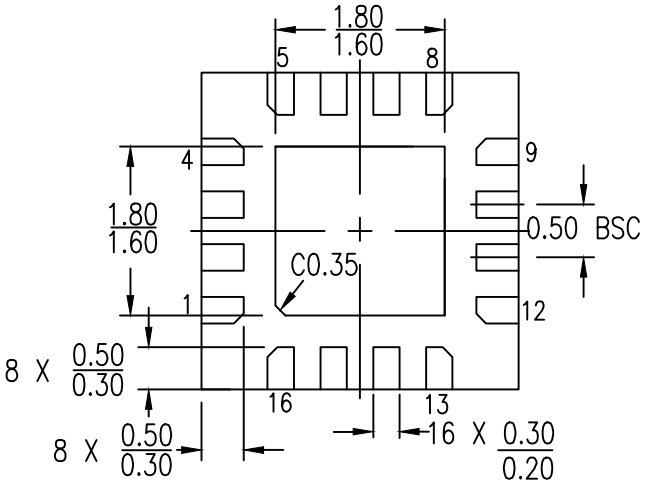


TOP VIEW

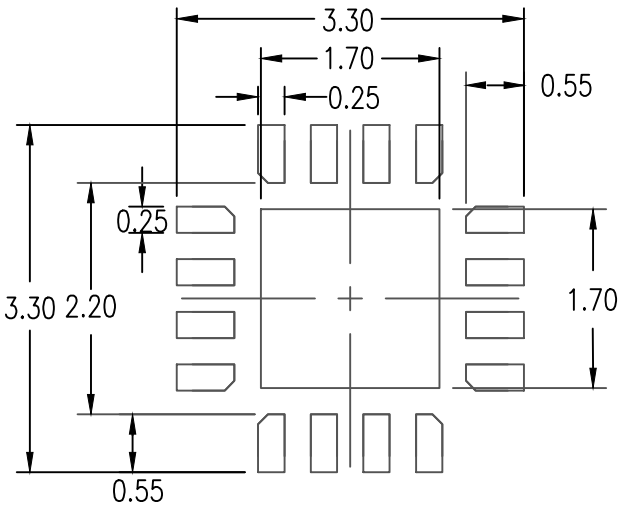


SIDE VIEW



BOTTOM VIEW

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES



RECOMMENDED LAND PATTERN DIMENSION

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES
2. TOP DOWN VIEW–AS VIEWED ON PCB
3. LAND PATTERN RECOMMENDATION IS PER IPC–7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN

Package Revision History		
Date Created	Rev No.	Description
Oct 25, 2017	Rev 04	Remove Bookmak at Pdf Format & Update Thickness Tolerance
Jan 18, 2018	Rev 05	Change QFN to VFQFPN