SNx4HC377 Octal D-Type Flip-Flops With Clock Enable

1 Features

- Wide operating voltage range of 2 V to 6 V
- Outputs can drive up to 10 LSTTL loads
- Low power consumption, 80-µA max I_{CC}
- Typical t_{pd} = 12 ns
- ±4-mA output drive at 5 V
- Low input current of 1 µA max
- Eight flip-flops with single-rail outputs
- Clock enable latched to avoid false clocking

2 Applications

- Buffer/storage registers
- Shift registers
- Pattern generators

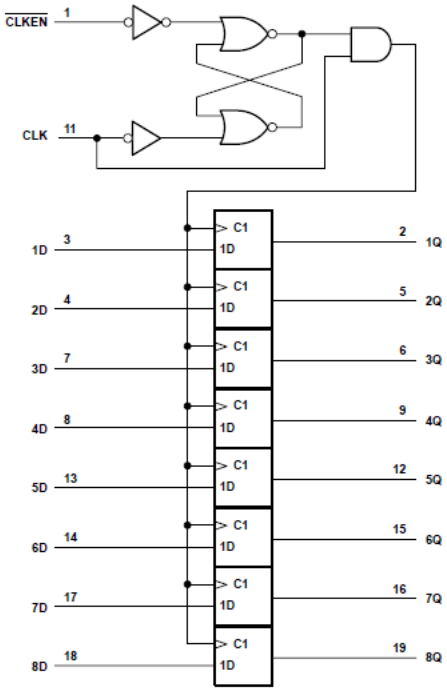
3 Description

These devices are positive-edge-triggered octal D-type flip-flops with an enable input. The ’HC377 devices are similar to the ’HC273 devices, but feature a latched clock-enable ($\overline{\text{CLKEN}}$) input instead of a common clear.

Device Information

PART NUMBER	PACKAGE(1)	BODY SIZE (NOM)
SN74HC377DW	SOIC (20)	12.80 mm × 7.50 mm
SN74HC377N	PDIP (20)	25.40 mm × 6.35 mm
SN74HC377NS	SO (20)	15.00 mm × 5.30 mm
SN54HC377J	CDIP (20)	26.92 mm × 6.92 mm
SNJ54HC377FK	LCCC (20)	8.89 mm × 8.45 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



Functional Block Diagram

Table of Contents

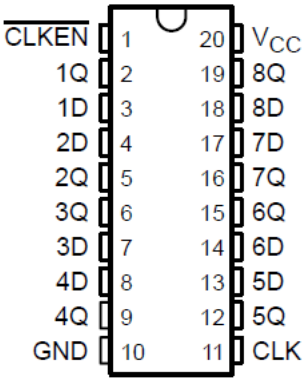
4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

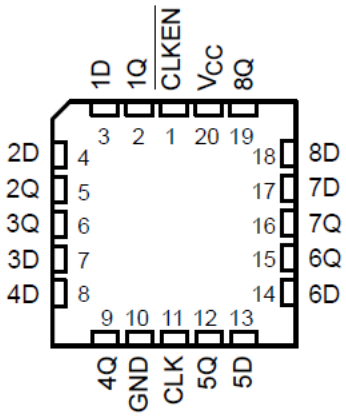
Changes from Revision C (January 2022) to Revision D (May 2022)	Page
• Junction-to-ambient thermal resistance values increased. DW was 58 is now 109.1, N was 69 is now 84.6, NS was 60 is now 113.4	4

Changes from Revision B (January 2003) to Revision C (January 2022)	Page
• Updated the numbering, formatting, tables, figures, and cross-references throughout the document to reflect modern data sheet standards	1

5 Pin Configuration and Functions



J, DW, N, or NS package
20-Pin CDIP, SOIC, PDIP, SO
Top View



FK package
20-Pin LCCC
Top View

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		-0.5	7	V
I_{IK}	Input clamp current(2)	(V_I < 0 or V_I > V_{CC})		±20	mA
I_{OK}	Output clamp current(2)	(V_O < 0 or V_O > V_{CC})		±20	mA
I_O	Continuous output current	(V_O = 0 to V_{CC})		±25	mA
	Continuous current through V_{CC} or GND			±50	mA
T_J	Junction temperature			150	°C
T_{stg}	Storage temperature		-65	150	°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

6.2 Recommended Operating Conditions(1)

			SN54HC377			SN74HC377			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage		2	5	6	2	5	6	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5			1.5			V
		V_{CC} = 4.5 V	3.15			3.15			
		V_{CC} = 6 V	4.2			4.2			
V_{IL}	Low-level input voltage	V_{CC} = 2 V			0.5			0.5	V
		V_{CC} = 4.5 V			1.35			1.35	
		V_{CC} = 6 V			1.8			1.8	
V_I	Input voltage		0		V_{CC}	0		V_{CC}	V
V_O	Output voltage		0		V_{CC}	0		V_{CC}	V
t_t	Input transition rise/fall time	V_{CC} = 2 V			1000			1000	ns
		V_{CC} = 4.5 V			500			500	
		V_{CC} = 6 V			400			400	
T_A	Operating free-air temperature		– 55		125	– 40		85	°C

(1) All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report Implications of Slow or Floating SMOS Inputs, literature number SCBA004.

6.3 Thermal Information

THERMAL METRIC		DW (SOIC) 20 PINS	N (PDIP) 20 PINS	NS (SO) 20 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance(1)	109.1	84.6	113.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	76	72.5	78.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	77.6	65.3	78.4	°C/W
ψ_{JT}	Junction-to-top characterization parameter	51.5	55.3	47.1	°C/W
ψ_{JB}	Junction-to-top characterization parameter	77.1	65.2	78.1	°C/W

6.3 Thermal Information (continued)

THERMAL METRIC		DW (SOIC) 20 PINS	N (PDIP) 20 PINS	NS (SO) 20 PINS	UNIT
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC package thermal metrics* application report.

6.4 Electrical Characteristics

PARAMETER	TEST CONDITIONS(1)	V_{CC} (V)	T_A = 25°C			SN74HC377		SN74HC377		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	I_{OH} = –20 µA	2	1.9	1.998		1.9		1.9		V
		4.5	4.4	4.499		4.4		4.4		
		6	5.9	5.999		5.9		5.9		
	I_{OH} = –4 mA	4.5	3.98	4.3		3.7		3.84		
	I_{OH} = – 5.2 mA	6	5.48	5.8		5.2		5.34		
V_{OL}	I_{OL} = 20 µA	2		0.002	0.1		0.1		0.1	V
		4.5		0.001	0.1		0.1		0.1	
		6		0.001	0.1		0.1		0.1	
	I_{OL} = 4 mA	4.5		0.17	0.26		0.4		0.33	
	I_{OL} = 5.2 mA	6		0.15	0.26		0.4		0.33	
I_I	V_I = V_{CC} or 0	6			±0.1		±1000		±1000	nA
I_{CC}	V_I = V_{CC} or 0. I_O = 0	6			8		160		80	µA
C_i		2 to 6		3	10		10		10	pF

(1) V_I = V_{IH} or V_{IL}, unless otherwise noted.

6.5 Timing Requirements

			V_{CC}	T_A = 25°C		SN54HC377		SN74HC377		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		2		5		3		4	MHz
			4.5		25		16		20	
			6		29		19		23	
t_W	Pulse duration, CLK high or low		2	100		150		125		ns
			4.5	20		30		25		
			6	17		25		21		
t_{su}	Setup time, data before CLK↑	D	2	100		150		125		ns
			4.5	20		30		25		
			6	17		25		21		
		$\overline{CLKEN}$ high or low	2	100		150		125		
			4.5	20		30		25		
			6	17		25		21		
t_h	Hold time, data after LE↑	$\overline{CLKEN}$ inactive or active, data	2	5		5		5		ns
			4.5	5		5		5		
			6	5		5		5		

6.6 Switching Characteristics

over recommended operating free-air temperature range, C_L = 50 pF (unless otherwise noted) See Parameter Measurement Information

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} (V)	T_A = 25°C			SN54HC377		SN74HC377		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			2	5	11		3		4		MHz
			4.5	25	54		16		20		
			6	29	64		19		23		
t_{pd}	$\overline{CLK}$	Any	2		56	160		240		200	ns
			4.5		15	32		48		40	
			6		12	27		41		34	
t_t		Any	2		38	75		110		95	ns
			4.5		8	15		22		19	
			6		6	13		19		16	

6.7 Operating Characteristics

T_A = 25°C

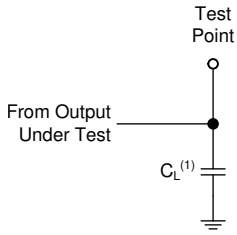
		Test Conditions	TYP	UNIT
C_{pd}	Power dissipation capacitance per flip-flop	No load	30	pF

7 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_t < 2.5 ns.

For clock inputs, f_{max} is measured when the input duty cycle is 50%.

The outputs are measured one at a time with one input transition per measurement.



(1) C_L includes probe and test-fixture capacitance.

Figure 7-1. Load Circuit for Push-Pull Outputs

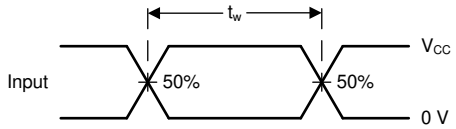


Figure 7-2. Voltage Waveforms, Standard CMOS Inputs Pulse Duration

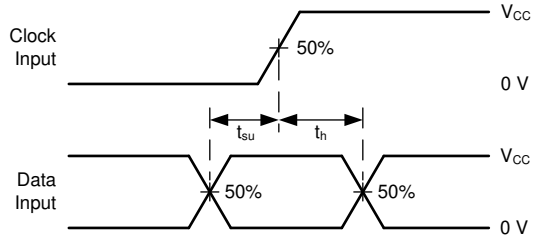
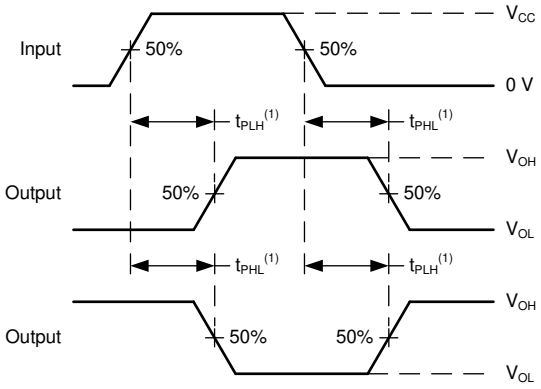
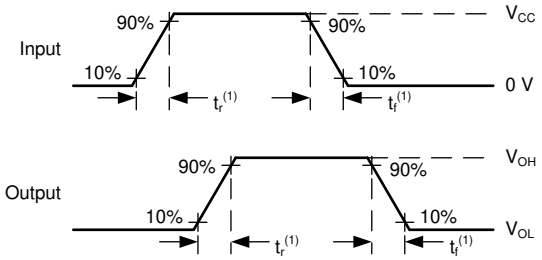


Figure 7-3. Voltage Waveforms, Standard CMOS Inputs Setup and Hold Times



(1) The greater between t_{PLH} and t_{PHL} is the same as t_{pd}.

Figure 7-4. Voltage Waveforms, Propagation Delays for Standard CMOS Inputs



(1) The greater between t_r and t_f is the same as t_t.

Figure 7-5. Voltage Waveforms, Input and Output Transition Times for Standard CMOS Inputs

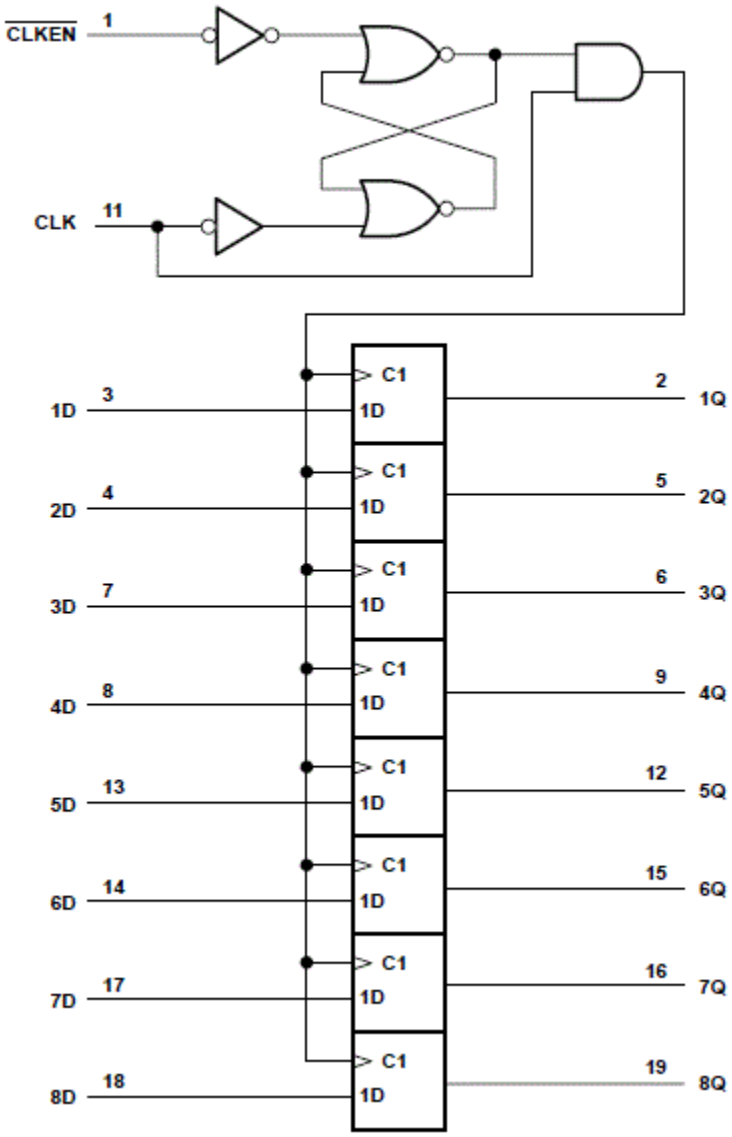
8 Detailed Description

8.1 Overview

These devices are positive-edge-triggered octal D-type flip-flops with an enable input. The ’HC377 devices are similar to the ’HC273 devices, but feature a latched clock-enable ($\overline{\text{CLKEN}}$) input instead of a common clear.

Information at the data (D) inputs meeting the setup time requirements is transferred to the Q outputs on the positive-going edge of the clock (CLK) pulse, if $\overline{\text{CLKEN}}$ is low. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When CLK is at either the high or low level, the D input has no effect at the output. These devices are designed to prevent false clocking by transitions at $\overline{\text{CLKEN}}$.

8.2 Functional Block Diagram



8.3 Device Functional Modes

Function Table
(Each Flip-Flop)

INPUTS			OUTPUT Q
$\overline{\text{CLKEN}}$	CLK	D	
H	X	X	Q_0
L	↑	H	H
L	↑	L	L
X	L	X	Q_0

9 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. A 0.1-µF capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1-µF and 1-µF capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

10 Layout

10.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices inputs must not ever be left floating. In many cases, functions or parts of functions of digital logic devices are unused; for example, when only two inputs of a triple-input AND gate are used or only 3 of the 4 buffer gates are used. Such unused input pins must not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. All unused inputs of digital logic devices must be connected to a logic high or logic low voltage, as defined by the input voltage specifications, to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, the inputs are tied to GND or V_{CC}, whichever makes more sense for the logic function or is more convenient.

11 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

11.1 Documentation Support

11.1.1 Related Documentation

11.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

11.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

11.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

11.5 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.6 Glossary

TI Glossary	This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-87807012A	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-87807012A SNJ54HC 377FK	Samples
5962-8780701RA	ACTIVE	CDIP	J	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8780701RA SNJ54HC377J	Samples
SN54HC377J	ACTIVE	CDIP	J	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54HC377J	Samples
SN74HC377DW	ACTIVE	SOIC	DW	20	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC377	Samples
SN74HC377DWR	ACTIVE	SOIC	DW	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC377	Samples
SN74HC377N	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 85	SN74HC377N	Samples
SN74HC377NE4	ACTIVE	PDIP	N	20	20	RoHS & Green	NIPDAU	N / A for Pkg Type	-40 to 85	SN74HC377N	Samples
SN74HC377NSR	ACTIVE	SO	NS	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC377	Samples
SNJ54HC377FK	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-87807012A SNJ54HC 377FK	Samples
SNJ54HC377J	ACTIVE	CDIP	J	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8780701RA SNJ54HC377J	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

OTHER QUALIFIED VERSIONS OF SN54HC377, SN74HC377 :

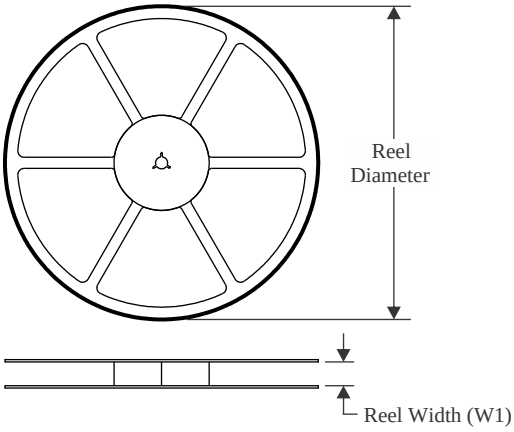
- Catalog : SN74HC377
- Military : SN54HC377

NOTE: Qualified Version Definitions:

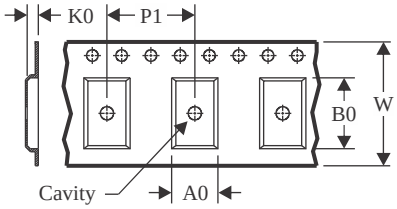
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

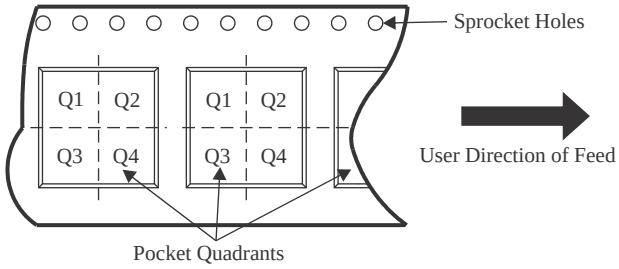


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

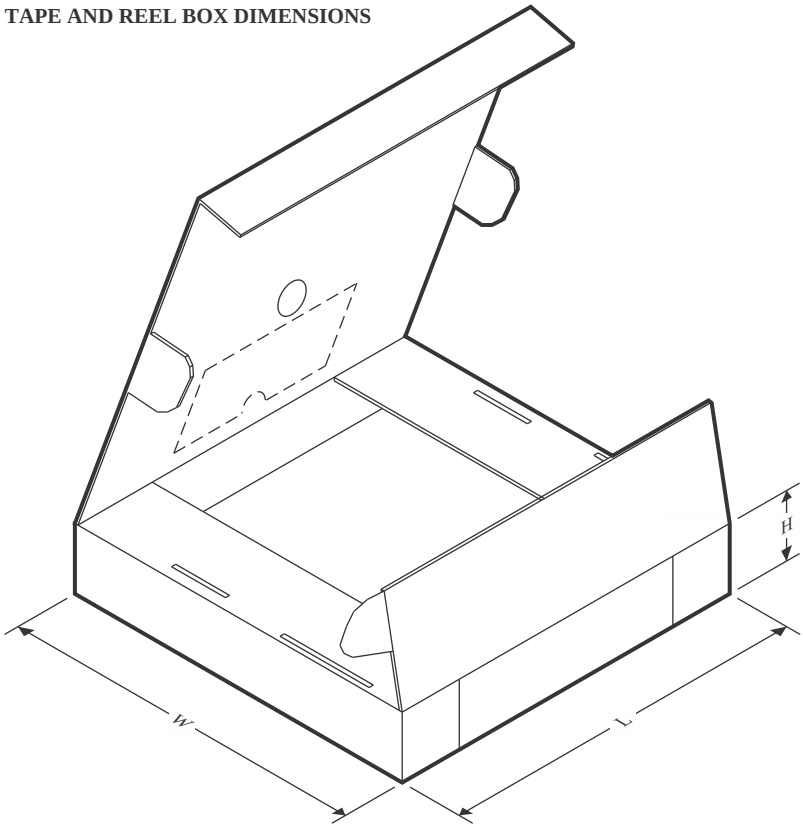
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74HC377DWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.3	2.7	12.0	24.0	Q1
SN74HC377DWR	SOIC	DW	20	2000	330.0	24.4	10.9	13.3	2.7	12.0	24.0	Q1
SN74HC377NSR	SO	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1
SN74HC377NSR	SO	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1

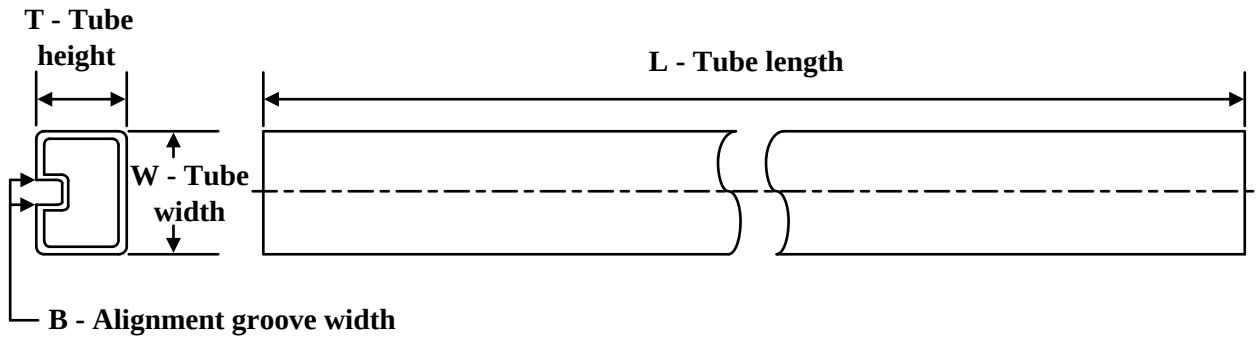
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74HC377DWR	SOIC	DW	20	2000	367.0	367.0	45.0
SN74HC377DWR	SOIC	DW	20	2000	367.0	367.0	45.0
SN74HC377NSR	SO	NS	20	2000	367.0	367.0	45.0
SN74HC377NSR	SO	NS	20	2000	367.0	367.0	45.0

TUBE

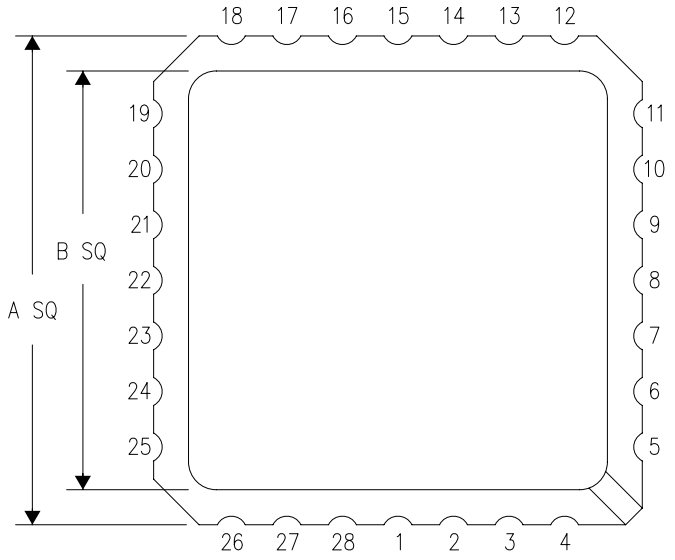


*All dimensions are nominal

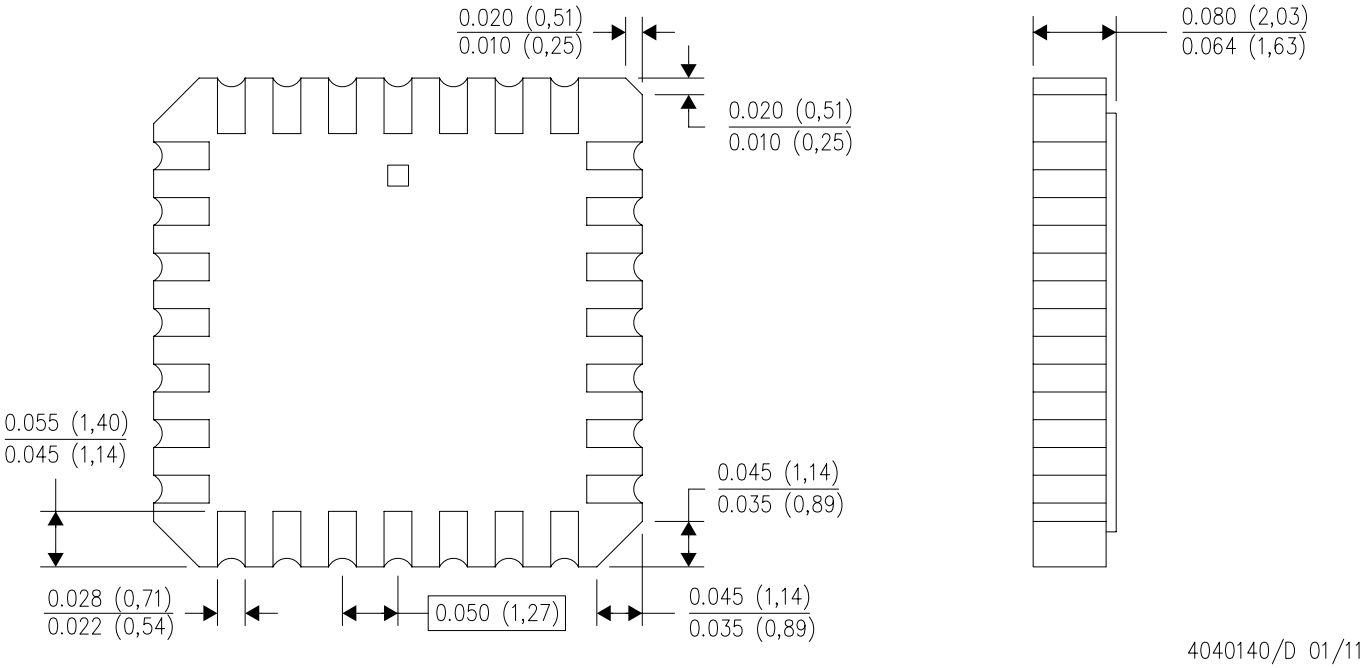
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
5962-87807012A	FK	LCCC	20	1	506.98	12.06	2030	NA
SN74HC377DW	DW	SOIC	20	25	507	12.83	5080	6.6
SN74HC377N	N	PDIP	20	20	506	13.97	11230	4.32
SN74HC377NE4	N	PDIP	20	20	506	13.97	11230	4.32
SNJ54HC377FK	FK	LCCC	20	1	506.98	12.06	2030	NA

FK (S–CQCC–N**) LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



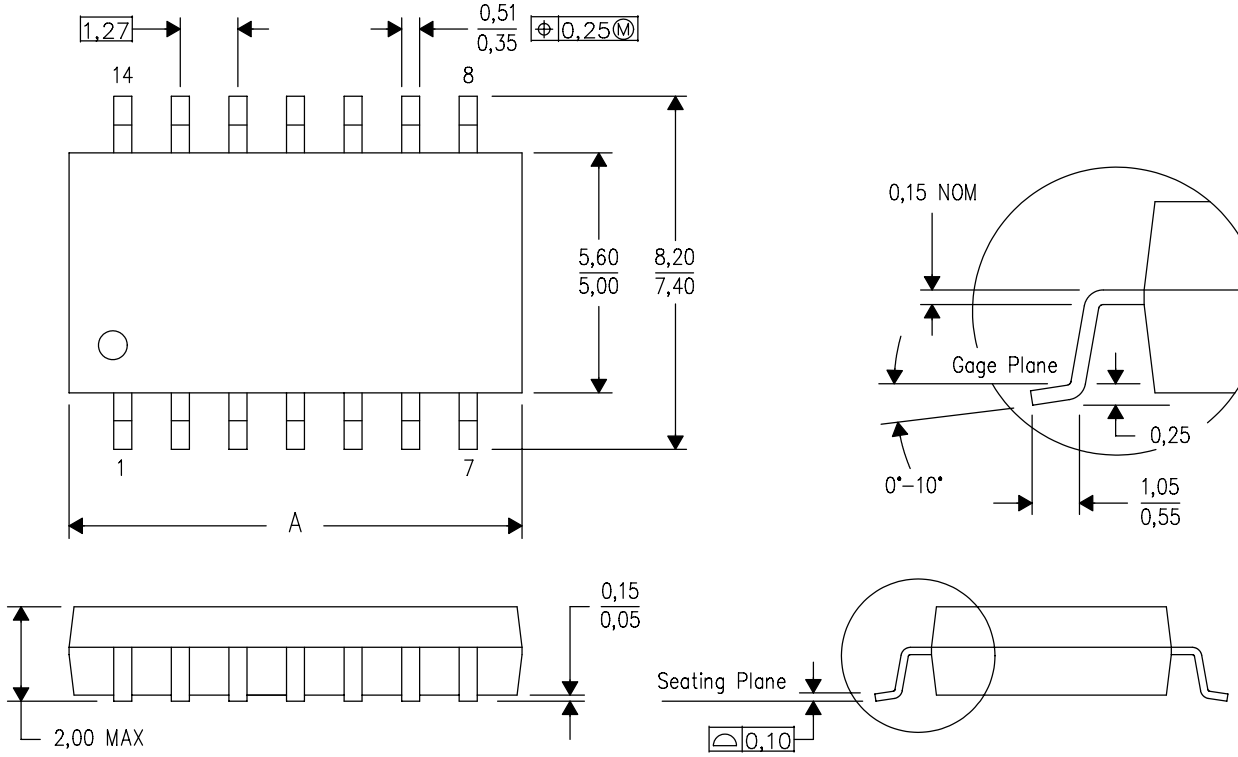
4040140/D 01/11

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. Falls within JEDEC MS–004

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

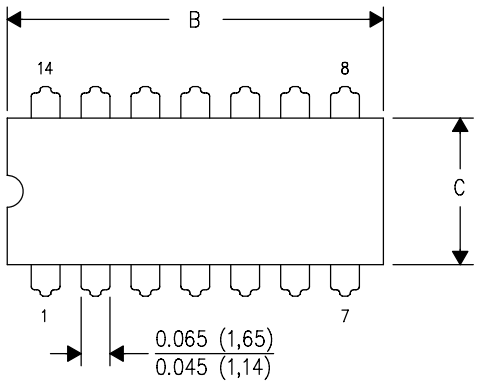
4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

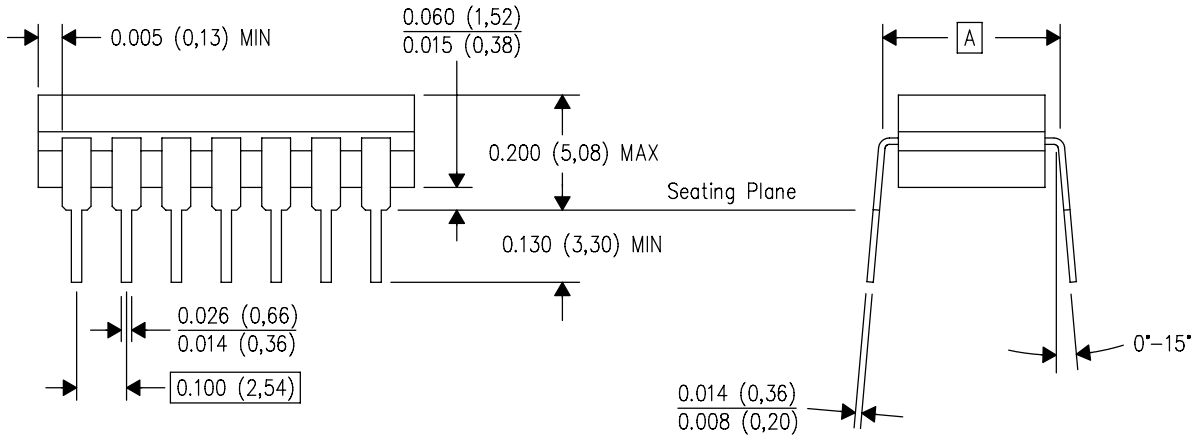
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



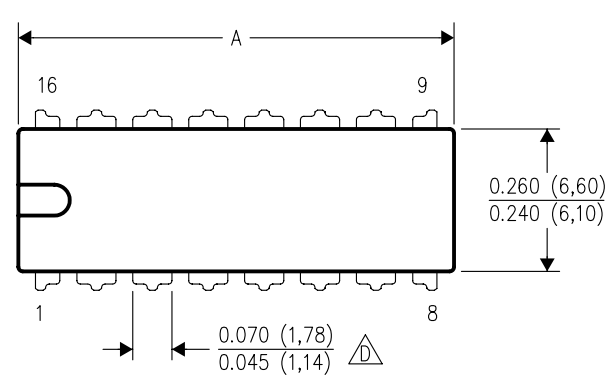
4040083/F 03/03

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

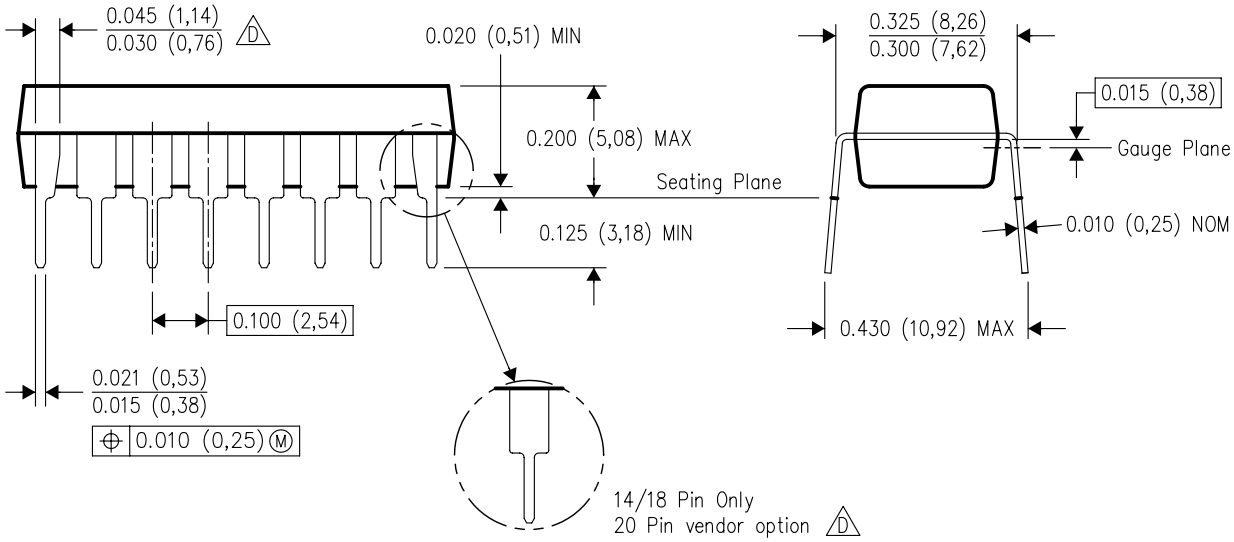
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN

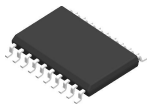


DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

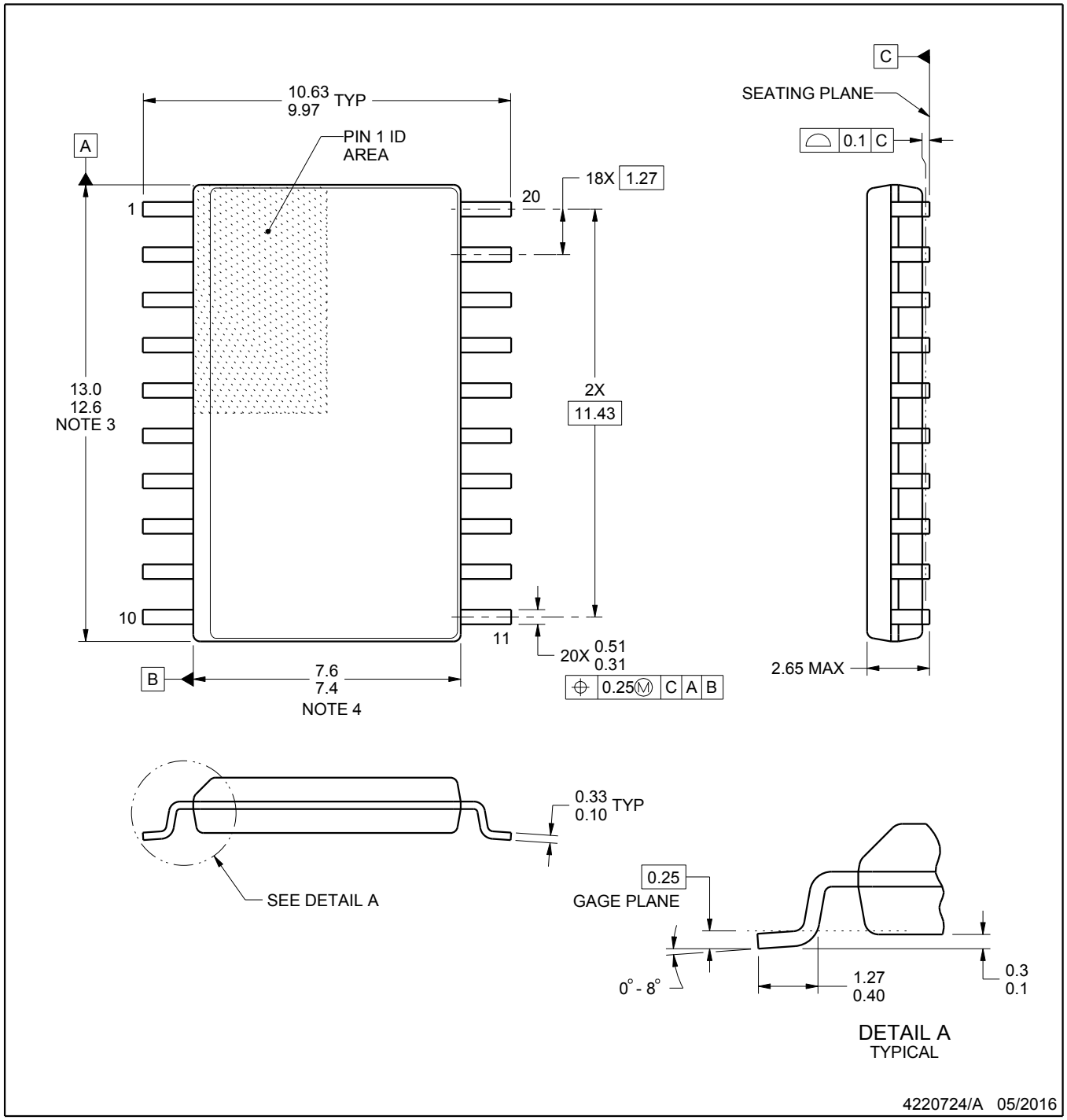


PACKAGE OUTLINE

DW0020A

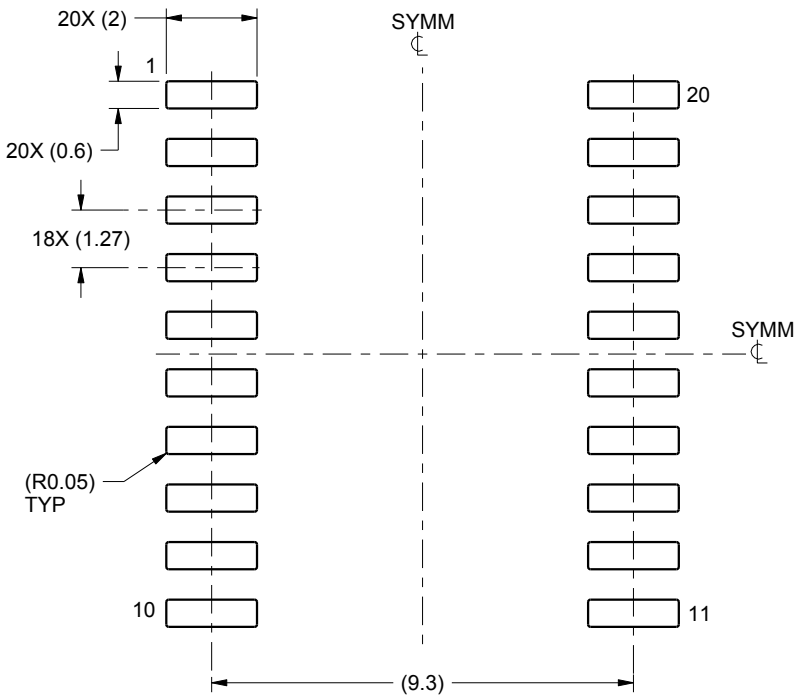
SOIC - 2.65 mm max height

SOIC

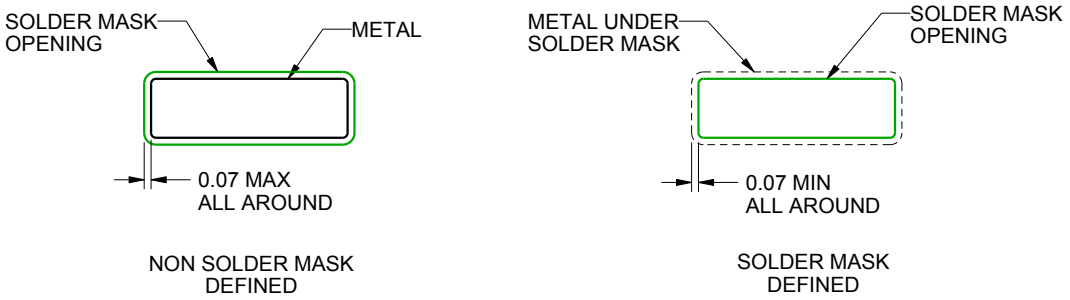


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.



LAND PATTERN EXAMPLE
SCALE:6X

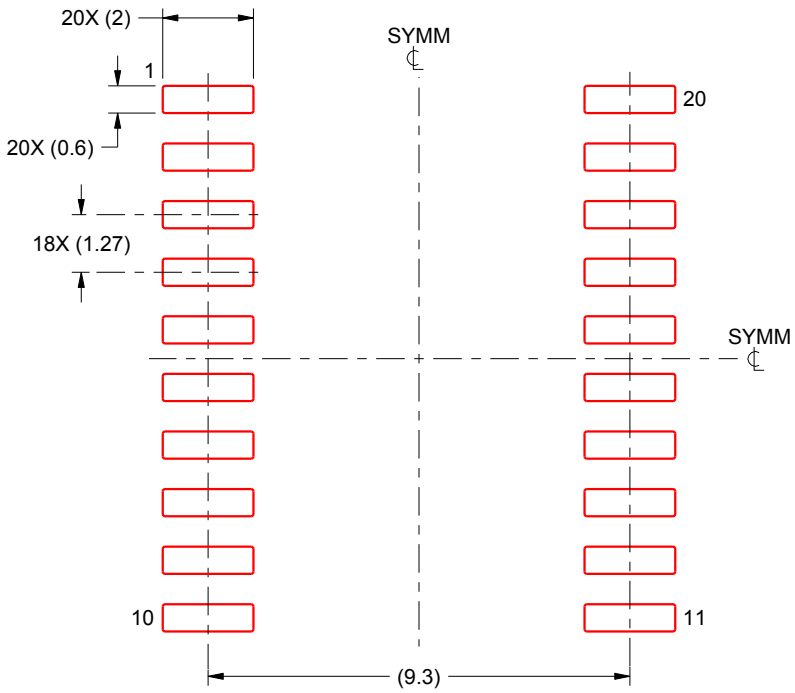


SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4220724/A 05/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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