

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- μ A max I_{CC}
- Typical $t_{pd} = 12$ ns
- ± 4 -mA output drive at 5 V
- Low input current of 1 μ A max
- Eight flip-flops with single-rail outputs
- Clock enable latched to avoid false clocking

2 Applications

- Buffer/storage registers
- Shift registers
- Pattern generators

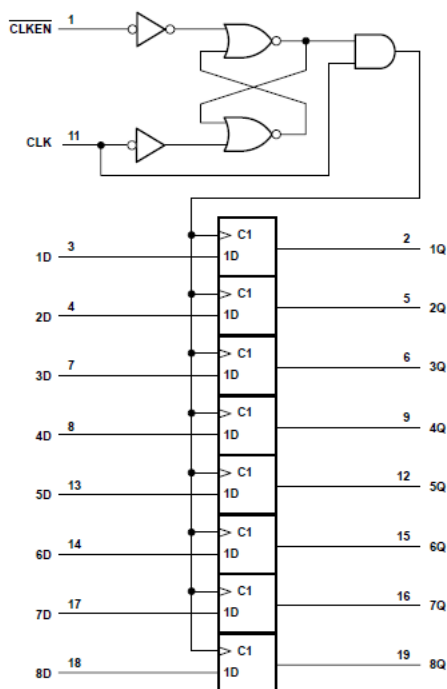
3 Description

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{CLKEN}) input instead of a common clear.

Device Information

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

1 Features	1	8.1 Overview.....	8
2 Applications	1	8.2 Functional Block Diagram.....	8
3 Description	1	8.3 Device Functional Modes.....	9
4 Revision History	2	9 Power Supply Recommendations	10
5 Pin Configuration and Functions	3	10 Layout	10
6 Specifications	4	10.1 Layout Guidelines.....	10
6.1 Absolute Maximum Ratings.....	4	11 Device and Documentation Support	11
6.2 Recommended Operating Conditions ⁽¹⁾	4	11.1 Documentation Support.....	11
6.3 Thermal Information.....	4	11.2 Receiving Notification of Documentation Updates..	11
6.4 Electrical Characteristics.....	5	11.3 Support Resources.....	11
6.5 Timing Requirements.....	5	11.4 Trademarks.....	11
6.6 Switching Characteristics.....	6	11.5 Electrostatic Discharge Caution.....	11
6.7 Operating Characteristics.....	6	11.6 Glossary.....	11
7 Parameter Measurement Information	7	12 Mechanical, Packaging, and Orderable Information	11
8 Detailed Description	8		

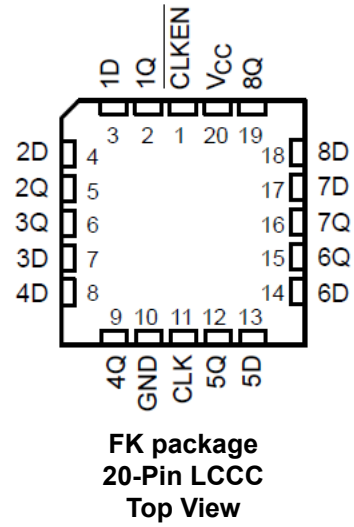
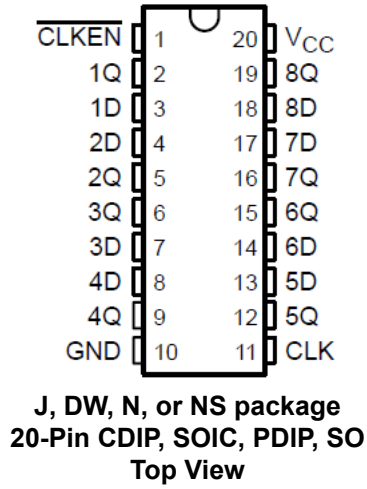
4 Revision History

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



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		V
		V _{CC} = 4.5 V				1.35		
		V _{CC} = 6 V				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)	N (PDIP)	NS (SO)	UNIT
		20 PINS	20 PINS	20 PINS	
R _{θJA}	Junction-to-ambient thermal resistance ⁽¹⁾	109.1	84.6	113.4	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	76	72.5	78.6	°C/W
R _{θJB}	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)	N (PDIP)	NS (SO)	UNIT
		20 PINS	20 PINS	20 PINS	
$R_{\theta JC(bot)}$	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)	$T_A = 25^\circ\text{C}$			SN74HC377		SN74HC377		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	$I_{OH} = -20 \mu\text{A}$	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		
	$I_{OH} = -4 \text{ mA}$	4.5	3.98	4.3		3.7		3.84		
	$I_{OH} = -5.2 \text{ mA}$	6	5.48	5.8		5.2		5.34		
V_{OL}	$I_{OL} = 20 \mu\text{A}$	2		0.002	0.1		0.1		0.1	
		4.5		0.001	0.1		0.1		0.1	
		6		0.001	0.1		0.1		0.1	
	$I_{OL} = 4 \text{ mA}$	4.5		0.17	0.26		0.4		0.33	
	$I_{OL} = 5.2 \text{ mA}$	6		0.15	0.26		0.4		0.33	
I_I	$V_I = V_{CC}$ or 0	6		± 0.1	± 100		± 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}	$T_A = 25^\circ\text{C}$		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 \uparrow	D	2	100		150		125	ns
			4.5	20		30		25	
			6	17		25		21	
	CLKEN high or low	2	100		150		125		
		4.5	20		30		25		
		6	17		25		21		
t_h	Hold time, data after LE \uparrow	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)	$T_A = 25^\circ\text{C}$			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}	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

$T_A = 25^\circ\text{C}$

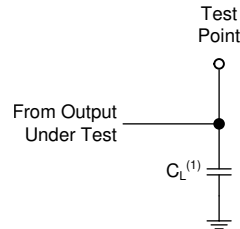
		Test Conditions	TYP	UNIT
C_{pd}	Power dissipation capacitance per flip-flop	No load	30	pF

7 Parameter Measurement Information

Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1 \text{ MHz}$, $Z_O = 50 \Omega$, $t_t < 2.5 \text{ ns}$.

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

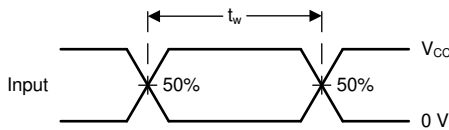


Figure 7-2. Voltage Waveforms, Standard CMOS Inputs Pulse Duration

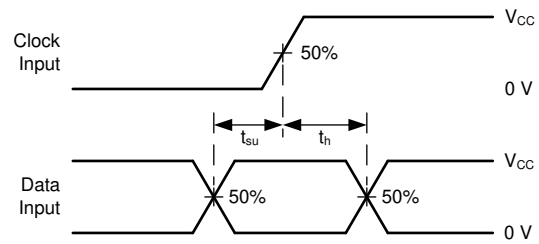
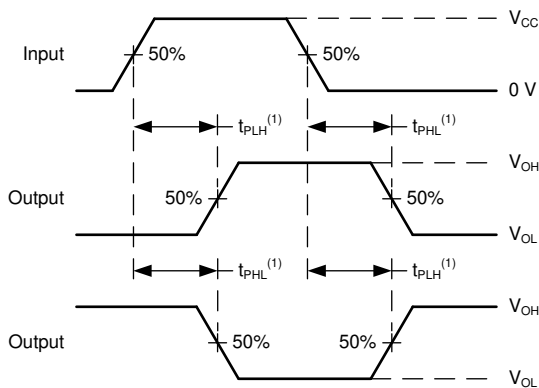
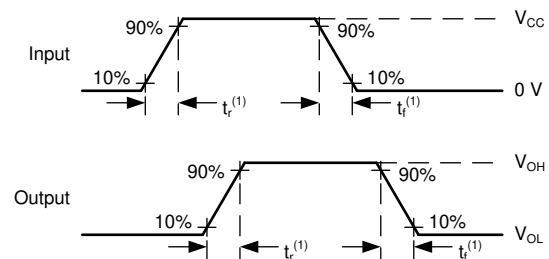


Figure 7-3. Voltage Waveforms, Standard CMOS Inputs Setup and Hold Times



(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

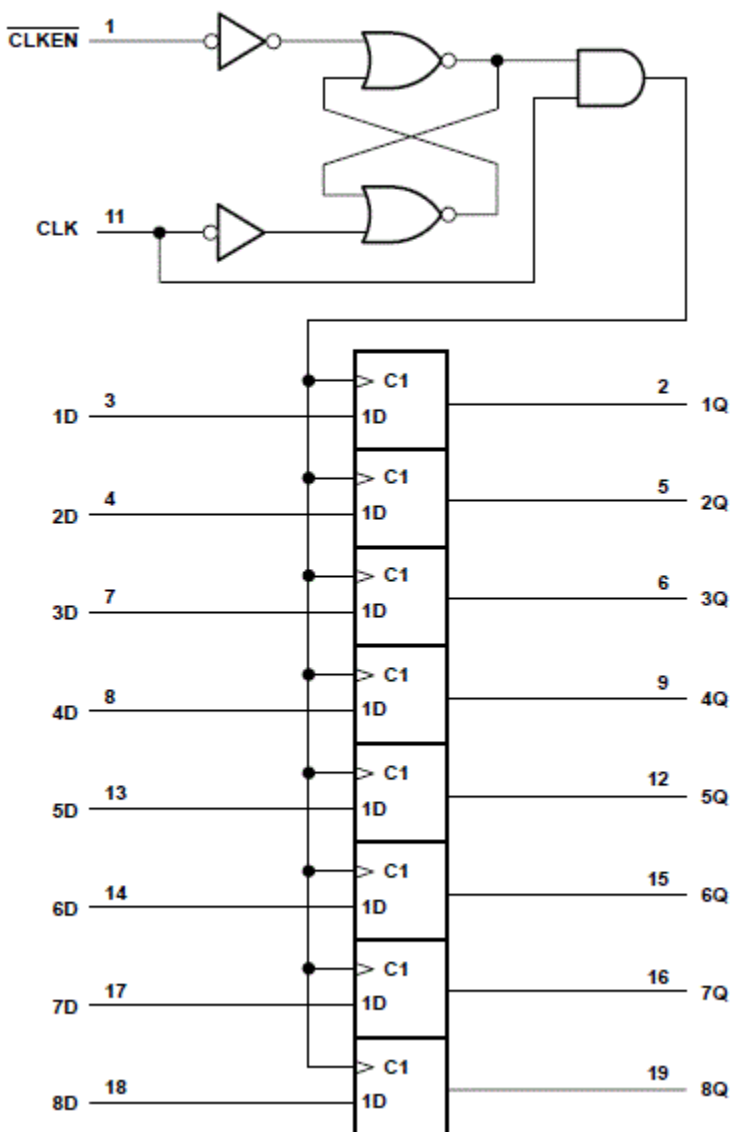
8 Detailed Description

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
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	55	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 87807012A SNJ54HC 377FK	Samples
5962-8780701RA	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-8780701RA SNJ54HC377J	Samples
SN54HC377J	ACTIVE	CDIP	J	20	20	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	SN54HC377J	Samples
SN74HC377DW	OBSOLETE	SOIC	DW	20		TBD	Call TI	Call TI	-40 to 85	HC377	
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	SOP	NS	20	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	HC377	Samples
SNJ54HC377FK	ACTIVE	LCCC	FK	20	55	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 87807012A SNJ54HC 377FK	Samples
SNJ54HC377J	ACTIVE	CDIP	J	20	20	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.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

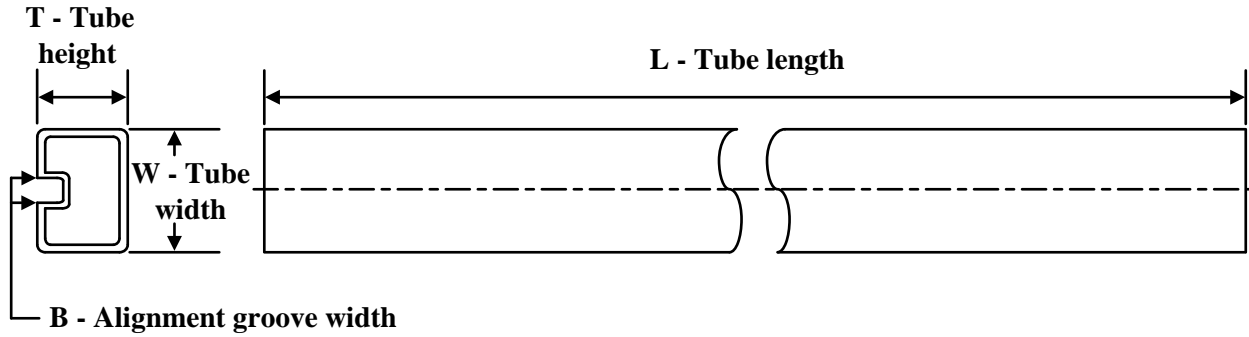

*All dimensions are nominal

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	SOP	NS	20	2000	330.0	24.4	8.4	13.0	2.5	12.0	24.0	Q1
SN74HC377NSR	SOP	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	SOP	NS	20	2000	367.0	367.0	45.0
SN74HC377NSR	SOP	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	55	506.98	12.06	2030	NA
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	55	506.98	12.06	2030	NA

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN

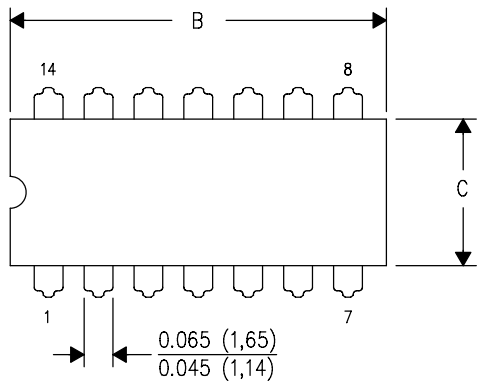


- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

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

GENERIC PACKAGE VIEW

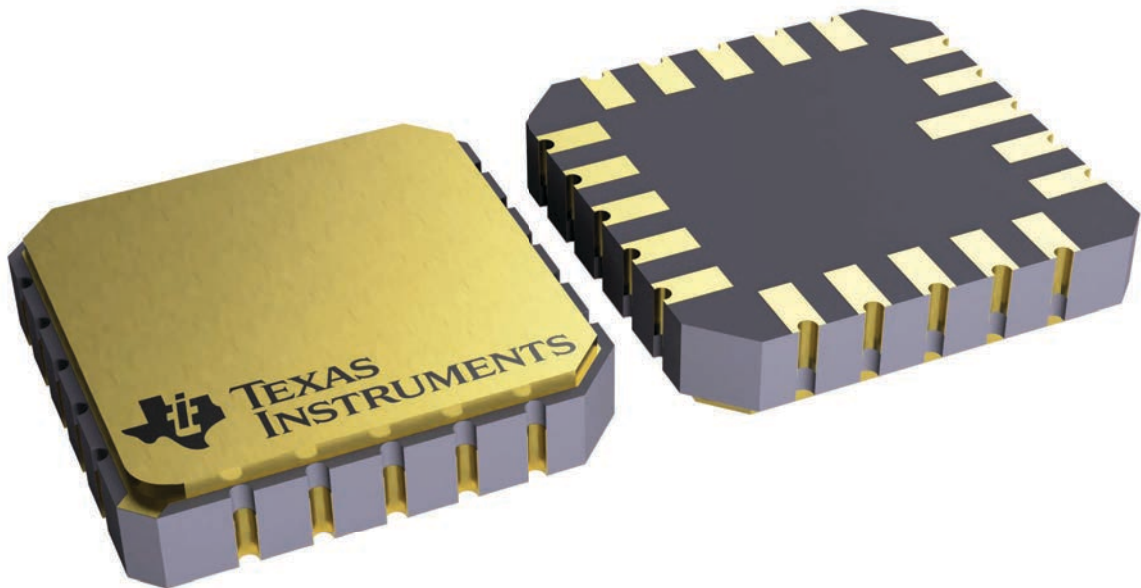
FK 20

LCCC - 2.03 mm max height

8.89 x 8.89, 1.27 mm pitch

LEADLESS CERAMIC CHIP CARRIER

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4229370VA\

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



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

EXAMPLE BOARD LAYOUT

DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

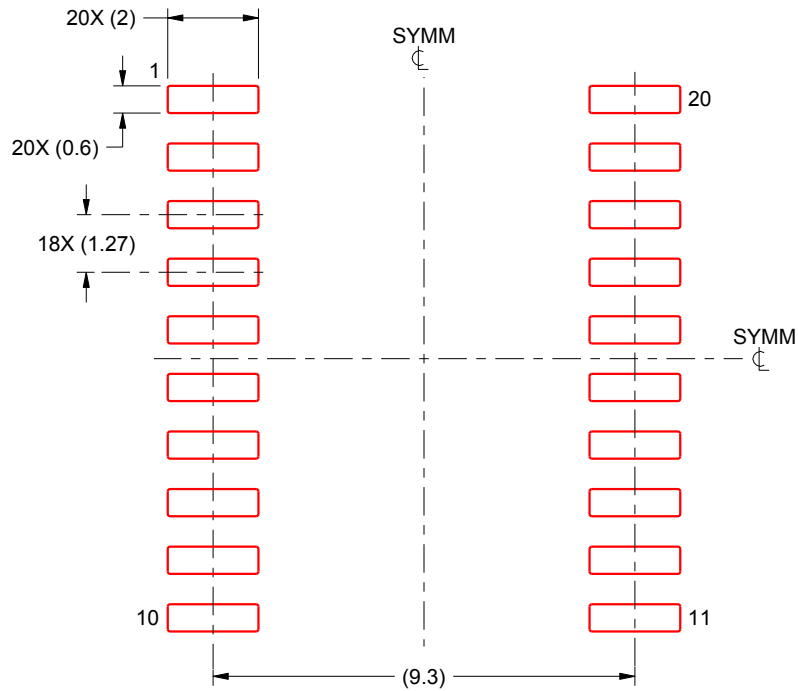
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



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.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), 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 AND 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 skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated