DM54161,DM74161,DM74163

DM54161 DM74161 DM74163 Synchronous 4-Bit Counters

Literature Number: SNOS240A

National Semiconductor

October 1992

DM54161/DM74161/DM74163 Synchronous 4-Bit Counters

General Description

These synchronous, presettable counters feature an internal carry look-ahead for application in high-speed counting designs. The 161 and 163 are 4-bit binary counters. The carry output is decoded by means of a NOR gate, thus preventing spikes during the normal counting mode of operation. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse, regardless of the levels of the enable input. The clear function for the 161 is asynchronous; and a low level at the clear input sets all four of the flip-flop outputs low, regardless of the levels of clock, load, or enable inputs. The clear function for the 163 is synchronous; and a low level at the clear input sets all four of the flip-flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily, as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to synchronously clear the counter to all low outputs. Low-to-high transitions at the clear input of the 163 are also permissible, regardless of the logic levels on the clock, enable, or load inputs.

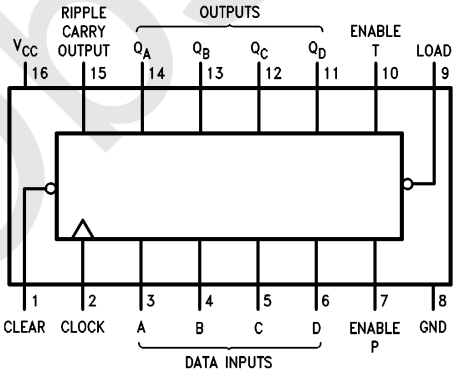
The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. High-to-low-level transitions at the enable P or T inputs of the 161 through 163 may occur, regardless of the logic level on the clock.

Features

- Synchronously programmable
- Internal look-ahead for fast counting
- Carry output for n-bit cascading
- Synchronous counting
- Load control line
- Diode-clamped inputs

Connection Diagram

Dual-In-Line Package



TL/F/6551–1

Order Number DM54161J, DM54161W, DM74161N or DM74163N
See NS Package Number J16A, N16E or W16A

Obsolete

©1995 National Semiconductor Corporation TL/F/6551

RRD-B30M105/Printed in U. S. A.

Absolute Maximum Ratings (Note)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	
DM54	−55°C to +125°C
DM74	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note: *The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.*

Recommended Operating Conditions

Symbol	Parameter		DM54161			DM74161 and 163			Units
			Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage		4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage		2			2			V
V_{IL}	Low Level Input Voltage				0.8			0.8	V
I_{OH}	High Level Output Current				−0.8			−0.8	mA
I_{OL}	Low Level Output Current				16			16	mA
f_{CLK}	Clock Frequency (Note 6)		0		25	0		25	MHz
t_W	Pulse Width (Note 6)	Clock	25			25			ns
		Clear	20			20			
t_{SU}	Setup Time (Note 6)	Data	20			20			ns
		Enable P	34			34			
		Load	25			25			
		Clear (Note 5)	20			20			
t_H	Hold Time (Note 6)		0			0			ns
T_A	Free Air Operating Temperature		−55		125	0		70	°C

Electrical Characteristics

Over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ (Note 1)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −12 mA				−1.5	V
V_{OH}	High Level Output Voltage	V_{CC} = Min, I_{OH} = Max V_{IL} = Max, V_{IH} = Min		2.4	3.4		V
V_{OL}	Low Level Output Voltage	V_{CC} = Min, I_{OL} = Max V_{IH} = Min, V_{IL} = Max			0.2	0.4	V
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 5.5V				1	mA
I_{IH}	High Level Input Current	V_{CC} = Max V_I = 2.4V	Enable T			80	μA
			Clock			80	
			Others			40	
I_{IL}	Low Level Input Current	V_{CC} = Max V_I = 0.4V	Enable T			−3.2	mA
			Clock			−3.2	
			Others			−1.6	

Obsolete

Electrical Characteristics

Over recommended operating free air temperature range (unless otherwise noted) (Continued)

Symbol	Parameter	Conditions		Min	Typ (Note 1)	Max	Units
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	DM54	−20		−57	mA
			DM74	−20		−57	
I_{CCH}	Supply Current with Outputs High	V_{CC} = Max (Note 3)	DM54			85	mA
			DM74		59	94	
I_{CCL}	Supply Current with Outputs Low	V_{CC} = Max (Note 4)	DM54			91	mA
			DM74		63	101	

Note 1: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 2: Not more than one output should be shorted at a time.

Note 3: I_{CCH} is measured with the LOAD high, then again with the LOAD low, with all inputs high and all outputs open.

Note 4: I_{CCL} is measured with the CLOCK high, then again with the CLOCK input low, with all inputs low and all outputs open.

Note 5: Applies to 163 which has synchronous clear inputs.

Note 6: T_A = 25°C and V_{CC} = 5V.

Switching Characteristics at V_{CC} = 5V and T_A = 25°C (See Section 1 for Test Waveforms and Output Load)

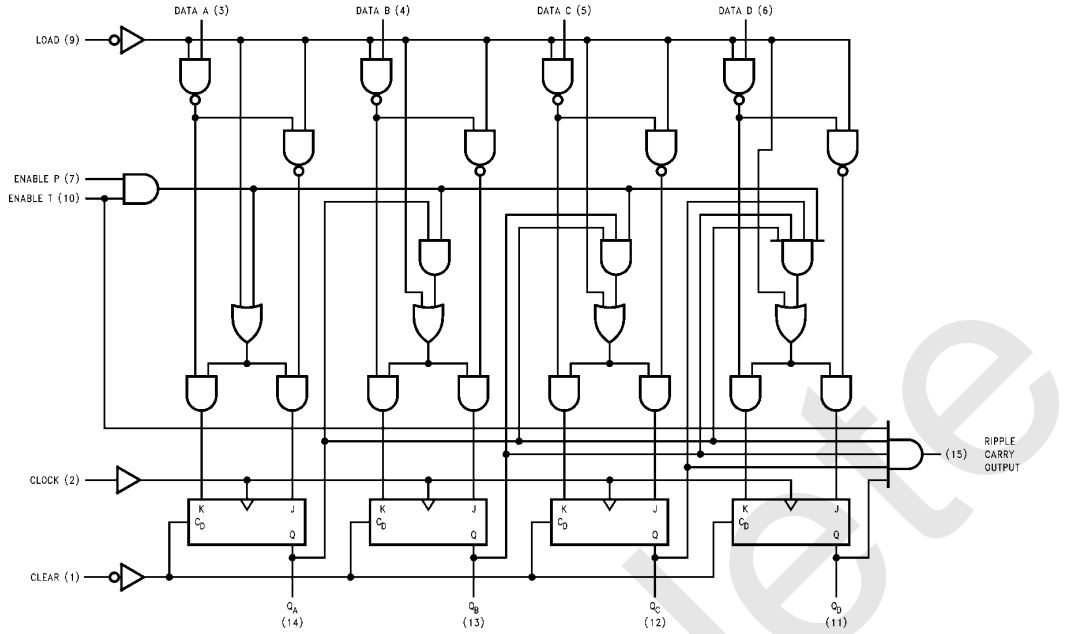
Symbol	Parameter	From (Input) To (Output)	R_L = 400Ω, C_L = 15 pF		Units
			Min	Max	
f_{MAX}	Maximum Clock Frequency		25		MHz
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Ripple Carry		35	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Ripple Carry		35	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock (Load High) to Q		20	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock (Load High) to Q		23	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock (Load Low) to Q		25	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock (Load Low) to Q		29	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Enable T to Ripple Carry		16	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Enable T to Ripple Carry		16	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clear (Note 7) to Q		38	ns

Note 7: Propagation delay for clearing is measured from the clear input for the 161 or from the clock input transition for the 163.

Obsolete

Logic Diagrams

161

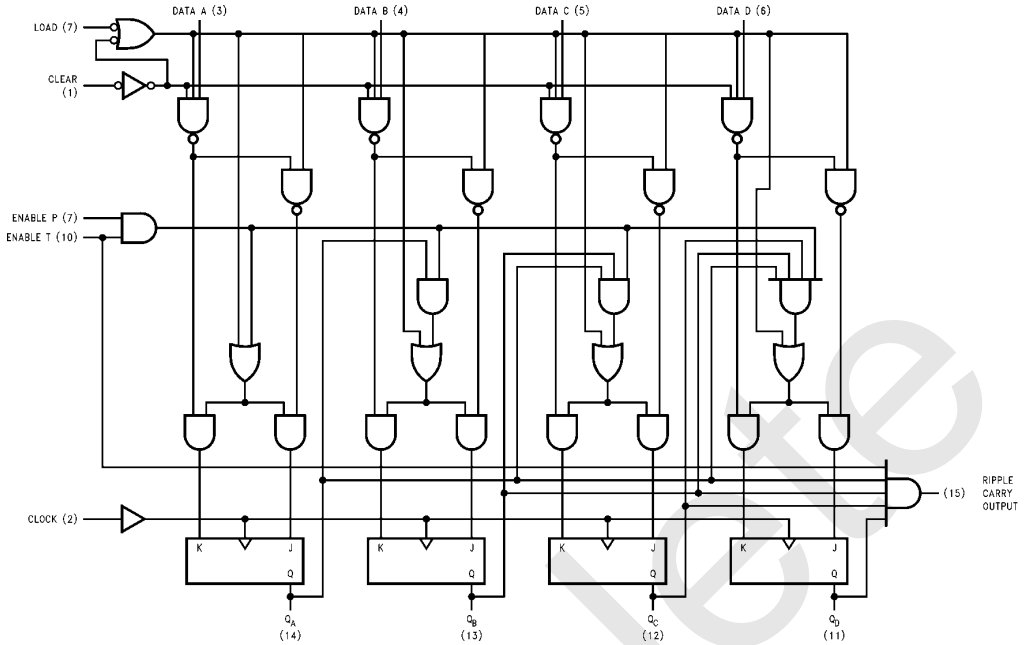


TL/F/6551–3

Obsolete

Logic Diagrams (Continued)

163

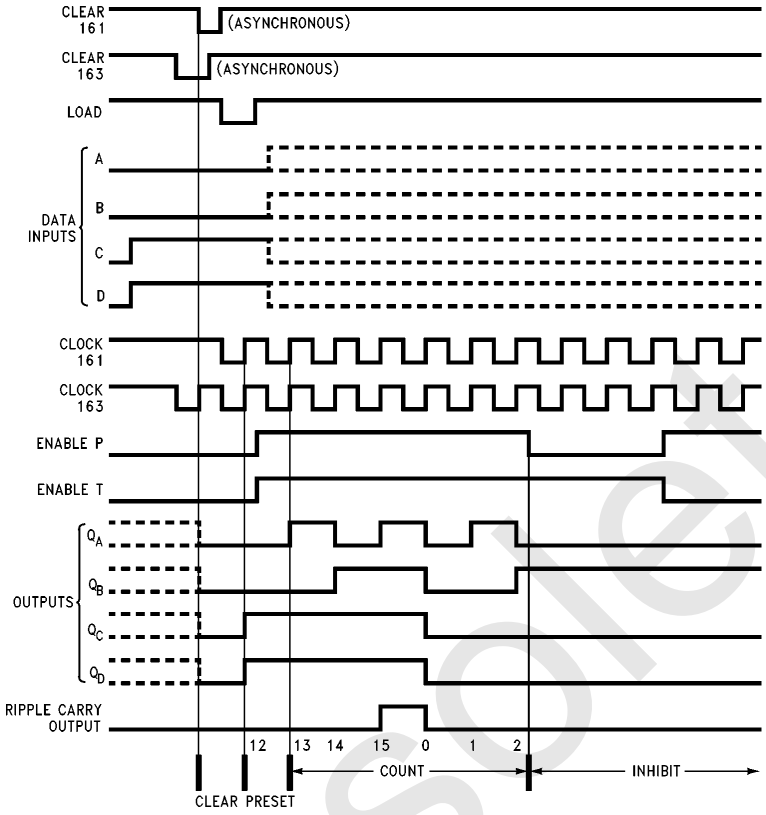


TL/F/6551–8

Obsolete

Logic Diagrams (Continued)

161, 163 Synchronous Binary Counters
Typical Clear, Preset, Count and Inhibit Sequences



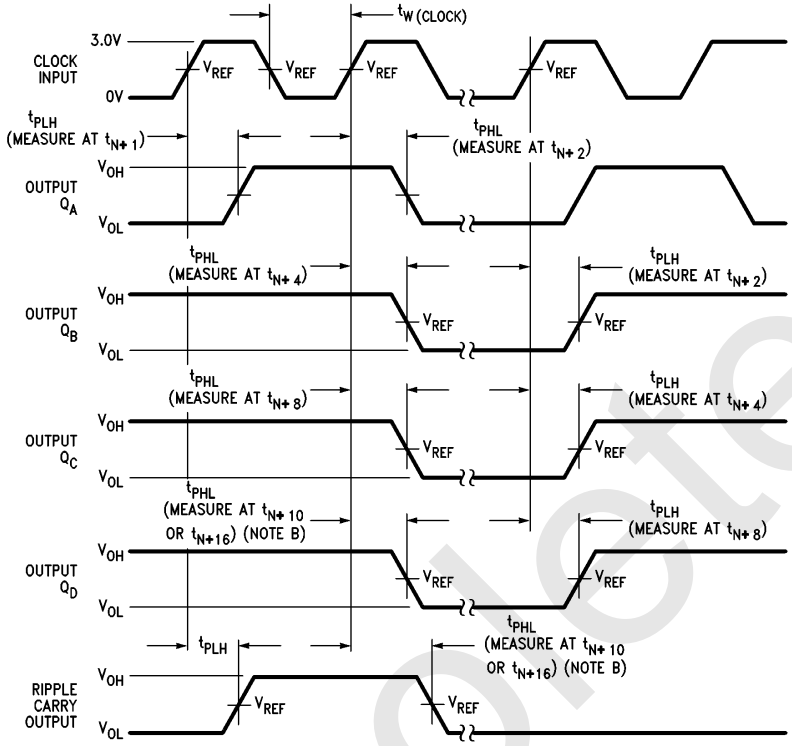
TL/F/6551–5

(1) Clear outputs to zero
(2) Reset to binary twelve
(3) Count to thirteen, fourteen, fifteen, zero, one and two
(4) Inhibit

Obsolete

Parameter Measurement Information

Switching Time Waveforms



TL/F/6551–6

Note A: The input pulses are supplied by generators having the following characteristics: PRR $\leq$ 1 MHz, duty cycle $\leq$ 50%, $Z_{OUT} \approx 50\Omega$. For 161 and 163, $t_r \leq 10$ ns, $t_f \leq 10$ ns. Vary PRR to measure f_{MAX}.

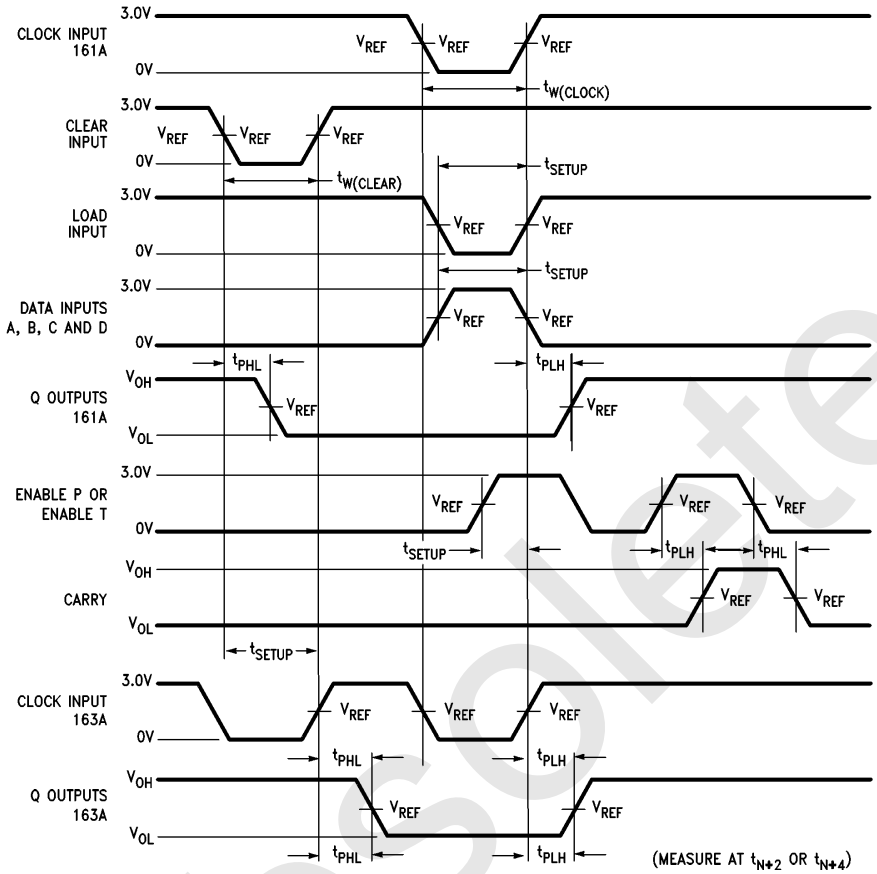
Note B: Outputs Q_D and carry are tested at t_{n+16} for 161, 163 where t_n is the bit time when all outputs are low.

Note C: For 161 and 163, $V_{REF} = 1.5V$.

Obsolete

Parameter Measurement Information (Continued)

Switching Time Waveforms



TL/F/6551–7

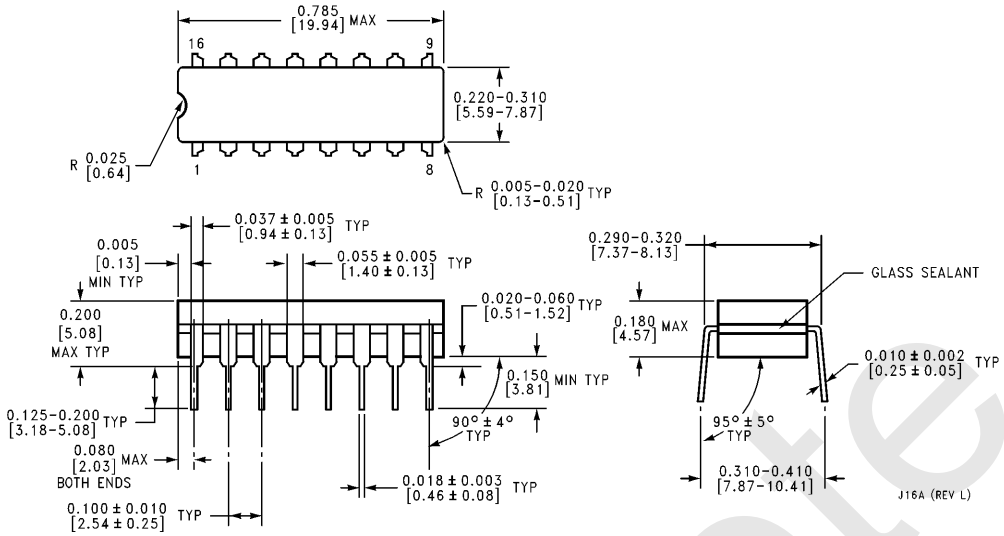
Note A: The input pulses are supplied by generators having the following characteristics: PRR $\leq$ 1 MHz, duty cycle $\leq$ 50%, $Z_{OUT} \approx 50\Omega$. For 161 and 163, $t_r \leq 10$ ns, $t_f \leq 10$ ns. Vary PRR to measure f_{MAX}.

Note B: Enable P and enable T setup times are measured at t_{n+0}.

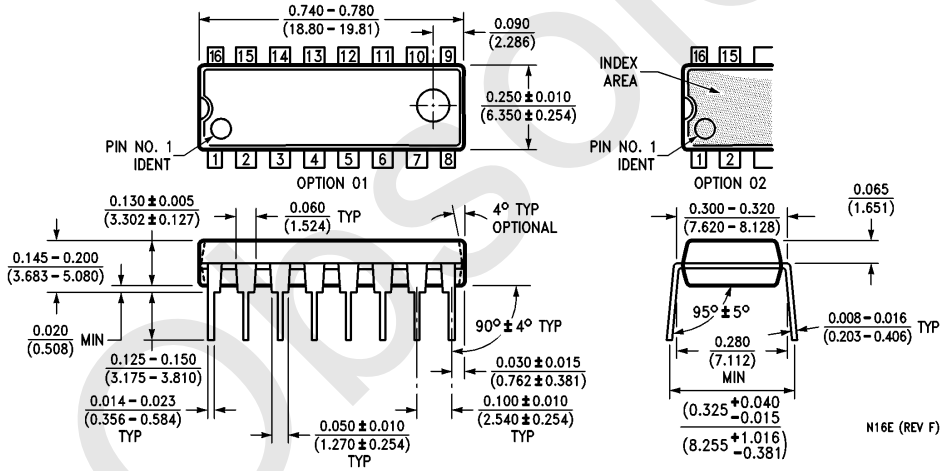
Note C: For 161 and 163, $V_{REF} = 1.5V$.

Obsolete

Physical Dimensions inches (millimeters)



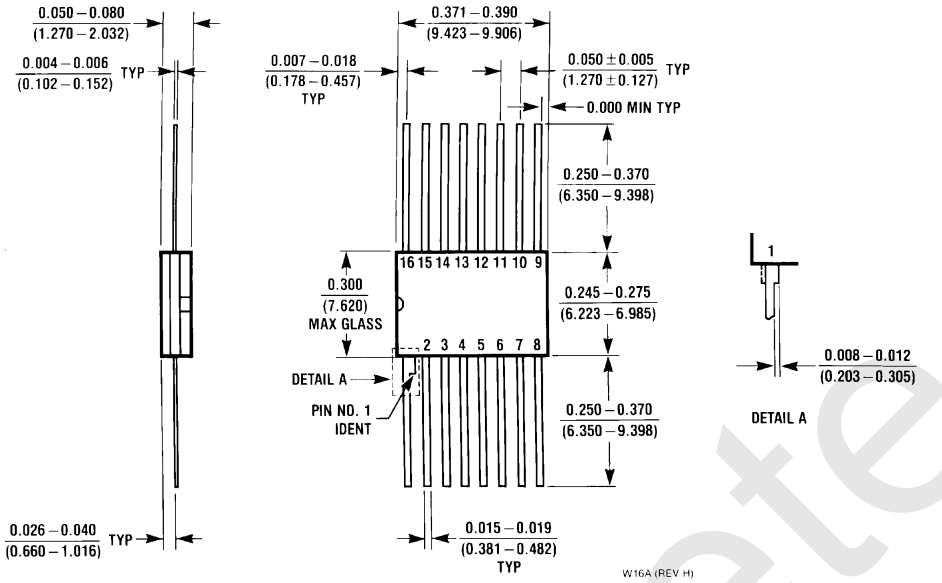
16-Lead Ceramic Dual-In-Line Package (J)
Order Number DM54161J or DM54163AJ
NS Package Number J16A



16-Lead Molded Dual-In-Line Package (N)
Order Number DM74161N or DM74163N
NS Package Number N16E

Obsolete

Physical Dimensions inches (millimeters) (Continued)



16-Lead Ceramic Flat Package (W)
Order Number DM54161W or DM54163AW
NS Package Number W16A

Obsolete

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated