National Semiconductor

June 1989

54191/DM54191/DM74191 Synchronous Up/Down 4-Bit Binary Counter with Mode Control

General Description

This circuit is a synchronous, reversible, up/down counter. The 191 is a 4-bit binary counter. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change simultaneously when so instructed by the steering logic. This mode of operation eliminates the output counting spikes normally associated with asynchronous (ripple clock) counters.

The outputs of the four master-slave flip-flops are triggered on a low-to-high level transition of the clock input, if the enable input is low. A high at the enable input inhibits counting. Level changes at either the enable input or the down/up input should be made only when the clock input is high. The direction of the count is determined by the level of the down/up input. When low, the counter counts up and when high, it counts down.

This counter is fully programmable; that is, the outputs may be preset to either level by placing a low on the load input and entering the desired data at the data inputs. The output will change independent of the level of the clock input. This feature allows the counters to be used as modulo-N dividers by simply modifying the count length with the preset inputs.

The clock, down/up, and load inputs are buffered to lower the drive requirement; which significantly reduces the number of clock drivers, etc., required for long parallel words.

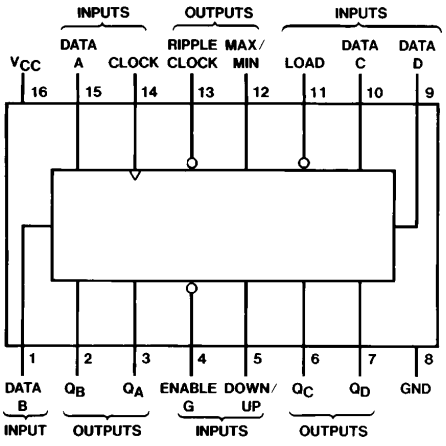
Two outputs have been made available to perform the cascading function: ripple clock and maximum/minimum count. The latter output produces a high-level output pulse with a duration approximately equal to one complete cycle of the clock when the counter overflows or underflows. The ripple clock output produces a low-level output pulse equal in width to the low-level portion of the clock input when an overflow or underflow condition exists. The counters can be easily cascaded by feeding the ripple clock output to the enable input of the succeeding counter if parallel clocking is used, or to the clock input if parallel enabling is used. The maximum/minimum count output can be used to accomplish look-ahead for high-speed operation.

Features

- Single down/up count control line
- Count enable control input
- Ripple clock output for cascading
- Asynchronously presettable with load control
- Parallel outputs
- Cascadable for n-bit applications
- Alternate Military/Aerospace device (54191) is available. Contact a National Semiconductor Sales Office/ Distributor for specifications.

Connection Diagram

Dual-In-Line Package



TL/F/6562–1

Order Number 54191DMQB, 54191FMQB, DM54191J, DM54191W or DM74191N
See NS Package Number J16A, N16E or W16A

 TL/F/6562

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

54191/DM54191/DM74191 Synchronous Up/Down 4-Bit Binary Counter with Mode Control

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 and 54	−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		DM54191			DM74191			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 4)		0		20	0		20	MHz
t_W	Pulse Width (Note 4)	Clock	25			25			ns
		Load	35			35			
t_{SU}	Data Setup Time (Note 4)		28			28			ns
t_H	Hold Time (Note 4)		0			0			ns
t_{REL}	Load Release Time (Note 4)		30			30			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			120	μA
			Others			40	
I_{IL}	Low Level Input Current	V_{CC} = Max V_I = 0.4V	Enable			−4.8	mA
			Others			−1.6	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	DM54	−20		−65	mA
			DM74	−18		−65	
I_{CC}	Supply Current	V_{CC} = Max (Note 3)	DM54		65	99	mA
			DM74		65	105	

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_{CC} is measured with all inputs grounded and all outputs open.

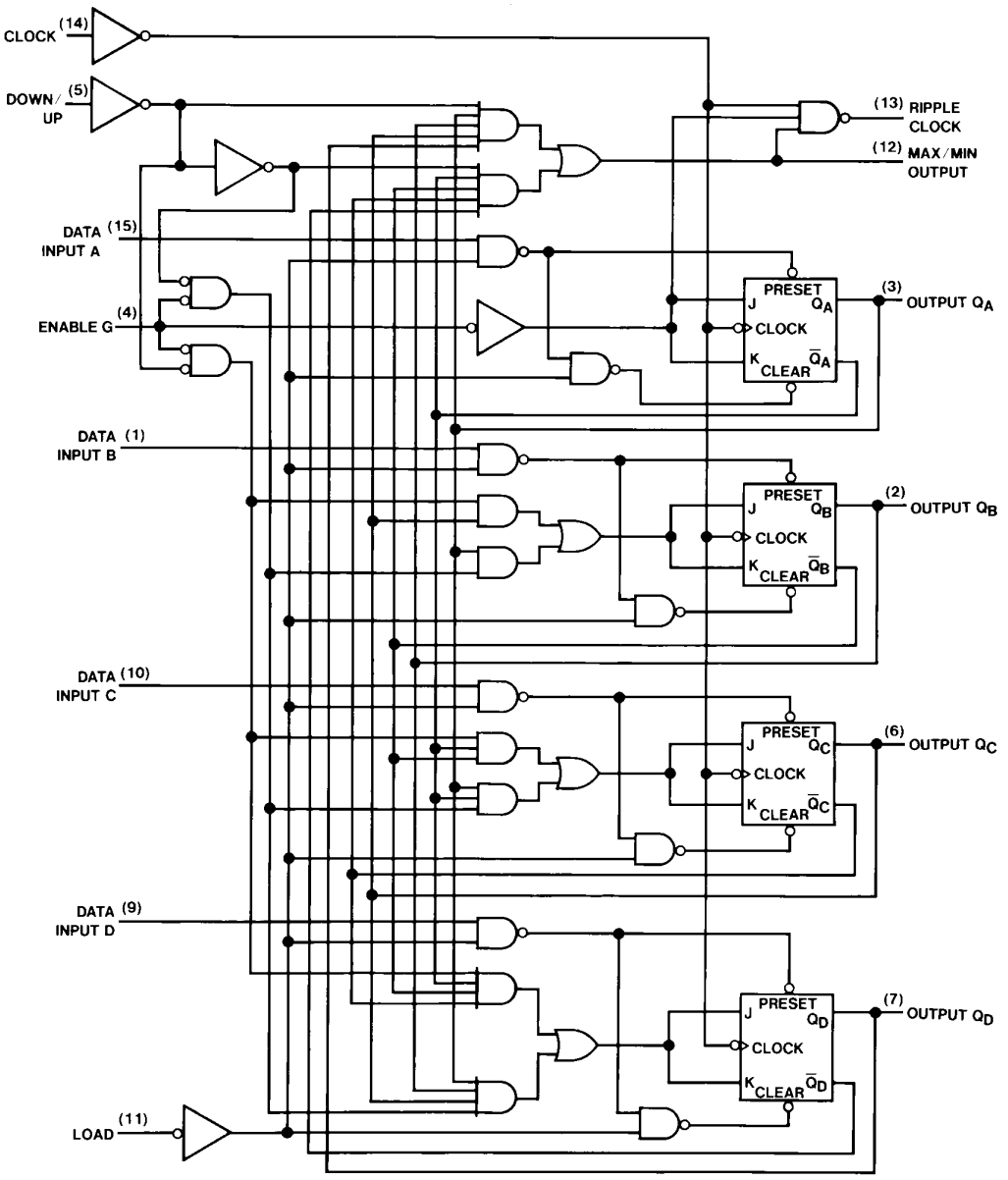
Note 4: T_A = 25°C and V_{CC} = 5V.

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)	$R_L = 400\Omega$, $C_L = 15$ pF		Units
			Min	Max	
f_{MAX}	Maximum Clock Frequency		20		MHz
t_{PLH}	Propagation Delay Time Low to High Level Output	Load to Any Q		33	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Load to Any Q		70	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Data to Any Q		22	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Data to Any Q		70	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Ripple Carry		20	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Ripple Carry		24	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Any Q		24	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Any Q		36	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Max/Min		42	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Max/Min		52	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Down/Up to Ripple Carry		45	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Down/Up to Ripple Carry		45	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Down/Up to Max/Min		33	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Down/Up to Max/Min		33	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Enable G to Ripple Carry		24	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Enable G to Ripple Carry		24	ns

Logic Diagram

191 Binary Counter

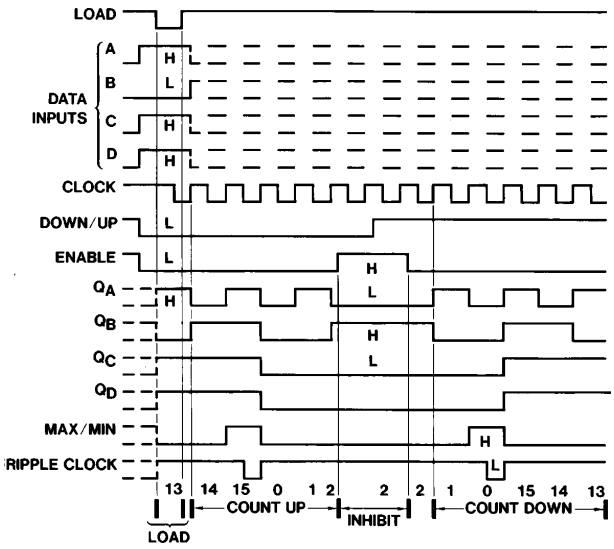


TL/F/6562–2

Pin (16) = V_{CC}, Pin (8) = GND

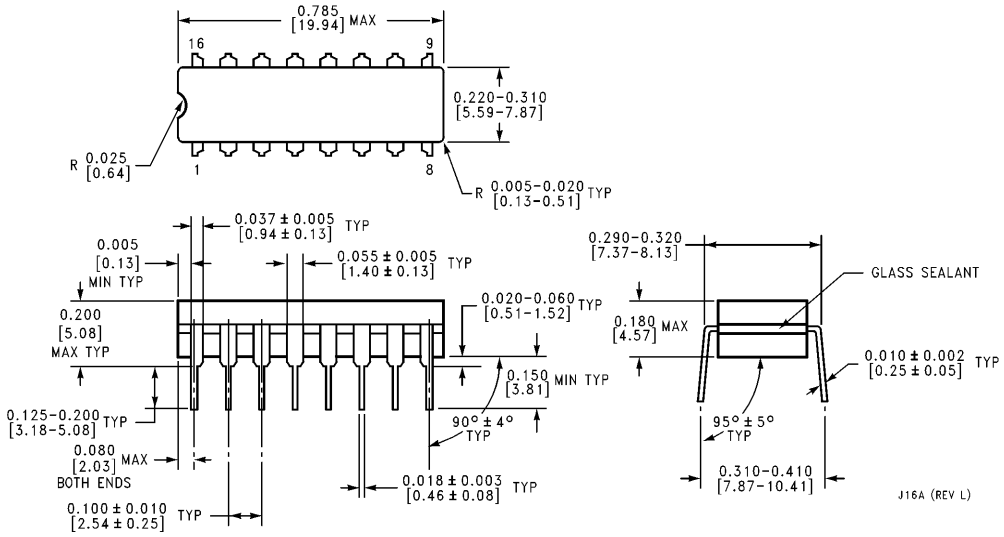
Timing Diagrams

191 Decade Counter
Typical Load, Count, and Inhibit Sequences



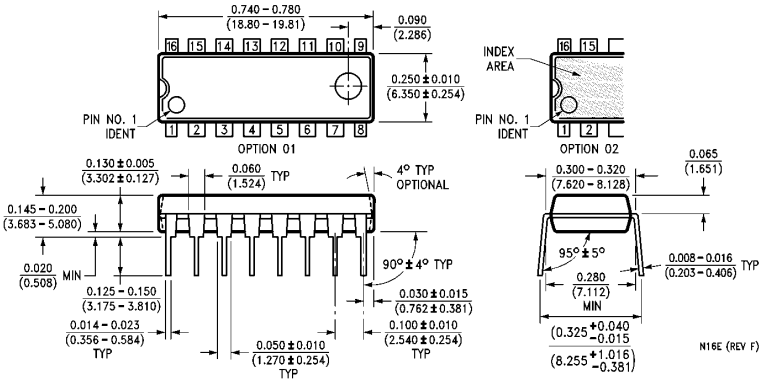
TL/F/6562–3

Physical Dimensions inches (millimeters)

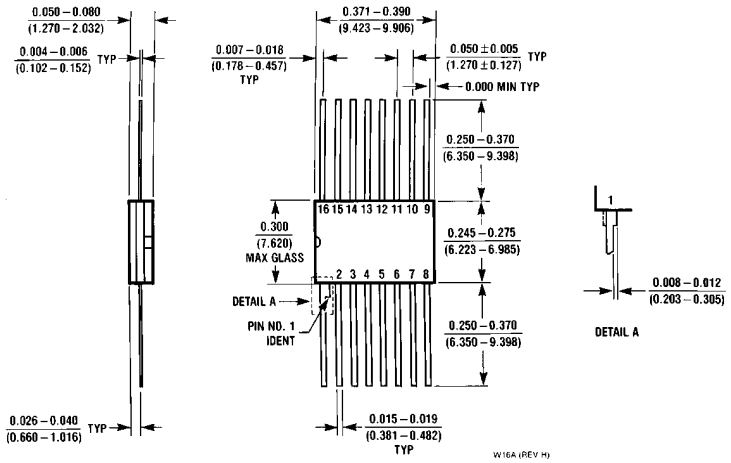


16-Lead Ceramic Dual-In-Line Package (J)
Order Number 54191DMQB or DM54191J
NS Package Number J16A

Physical Dimensions inches (millimeters) (Continued)



16-Lead Molded Dual-In-Line Package (N)
Order Number DM74191N
NS Package Number N16E



16-Lead Ceramic Flat Package (W)
Order Number 54191FMQB or DM54191W
NS Package Number W16A

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