National Semiconductor

February 1988

CD4511BM/CD4511BC BCD-to-7 Segment Latch/Decoder/Driver

General Description

The CD4511BM/CD4511BC BCD-to-seven segment latch/decoder/driver is constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and an output drive capability. Lamp test (LT), blanking (BI), and latch enable (LE) inputs are used to test the display, to turn-off or pulse modulate the brightness of the display, and to store a BCD code, respectively. It can be used with seven-segment light emitting diodes (LED), incandescent, fluorescent, gas discharge, or liquid crystal readouts either directly or indirectly.

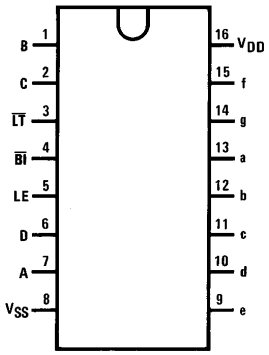
Applications include instrument (e.g., counter, DVM, etc.) display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

Features

- Low logic circuit power dissipation
- High current sourcing outputs (up to 25 mA)
- Latch storage of code
- Blanking input
- Lamp test provision
- Readout blanking on all illegal input combinations
- Lamp intensity modulation capability
- Time share (multiplexing) facility
- Equivalent to Motorola MC14511

Connection Diagram

Dual-In-Line Package

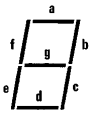


TL/F/5991–1

Top View

Order Number CD4511B

Segment Identification



TL/F/5991–3

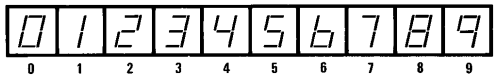
Truth Table

Inputs							Outputs							
LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	B
X	0	1	X	X	X	X	0	0	0	0	0	0	0	
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	
0	1	1	1	0	1	1	0	0	0	0	0	0	0	
0	1	1	1	1	0	0	0	0	0	0	0	0	0	
0	1	1	1	1	0	1	0	0	0	0	0	0	0	
0	1	1	1	1	1	0	0	0	0	0	0	0	0	
0	1	1	1	1	1	1	0	0	0	0	0	0	0	
1	1	1	X	X	X	X				*				*

X = Don't Care

*Depends upon the BCD code applied during the 0 to 1 transition of LE.

Display



TL/F/5991–2

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

Absolute Maximum Ratings (Notes 1 & 2)

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

DC Supply Voltage (V_{DD})	−0.5V to +18V
Input Voltage (V_{IN})	−0.5V to V_{DD} +0.5V
Storage Temperature Range (T_S)	−65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T_L)	
(Soldering, 10 seconds)	260°C

Recommended Operating Conditions (Note 2)

DC Supply Voltage (V_{DD})	3V to 15V
Input Voltage (V_{IN})	0V to V_{DD}
Operating Temperature Range (T_A)	
CD4510BM, CD4516BM	−55°C to +125°C
CD4510BC, CD4516BC	−40°C to +85°C

DC Electrical Characteristics CD4511BM

Symbol	Parameter	Conditions	−55°C		+25°C			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Supply Current	V_{DD} = 5V, V_{IN} = V_{DD} or V_{SS}		5			5		150	μA
		V_{DD} = 10V, V_{IN} = V_{DD} or V_{SS}		10			10		300	μA
		V_{DD} = 15V, V_{IN} = V_{DD} or V_{SS}		20			20		600	μA
V_{OL}	Output Voltage Logical "0" Level	V_{DD} = 5V		0.01		0	0.01		0.05	V
		V_{DD} = 10V		0.01		0	0.01		0.05	V
		V_{DD} = 15V		0.01		0	0.01		0.05	V
V_{OH}	Output Voltage Logical "1" Level	V_{DD} = 5V	4.1		4.1	4.57		4.1		V
		V_{DD} = 10V	9.1		9.1	9.58		9.1		V
		V_{DD} = 15V	14.1		14.1	14.59		14.1		V
V_{IL}	Low Level Input Voltage	V_{DD} = 5V, V_{OUT} = 3.8V or 0.5V		1.5		2	1.5		1.5	V
		V_{DD} = 10V, V_{OUT} = 8.8V or 1.0V		3.0		4	3.0		3.0	V
		V_{DD} = 15V, V_{OUT} = 13.8V or 1.5V		4.0		6	4.0		4.0	V
V_{IH}	High Level Input Voltage	V_{DD} = 5V, V_{OUT} = 0.5V or 3.8V	3.5		3.5	3		3.5		V
		V_{DD} = 10V, V_{OUT} = 1.0V or 8.8V	7.0		7.0	6		7.0		V
		V_{DD} = 15V, V_{OUT} = 1.5V or 13.8V	11.0		11.0	9		11.0		V
V_{OH}	Output (Source) Drive Voltage	V_{DD} = 5V, I_{OH} = 0 mA	4.1		4.1	4.57		4.1		V
		V_{DD} = 5V, I_{OH} = 5 mA				4.24				V
		V_{DD} = 5V, I_{OH} = 10 mA	3.9		3.9	4.12		3.5		V
		V_{DD} = 5V, I_{OH} = 15 mA				3.94				V
		V_{DD} = 5V, I_{OH} = 20 mA	3.4		3.4	3.75		3.0		V
		V_{DD} = 5V, I_{OH} = 25 mA				3.54				V
		V_{DD} = 10V, I_{OH} = 0 mA	9.1		9.1	9.58		9.1		V
		V_{DD} = 10V, I_{OH} = 5 mA				9.26				V
		V_{DD} = 10V, I_{OH} = 10 mA	9.0		9.0	9.17		8.6		V
		V_{DD} = 10V, I_{OH} = 15 mA				9.04				V
		V_{DD} = 10V, I_{OH} = 20 mA	8.6		8.6	8.9		8.2		V
		V_{DD} = 10V, I_{OH} = 25 mA				8.75				V
		V_{DD} = 15V, I_{OH} = 0 mA	14.1		14.1	9.58		14.1		V
		V_{DD} = 15V, I_{OH} = 5 mA				14.27				V
		V_{DD} = 15V, I_{OH} = 10 mA	14.0		14.0	14.17		13.6		V
		V_{DD} = 15V, I_{OH} = 15 mA				14.07				V
		V_{DD} = 15V, I_{OH} = 20 mA	13.6		13.6	13.95		13.2		V
		V_{DD} = 15V, I_{OH} = 25 mA				13.8				V
I_{OL}	Low Level Output Current	V_{DD} = 5V, V_{OL} = 0.4V	0.64		0.51	0.88		0.36		mA
		V_{DD} = 10V, V_{OL} = 0.5V	1.6		1.3	2.25		0.9		mA
		V_{DD} = 15V, V_{OL} = 1.5V	4.2		3.4	8.8		2.4		mA
I_{IN}	Input Current	V_{DD} = 15V, V_{IN} = 0V		−0.10		-10^{-5}	−0.10		−1.0	μA
		V_{DD} = 15V, V_{IN} = 15V		0.10		10^{-5}	0.10		1.0	μA

Note 1: Devices should not be connected with power on.

DC Electrical Characteristics CD4511BC

Symbol	Parameter	Conditions	−55°C		+25°C			+85°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Supply Current	V_{DD} = 5V		20			20		150	μA
		V_{DD} = 10V		40			40		300	μA
		V_{DD} = 15V		80			80		600	μA
V_{OL}	Output Voltage Logical "0" Level	V_{DD} = 5V		0.01		0	0.01		0.05	V
		V_{DD} = 10V		0.01		0	0.01		0.05	V
		V_{DD} = 15V		0.01		0	0.01		0.05	V
V_{OH}	Output Voltage Logical "1" Level	V_{DD} = 5V	4.1		4.1	4.57		4.1		V
		V_{DD} = 10V	9.1		9.1	9.58		9.1		V
		V_{DD} = 15V	14.1		14.1	14.59		14.1		V
V_{IL}	Low Level Input Voltage	V_{DD} = 5V, V_{OUT} = 3.8V or 0.5V		1.5		2	1.5		1.5	V
		V_{DD} = 10V, V_{OUT} = 8.8V or 1.0V		3.0		4	3.0		3.0	V
		V_{DD} = 15V, V_{OUT} = 13.8V or 1.5V		4.0		6	4.0		4.0	V
V_{IH}	High Level Input Voltage	V_{DD} = 5V, V_{OUT} = 0.5V or 3.8V	3.5		3.5	3		3.5		V
		V_{DD} = 10V, V_{OUT} = 1.0V or 8.8V	7.0		7.0	6		7.0		V
		V_{DD} = 15V, V_{OUT} = 1.5V or 13.8V	11.0		11.0	9		11.0		V
V_{OH}	Output (Source) Drive Voltage	V_{DD} = 5V, I_{OH} = 0 mA	4.1		4.1	4.57		4.1		V
		V_{DD} = 5V, I_{OH} = 5 mA				4.24				V
		V_{DD} = 5V, I_{OH} = 10 mA	3.6		3.6	4.12		3.3		V
		V_{DD} = 5V, I_{OH} = 15 mA				3.94				V
		V_{DD} = 5V, I_{OH} = 20 mA	2.8		2.8	3.75		2.5		V
		V_{DD} = 5V, I_{OH} = 25 mA				3.54				V
		V_{DD} = 10V, I_{OH} = 0 mA	9.1		9.1	9.58		9.1		V
		V_{DD} = 10V, I_{OH} = 5 mA				9.26				V
		V_{DD} = 10V, I_{OH} = 10 mA	8.75		8.75	9.17		8.45		V
		V_{DD} = 10V, I_{OH} = 15 mA				9.04				V
		V_{DD} = 10V, I_{OH} = 20 mA	8.1		8.1	8.9		7.8		V
		V_{DD} = 10V, I_{OH} = 25 mA				8.75				V
		V_{DD} = 15V, I_{OH} = 0 mA	14.1		14.1	14.59		14.1		V
		V_{DD} = 15V, I_{OH} = 5 mA				14.27				V
		V_{DD} = 15V, I_{OH} = 10 mA	13.75		13.75	14.18		13.45		V
		V_{DD} = 15V, I_{OH} = 15 mA				14.07				V
		V_{DD} = 15V, I_{OH} = 20 mA	13.1		13.1	13.95		12.8		V
		V_{DD} = 15V, I_{OH} = 25 mA				13.8				V
I_{OL}	Low Level Output Current	V_{DD} = 5V, V_{OL} = 0.4V	0.52		0.44	0.88		0.36		mA
		V_{DD} = 10V, V_{OL} = 0.5V	1.3		1.1	2.25		0.9		mA
		V_{DD} = 15V, V_{OL} = 1.5V	3.6		3.0	8.8		2.4		mA
I_{IN}	Input Current	V_{DD} = 15V, V_{IN} = 0V		−0.30		-10^{-5}	−0.30		−1.0	μA
		V_{DD} = 15V, V_{IN} = 15V		0.30		10^{-5}	0.30		1.0	μA

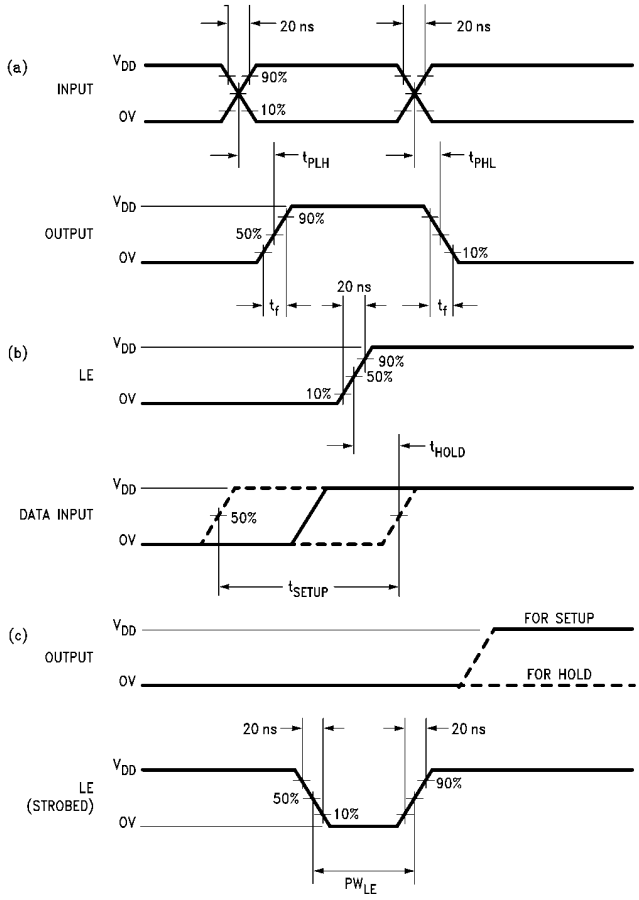
AC Electrical Characteristics*

$T_A = 25°C$ and $C_L = 50$ pF, typical temperature coefficient for all values of $V_{DD} = 0.3\%/°C$

Symbol	Parameter	Conditions	CD4511BX			Units
			Min	Typ	Max	
C_{IN}	Input Capacitance	$V_{IN} = 0$		5.0	7.5	pF
t_r	Output Rise Time	$V_{DD} = 5V$		40	80	ns
	(Figure 1a)	$V_{DD} = 10V$		30	60	ns
		$V_{DD} = 15V$		25	50	ns
t_f	Output Fall Time	$V_{DD} = 5V$		125	250	ns
	(Figure 1a)	$V_{DD} = 10V$		75	150	ns
		$V_{DD} = 15V$		65	130	ns
t_{PLH}	Turn-Off Delay Time	$V_{DD} = 5V$		640	1280	ns
	(Data) *(Figure 1a)*	$V_{DD} = 10V$		250	500	ns
		$V_{DD} = 15V$		175	350	ns
t_{PHL}	Turn-On Delay Time	$V_{DD} = 5V$		720	1440	ns
	(Data) *(Figure 1a)*	$V_{DD} = 10V$		290	580	ns
		$V_{DD} = 15V$		195	400	ns
t_{PLH}	Turn-Off Delay Time	$V_{DD} = 5V$		320	640	ns
	(Blank) *(Figure 1a)*	$V_{DD} = 10V$		130	260	ns
		$V_{DD} = 15V$		100	200	ns
t_{PHL}	Turn-On Delay Time	$V_{DD} = 5V$		485	970	ns
	(Blank) *(Figure 1a)*	$V_{DD} = 10V$		200	400	ns
		$V_{DD} = 15V$		160	320	ns
t_{PLH}	Turn-Off Delay Time	$V_{DD} = 5V$		313	625	ns
	(Lamp Test) *(Figure 1a)*	$V_{DD} = 10V$		125	250	ns
		$V_{DD} = 15V$		90	180	ns
t_{PHL}	Turn-On Delay Time	$V_{DD} = 5V$		313	625	ns
	(Lamp Test) *(Figure 1a)*	$V_{DD} = 10V$		125	250	ns
		$V_{DD} = 15V$		90	180	ns
t_{SETUP}	Setup Time	$V_{DD} = 5V$	180	90		ns
	(Figure 1b)	$V_{DD} = 10V$	76	38		ns
		$V_{DD} = 15V$	40	20		ns
t_{HOLD}	Hold Time	$V_{DD} = 5V$	0	−90		ns
	(Figure 1b)	$V_{DD} = 10V$	0	−38		ns
		$V_{DD} = 15V$	0	−20		ns
PW_{LE}	Minimum Latch Enable	$V_{DD} = 5V$	520	260		ns
	Pulse Width *(Figure 1c)*	$V_{DD} = 10V$	220	110		ns
		$V_{DD} = 15V$	130	65		ns

*AC Parameters are guaranteed by DC correlated testing.

Switching Time Waveforms

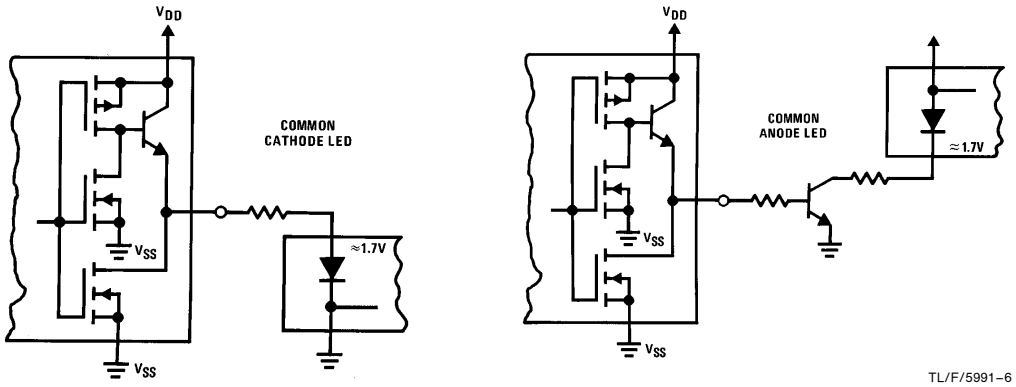


TL/F/5991–4

FIGURE 1

Typical Applications

Light Emitting Diode (LED) Readout

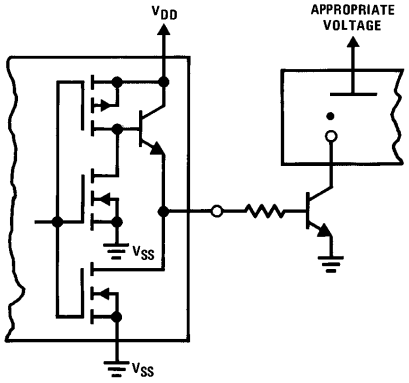


TL/F/5991–5

TL/F/5991–6

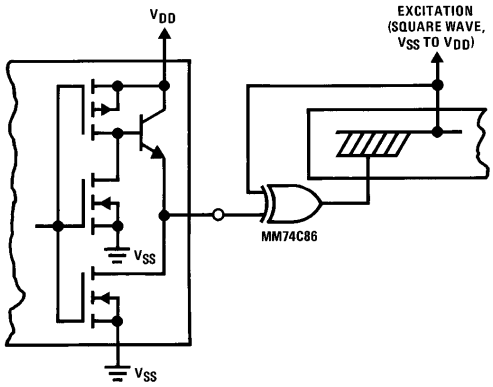
Typical Applications (Continued)

Gas Discharge Readout



TL/F/5991–7

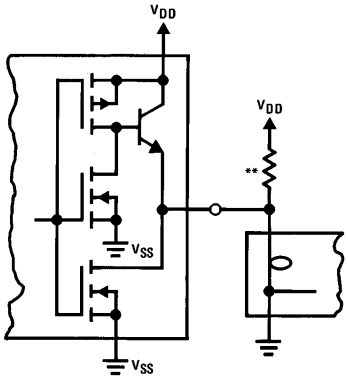
Liquid Crystal (LC) Readout



TL/F/5991–8

Direct DC drive of LC's not recommended for life of LC readouts.

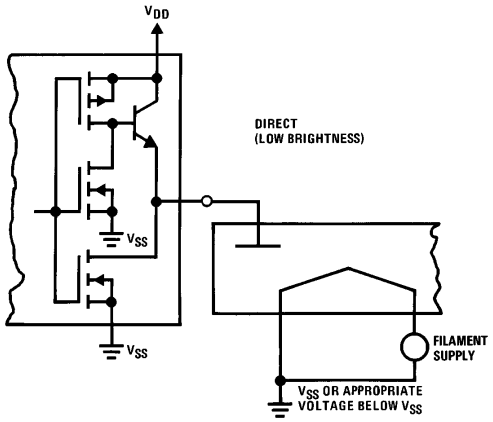
Incandescent Readout



TL/F/5991–9

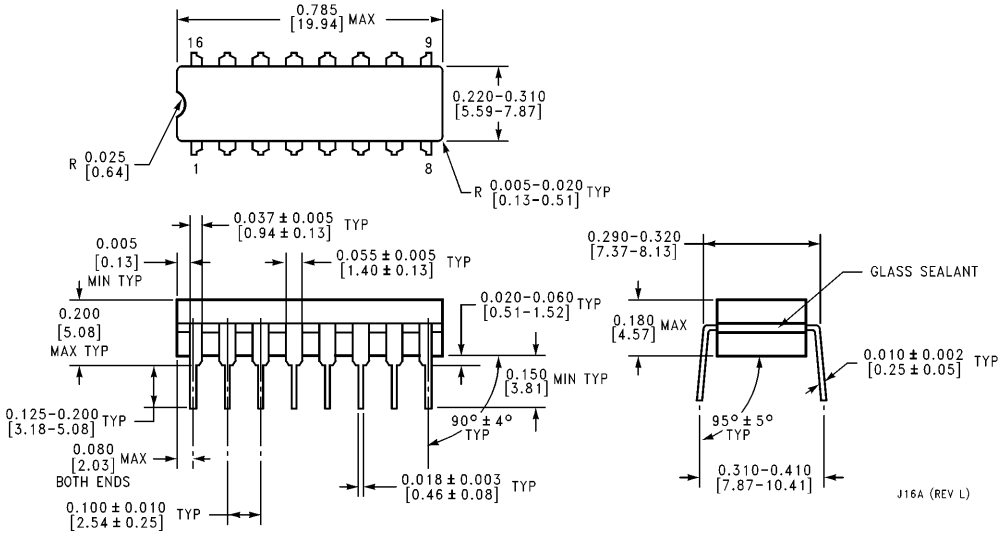
**A filament pre-warm resistor is recommended to reduce filament thermal shock and increase the effective cold resistance of the filament.

Fluorescent Readout



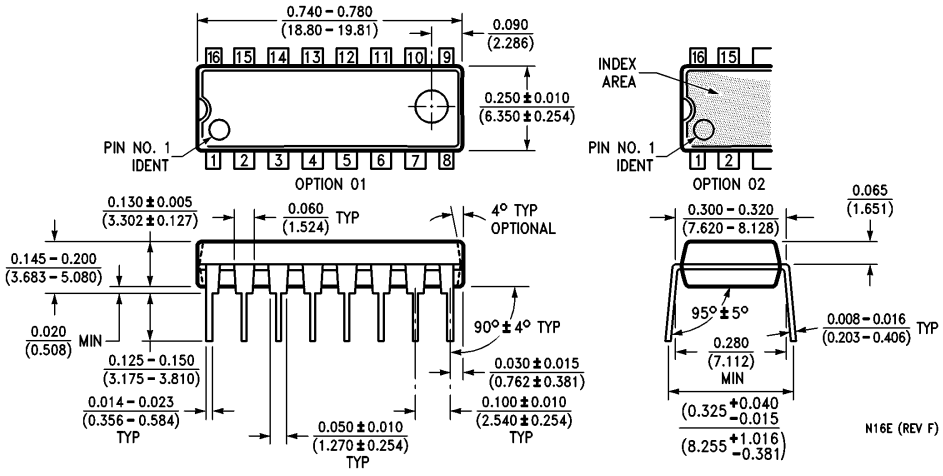
TL/F/5991–10

Physical Dimensions inches (millimeters)



Ceramic Dual-In-Line Package (J)
Order Number CD4511BMJ or CD4511BCJ
NS Package Number J16A

Physical Dimensions inches (millimeters) (Continued)



Molded Dual-In-Line Package (N)
Order Number CD4511BMN or CD4511BCN
NS Package Number N16E

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