

**TTL
MSI**

**TYPES SN54LS138, SN54LS139, SN54S138, SN54S139,
SN74LS138, SN74LS139, SN74S138, SN74S139
DECODERS/DEMULTIPLEXERS**

BULLETIN NO. DL-S 7611804, DECEMBER 1972—REVISED OCTOBER 1976

- Designed Specifically for High-Speed: Memory Decoders Data Transmission Systems
- 'S138 and 'LS138 3-to-8-Line Decoders Incorporate 3 Enable Inputs to Simplify Cascading and/or Data Reception
- 'S139 and 'LS139 Contain Two Fully Independent 2-to-4-Line Decoders/ Demultiplexers
- Schottky Clamped for High Performance

TYPE	TYPICAL PROPAGATION DELAY (3 LEVELS OF LOGIC)	TYPICAL POWER DISSIPATION
'LS138	22 ns	32 mW
'S138	8 ns	245 mW
'LS139	22 ns	34 mW
'S139	7.5 ns	300 mW

description

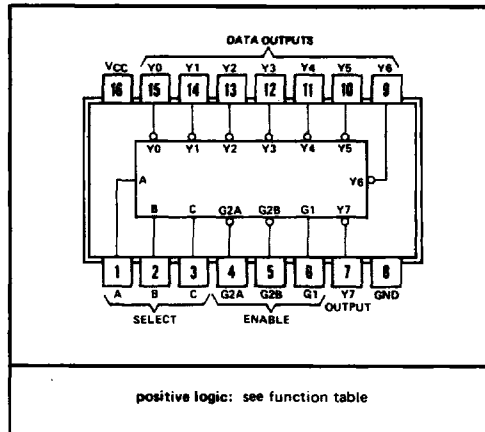
These Schottky-clamped TTL MSI circuits are designed to be used in high-performance memory-decoding or data-routing applications requiring very short propagation delay times. In high-performance memory systems these decoders can be used to minimize the effects of system decoding. When employed with high-speed memories utilizing a fast-enable circuit the delay times of these decoders and the enable time of the memory are usually less than the typical access time of the memory. This means that the effective system delay introduced by the Schottky-clamped system decoder is negligible.

The 'LS138 and 'S138 decode one-of-eight lines dependent on the conditions at the three binary select inputs and the three enable inputs. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

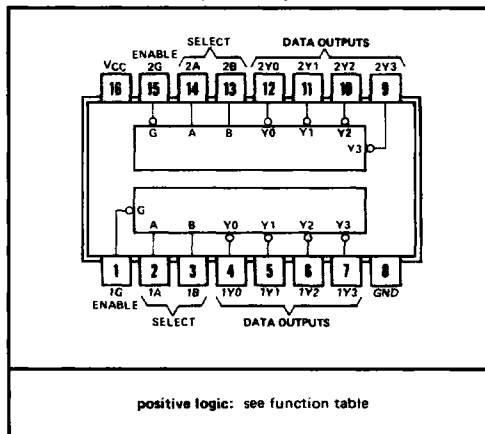
The 'LS139 and 'S139 comprise two individual two-line-to-four-line decoders in a single package. The active-low enable input can be used as a data line in demultiplexing applications.

All of these decoders/demultiplexers feature fully buffered inputs each of which represents only one normalized Series 54LS/74LS load ('LS138, 'LS139) or one normalized Series 54S/74S load ('S138, 'S139) to its driving circuit. All inputs are clamped with high-performance Schottky diodes to suppress line-ringing and simplify system design. Series 54LS and 54S devices are characterized for operation over the full military temperature range of -55°C to 125°C ; Series 74LS and 74S devices are characterized for 0°C to 70°C industrial systems.

SN54LS138, SN54S138 ... J OR W PACKAGE
SN74LS138, SN74S138 ... J OR N PACKAGE
(TOP VIEW)

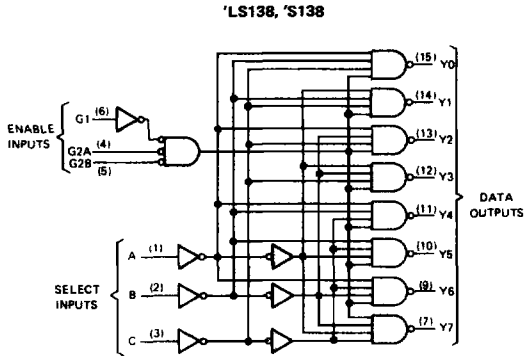


SN54LS139, SN54S139 ... J OR W PACKAGE
SN74LS139, SN74S139 ... J OR N PACKAGE
(TOP VIEW)



TYPES SN54LS138, SN54S138, SN54LS139, SN54S139 SN74LS138, SN74S138, SN74LS139, SN74S139 DECODERS/DEMULTIPLEXERS

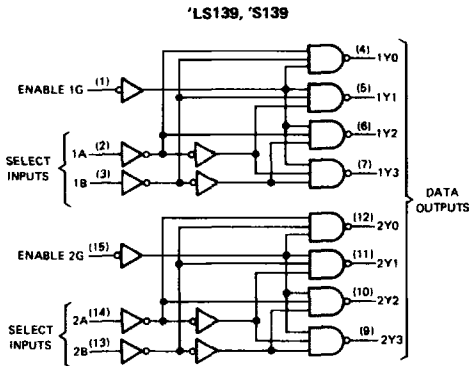
functional block diagrams and logic



'LS138, 'S138
FUNCTION TABLE

INPUTS					OUTPUTS							
ENABLE	SELECT				Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
G1	G2*	C	B	A								
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	L	H	H	H	H	H
H	L	H	L	H	H	H	H	L	H	H	H	H
H	L	H	H	L	H	H	H	H	L	H	H	H
H	L	H	H	H	H	H	H	H	H	L	H	H
H	L	H	H	H	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*G2 = G2A + G2B
H = high level, L = low level, X = irrelevant

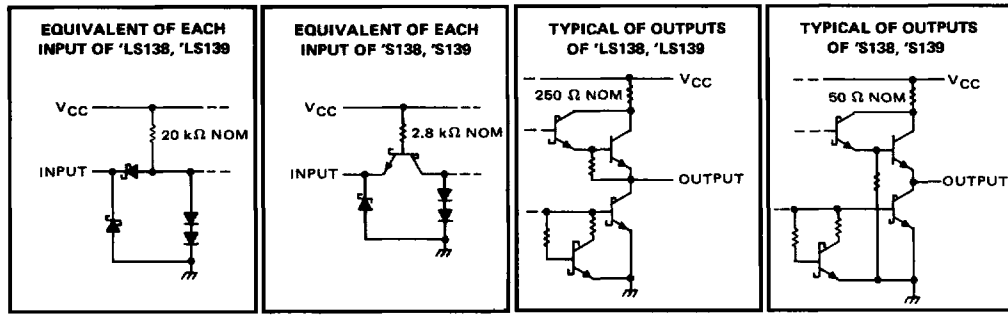


'LS139, 'S139
(EACH DECODER/DEMULTIPLEXER)
FUNCTION TABLE

INPUTS		OUTPUTS				
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

H = high level, L = low level, X = irrelevant

schematics of inputs and outputs



TYPES SN54LS138, SN54LS139, SN74LS138, SN74LS139, DECODERS/DEMULTIPLEXERS

REVISED OCTOBER 1976

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	7 V
Operating free-air temperature range: SN54LS138, SN54LS139 Circuits	-55°C to 125°C
SN74LS138, SN74LS139 Circuits	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54LS138 SN54LS139			SN74LS138 SN74LS139			UNIT	
	MIN	NOM	MAX	MIN	NOM	MAX		
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V	
High-level output current, I_{OH}	-400			-400			μ A	
Low-level output current, I_{OL}	4			8			mA	
Operating free-air temperature, T_A	-55			0			70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54LS138 SN54LS139			SN74LS138 SN74LS139			UNIT		
		MIN	TYP‡	MAX	MIN	TYP‡	MAX			
V_{IH} High-level input voltage		2			2			V		
V_{IL} Low-level input voltage		0.7			0.8			V		
V_{IK} Input clamp voltage	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$	-1.5			-1.5			V		
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = V_{IL \text{ max}}, I_{OH} = -400 \mu\text{A}$	2.5	3.4		2.7	3.4		V		
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = V_{IL \text{ max}}$	$I_{OL} = 4 \text{ mA}$ $I_{OL} = 8 \text{ mA}$		0.25	0.4	0.25	0.4	V		
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX}, V_I = 7 \text{ V}$	0.1			0.1			mA		
I_{IH} High-level input current	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$	20			20			μ A		
I_{IL} Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$	-0.4			-0.4			mA		
I_{OS} Short-circuit output current‡	$V_{CC} = \text{MAX}$	-6			-5			-42	mA	
I_{CC} Supply current	$V_{CC} = \text{MAX},$ Outputs enabled and open	'LS138		6.3	10	'LS139		6.3	11	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ Not more than one output should be shorted at a time.

switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

PARAMETER†	FROM (INPUT)	TO (OUTPUT)	LEVELS OF DELAY	TEST CONDITIONS	SN54LS138 SN74LS138			SN54LS139 SN74LS139			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}	Binary Select	Any	2	$C_L = 15 \text{ pF},$ $R_L = 2 \text{ k}\Omega,$ See Note 2	13	20		13	20		ns
t_{PHL}					27	41		22	33		ns
t_{PLH}					18	27		18	29		ns
t_{PHL}					26	39		25	38		ns
t_{PLH}	Enable	Any	2		12	18		16	24		ns
t_{PHL}					21	32		21	32		ns
t_{PLH}					17	26					ns
t_{PHL}					25	38					ns

† $t_{PLH} \equiv$ propagation delay time, low-to-high-level output; $t_{PHL} \equiv$ propagation delay time, high-to-low-level output.

NOTE 2: Load circuits and waveforms are shown on page 3-11.

TYPES SN54S138, SN54S139, SN74S138, SN74S139 DECODERS/DEMULTIPLEXERS

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	5.5 V
Operating free-air temperature range: SN54S138, SN54S139 Circuits	-55°C to 125°C
SN74S138, SN74S139 Circuits	0°C to 70°C
Storage temperature range	-65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54S138 SN74S139			SN74S138 SN74S139			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			-1			-1	mA
Low-level output current, I_{OL}			20			20	mA
Operating free-air temperature, T_A	-65		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	SN54S138 SN74S139		SN54S139 SN74S139		UNIT
		MIN	TYP‡ MAX	MIN	TYP‡ MAX	
V_{IH} High-level input voltage		2		2		V
V_{IL} Low-level input voltage			0.8		0.8	V
V_{IK} Input clamp voltage	$V_{CC} = \text{MIN}$, $I_I = -18 \text{ mA}$		-1.2		-1.2	V
V_{OH} High-level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = 0.8 \text{ V}$, $I_{OH} = -1 \text{ mA}$	SN54S'	2.5 3.4	SN54S'	2.5 3.4	V
		SN74S'	2.7 3.4	SN74S'	2.7 3.4	
V_{OL} Low-level output voltage	$V_{CC} = \text{MIN}$, $V_{IH} = 2 \text{ V}$, $V_{IL} = 0.8 \text{ V}$, $I_{OL} = 20 \text{ mA}$		0.5		0.5	V
I_I Input current at maximum input voltage	$V_{CC} = \text{MAX}$, $V_I = 5.5 \text{ V}$		1		1	mA
I_{IH} High-level input current	$V_{CC} = \text{MAX}$, $V_I = 2.7 \text{ V}$		50		50	µA
I_{IL} Low-level input current	$V_{CC} = \text{MAX}$, $V_I = 0.5 \text{ V}$		-2		-2	mA
I_{OS} Short-circuit output current‡	$V_{CC} = \text{MAX}$		-40 -100		-40 -100	mA
I_{CC} Supply current	$V_{CC} = \text{MAX}$, Outputs enabled and open		49 74		60 90	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable device type.

‡ All typical values are at $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ \text{C}$.

§ Not more than one output should be shorted at a time, and duration of the short-circuit test should not exceed one second.

switching characteristics, $V_{CC} = 5 \text{ V}$, $T_A = 25^\circ \text{C}$

PARAMETER¶	FROM (INPUT)	TO (OUTPUT)	LEVELS OF DELAY	TEST CONDITIONS	SN54S138, SN74S138		SN54S139 SN74S139		UNIT
					MIN	TYP MAX	MIN	TYP MAX	
t_{PLH}	Binary select	Any	2	$C_L = 15 \text{ pF}$, $R_L = 280 \Omega$, See Note 3	4.5	7	5	7.5	ns
t_{PHL}					7	10.5	6.5	10	
t_{PLH}			3		7.5	12	7	12	ns
t_{PHL}					8	12	8	12	
t_{PLH}	Enable	Any	2		5	8	5	8	ns
t_{PHL}					7	11	6.5	10	
t_{PLH}			3		7	11			ns
t_{PHL}					7	11			

¶ t_{PLH} ≡ propagation delay time, low-to-high-level output

¶ t_{PHL} ≡ propagation delay time, high-to-low-level output

NOTE 3: Load circuits and waveforms are shown on page 3-10.