

# SN54LS630, SN74LS630

## 16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS

D2550, MARCH 1980—REVISED MARCH 1988

(TIM99630)

- Detects and Corrects Single-Bit Errors
- Detects and Flags Dual-Bit Errors
- Fast Processing Times:
  - Write Cycle: Generates Check Word in 45 ns Typical
  - Read Cycle: Flags Errors in 27 ns Typical
- Power Dissipation 600 mW Typical

### description

The 'LS630 device is a 16-bit parallel error detection and correction circuit (EDAC) in a 28-pin, 600-mil package. It uses a modified Hamming code to generate a 6-bit check word from a 16-bit data word. This check word is stored along with the data word during the memory write cycle. During the memory read cycle, the 22-bit words from memory are processed by the EDAC to determine if errors have occurred in memory.

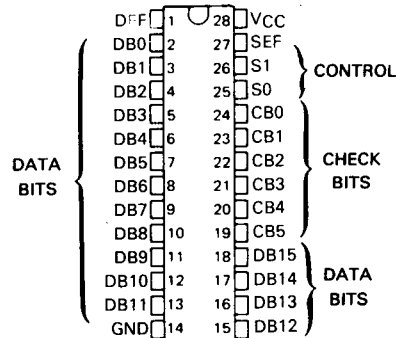
Single-bit errors in the 16-bit data word are flagged and corrected.

Single-bit errors in the 6-bit check word are flagged, and the CPU sends the EDAC through the correction cycle even though the 16-bit word is not in error. The correction cycle will simply pass along the original 16-bit word in this case and produce error syndrome bits to pinpoint the error-generating location.

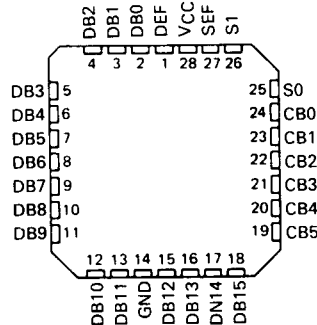
Dual-bit errors are flagged but not corrected. These dual errors may occur in any two bits of the 22-bit word from memory (two errors in the 16-bit data word, two errors in the 6-bit check word, or one error in each word).

The gross-error condition of all lows or all highs from memory will be detected. Otherwise, errors in three or more bits of the 22-bit word are beyond the capabilities of these devices to detect.

SN54LS630 . . . JD PACKAGE  
SN74LS630 . . . N PACKAGE  
(TOP VIEW)



SN54LS630 . . . FK PACKAGE  
(TOP VIEW)



CONTROL FUNCTION TABLE

Memory Cycle	Control		EDAC Function	Data I/O	Check Word I/O	Error Flags	
	S1	S0				SEF	DEF
WRITE	L	L	Generate Check Word	Input Data	Output Check Word	L	L
READ	L	H	Read Data & Check Word	Input Data	Input Check Word	L	L
READ	H	H	Latch & Flag Errors	Latch Data	Latch Check Word	Enabled	
READ	H	L	Correct Data Word & Generate Syndrome Bits	Output Corrected Data	Output Syndrome Bits	Enabled	

PRODUCTION DATA documents contain information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS  
INSTRUMENTS

POST OFFICE BOX 655012 • DALLAS, TEXAS 75265

2-1047

TTL Devices

2

## 2 TTL Devices

Total Number of Errors		Error Flags		Data Correction
16-Bit Data	6-Bit Checkword	SEF	DEF	
0	0	L	L	Not Applicable
1	0	H	L	Correction
0	1	H	L	Correction
1	1	H	H	Interrupt
2	0	H	H	Interrupt
0	2	H	H	Interrupt

The first case in the error function table represents the normal, no-error condition. The CPU sees lows on both flags. The next two cases of single-bit errors require data correction. Although the EDAC can discern the single check bit error and ignore it, the error flags are identical to the single error in the 16-bit data word. The CPU will ask for data correction in both cases. An interrupt condition to the CPU results in each of the last three cases, where dual errors occur.

During a memory write cycle, six check bits (CB0-CB5) are generated by eight-input parity generators using the data bits as defined below. During a memory read cycle, the 6-bit check word is retrieved along with the actual data.

# SN54LS630, SN74LS630

## 16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS

CHECKWORD BIT	16-BIT DATA WORD															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CB0	x	x		x	x				x	x	x			x		
CB1	x		x	x		x	x		x			x			x	
CB2		x	x		x	x		x		x			x			x
CB3	x	x	x				x	x			x	x	x			
CB4				x	x	x	x	x						x	x	x
CB5									x	x	x	x	x	x	x	x

The six check bits are parity bits derived from the matrix of data bits as indicated by "x" for each bit.

Error detection is accomplished as the 6-bit check word and the 16-bit data word from memory are applied to internal parity generators/checkers. If the parity of all six groupings of data and check bits are correct, it is assumed that no error has occurred and both error flags will be low. (It should be noted that the sense of two of the check bits, bits CB0 and CB1, is inverted to ensure that the gross-error condition of all lows and all highs is detected.)

If the parity of one or more of the check groups is incorrect, an error has occurred and the proper error flag or flags will be set high. Any single error in the 16-bit data word will change the sense of exactly three bits of the 6-bit check word. Any single error in the 6-bit check word changes the sense of only that one bit. In either case, the single error flag will be set high while the dual error flag will remain low.

Any two-bit error will change the sense of an even number of check bits. The two-bit error is not correctable since the parity tree can only identify single-bit errors. Both error flags are set high when any two-bit error is detected.

Three or more simultaneous bit errors can fool the EDAC into believing that no error, a correctable error, or an uncorrectable error has occurred and produce erroneous results in all three cases.

Error correction is accomplished by identifying the bad bit and inverting it. Identification of the erroneous bit is achieved by comparing the 16-bit data word and 6-bit check word from memory with the new check word with one (check word error) or three (data word error) inverted bits.

As the corrected word is made available on the data word I/O port, the check word I/O port presents a 6-bit syndrome error code. This syndrome code can be used to identify the bad memory chip.

**ERROR SYNDROME TABLE**

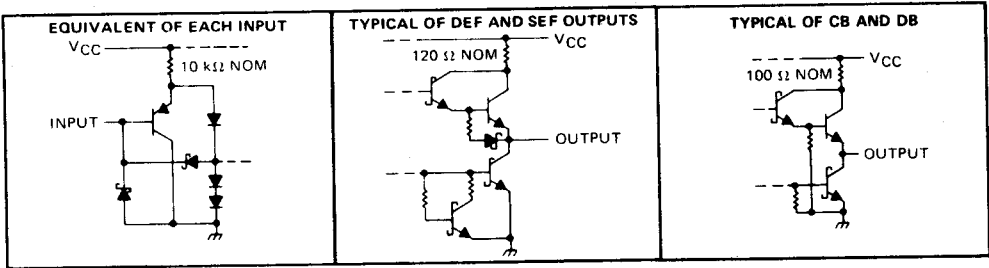
ERROR LOCATION	SYNDROME ERROR CODE					
	CB0	CB1	CB2	CB3	CB4	CB5
DB0	L	L	H	L	H	H
DB1	L	H	L	L	H	H
DB2	H	L	L	L	H	H
DB3	L	L	H	H	L	H
DB4	L	H	L	H	L	H
DB5	H	L	L	H	L	H
DB6	H	L	H	L	L	H
DB7	H	H	L	L	L	H
DB8	L	L	H	H	H	L
DB9	L	H	L	H	H	L
DB10	L	H	H	L	H	L
DB11	H	L	H	L	H	L
DB12	H	H	L	L	H	L
DB13	L	H	H	H	L	L
DB14	H	L	H	H	L	L
DB15	H	H	L	H	L	L
CB0	L	H	H	H	H	H
CB1	H	L	H	H	H	H
CB2	H	H	L	H	H	H
CB3	H	H	H	L	H	H
CB4	H	H	H	H	L	H
CB5	H	H	H	H	H	L
NO ERROR	H	H	H	H	H	H

2

TTL Devices

SN54LS630, SN74LS630  
16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS

schematics of inputs and outputs



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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage: S0 and S1	7 V
CB and DB	5.5 V
Off-state output voltage	5.5 V
Operating free-air temperature range: SN54LS630	-55°C to 125°C
SN74LS630	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

			SN54LS630			SN74LS630			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V <sub>CC</sub>	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
I <sub>OH</sub>	High-level output current	CB or DB, 'LS630 only	- 1			- 1			mA
		DEF or SEF	- 0.4			- 0.4			
V <sub>OH</sub>	High-level output voltage	CB or DB, 'LS631 only	5.5			5.5			V
I <sub>OL</sub>	Low-level output current	CB or DB	12			24			mA
		DEF or SEF	4			8			
t <sub>su</sub>	Setup time	CB or DB before S1† †	15			15			ns
		CB or DB before S1† ‡	45			45			
t <sub>h</sub>	Hold time	CB or DB after S1†	15			15			ns
T <sub>A</sub>	Operating free-air temperature		- 55			125			°C

† This time guarantees the input data and checkword will be latched.

‡ This time guarantees the input data and checkword will be latched plus that no glitch will occur on SEF or DEF flags.

† The upward-pointing arrow indicates a transition from low to high.

# SN54LS630, SN74LS630

## 16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS

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

PARAMETER			TEST CONDITIONS †	SN54LS630		SN74LS630		UNIT
				MIN	TYP‡ MAX	MIN	TYP‡ MAX	
V <sub>IH</sub>	High-level input voltage			2		2		V
V <sub>IL</sub>	Low-level input voltage			0.7		0.8		V
V <sub>IK</sub>	Input clamp voltage		V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA	-1.5		-1.5		V
V <sub>OH</sub>	High-level output voltage	CB or DB	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL min</sub>	I <sub>OH</sub> = MAX	2.4 3.3	2.4 3.2	V	
		DEF or SEF		I <sub>OH</sub> = -400 µA	2.5 3.4	2.7 3.4		
V <sub>OL</sub>	Low-level output voltage	CB or DB	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>IL max</sub>	I <sub>OL</sub> = 12 mA	0.25 0.4	0.25 0.4	V	
				I <sub>OL</sub> = 24 mA		0.35 0.5		
		DEF or SEF		I <sub>OL</sub> = 4 mA	0.25 0.4	0.25 0.4		
				I <sub>OL</sub> = 8 mA		0.35 0.5		
I <sub>OZH</sub>	Off-state output current, high-level voltage applied	CB or DB	V <sub>CC</sub> = MAX, S <sub>0</sub> and S <sub>1</sub> at 2 V, V <sub>O</sub> = 2.7 V,		20	20	µA	
I <sub>OZL</sub>	Off-state output current, low-level voltage applied	CB or DB	V <sub>CC</sub> = MAX, S <sub>0</sub> and S <sub>1</sub> at 2 V, V <sub>O</sub> = 0.4 V,		-200	-200	µA	
I <sub>I</sub>	Input current at maximum input voltage	CB or DB	V <sub>CC</sub> = MAX, S <sub>0</sub> or S <sub>1</sub>	V <sub>I</sub> = 5.5 V	0.1	0.1	mA	
			V <sub>IH</sub> = 4.5 V, V <sub>I</sub> = 7 V	0.1	0.1			
I <sub>IH</sub>	High-level input current		V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V		20	20	µA	
I <sub>IL</sub>	Low-level input current		V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		-0.2	-0.2	mA	
I <sub>OS</sub> §	Short-circuit output current	CB or DB	V <sub>CC</sub> = MAX		-30 -130	-30 -130	mA	
		DEF or SEF			-20 -100	-20 -100		
I <sub>CC</sub>	Supply current		V <sub>CC</sub> = MAX, S <sub>0</sub> and S <sub>1</sub> at 4.5 V, All CB and DB pins grounded, DEF and SEF open		143 230	143 230	mA	

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

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

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

2

TTL Devices

# SN54LS630, SN74LS630

## 16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $C_L = 45\text{ pF}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS630			UNIT
				MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low-to-high-level output <sup>†</sup>	DB	CB	S0 at 0 V, S1 at 0 V, $R_L = 667\ \Omega$ , See Figure 1	31	65		ns
$t_{PHL}$ Propagation delay time, high-to-low-level output <sup>†</sup>				45	65		ns
$t_{PLH}$ Propagation delay time, low-to-high-level output <sup>‡</sup>	S1†	DEF	S0 at 3 V, $R_L = 2\text{ k}\Omega$ , See Figure 1	27	40		ns
		SEF		20	30		
$t_{PZH}$ Output enable time to high level <sup>§</sup>	S0↓	CB, DB	S1 at 3 V, $R_L = 667\ \Omega$ , See Figure 2	24	40		ns
$t_{PZL}$ Output enable time to low level <sup>§</sup>	S0↓	CB, DB	S1 at 3 V, $R_L = 667\ \Omega$ , See Figure 1	30	45		ns
$t_{PHZ}$ Output disable time from high level <sup>¶</sup>	S0↑	CB, DB	S1 at 3 V, $R_L = 667\ \Omega$ , See Figure 2	43	65		ns
$t_{PLZ}$ Output disable time from low level <sup>¶</sup>	S0↑	CB, DB	S1 at 3 V, $R_L = 667\ \Omega$ , See Figure 1	31	65		ns

<sup>†</sup> These parameters describe the time intervals taken to generate the check word during the memory write cycle.

<sup>‡</sup> These parameters describe the time intervals taken to flag errors during the memory read cycle.

<sup>§</sup> These parameters describe the time intervals taken to correct and output the data word and to generate and output the syndrome error code during the memory read cycle.

<sup>¶</sup> These parameters describe the time intervals taken to disable the CB and DB buses in preparation for a new data word during the memory read cycle.

### PARAMETER MEASUREMENT INFORMATION

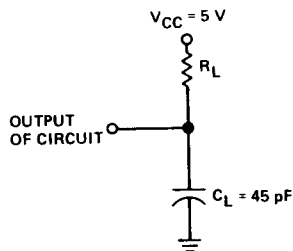


FIGURE 1—OUTPUT LOAD CIRCUIT

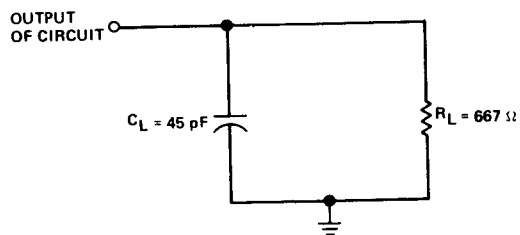
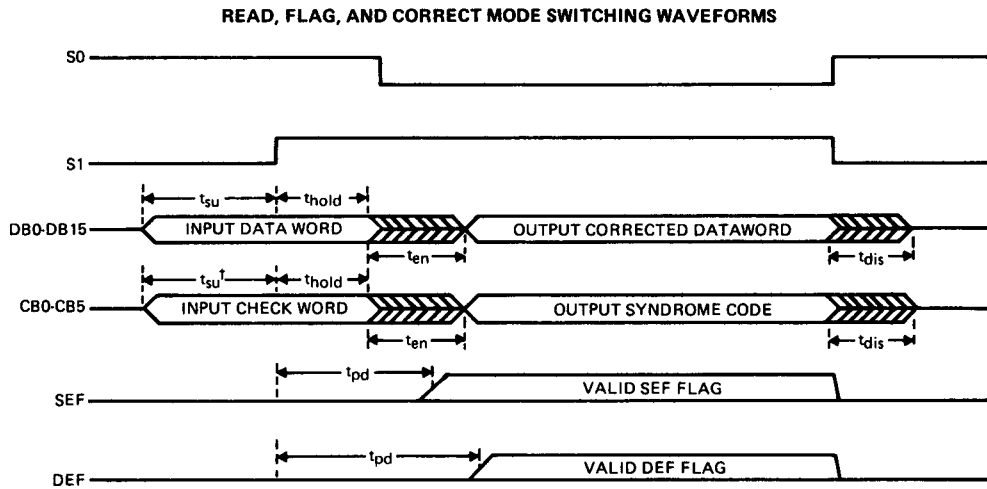


FIGURE 2—OUTPUT LOAD CIRCUIT

**SN54LS630, SN74LS630**  
**16-BIT PARALLEL ERROR DETECTION AND CORRECTION CIRCUITS**

**typical operating sequences**



<sup>†</sup> NOTE: There are two conditions specified for  $t_{su}$  of Data or Checkword before  $S1$ <sup>†</sup>. See recommended operating conditions for details.

**2**

**TTL Devices**