

T-45-17

MC8503
UNIVERSAL POLYNOMIAL GENERATOR (UPG)

The MC8503 Universal Polynomial Generator (UPG) is used in serial digital data handling systems for error detection and correction. The serial data stream is divided by a selected polynomial and the division remainder is transmitted at the end of the data stream as a Cyclic Redundancy Check Character (CRCC). When the data is received the same calculation is performed. If there were no errors in transmission, the new remainder will be zero.

The MC8503 offers four of the more common polynomials for error detection techniques including a read forward and reverse on the CRCC-16 and CRCC-CCITT polynomial functions. These polynomials can be generated by changing the binary select codes as shown in Figure 1.

- Four Unique Polynomial Codes in One Package
- Compatible with TTL
Maximum Fan-Out = 1 TTL Load
- Data Rate = 3.5 MHz Typical
- Total Power Dissipation = 400 mW Typical
- +5.0-Volt Operation

Typical Applications Include:

- Floppy Disks
- Cassettes
- Data Communications

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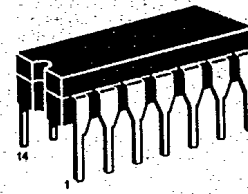
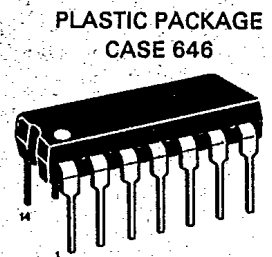
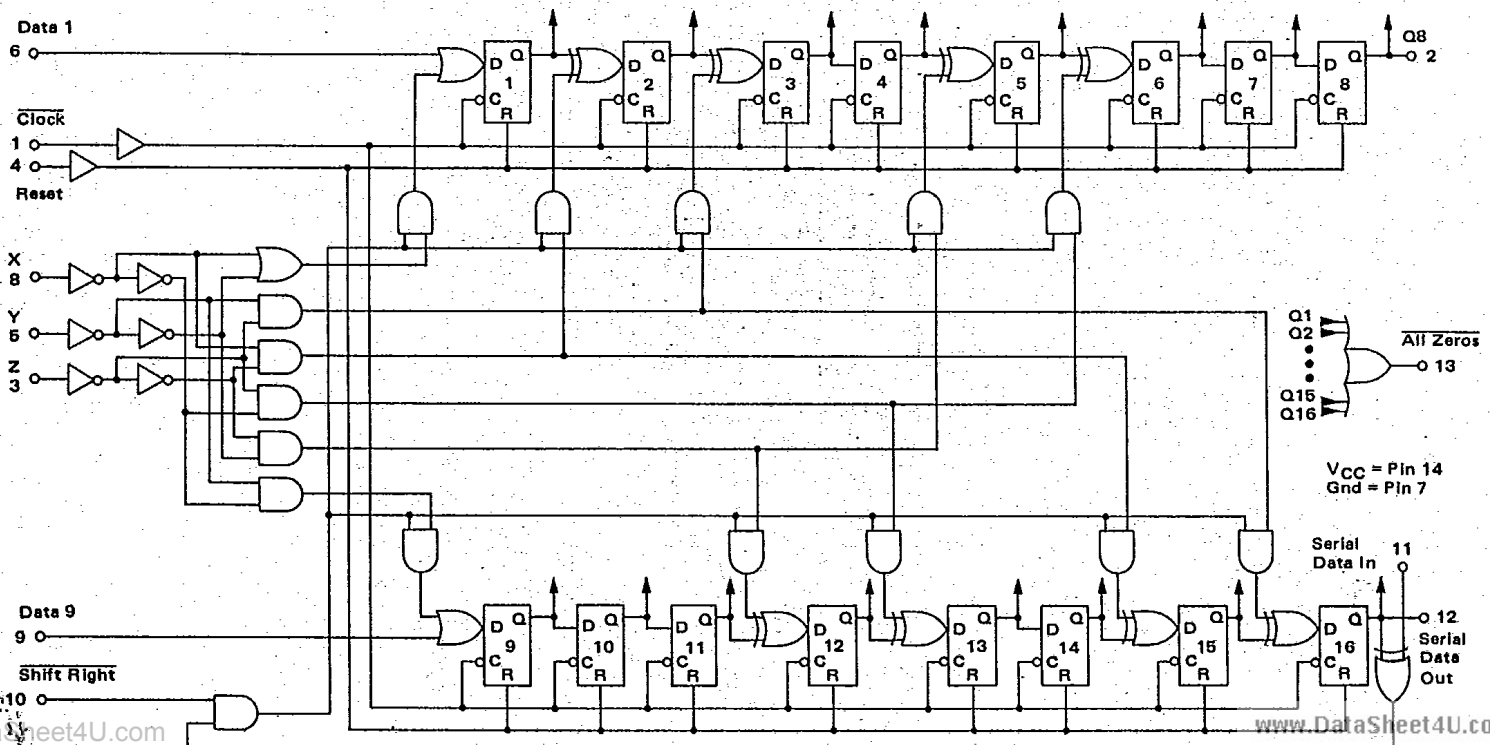
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 CERAMIC PACKAGE
CASE 632

 PLASTIC PACKAGE
CASE 646

FIGURE 1 - AVAILABLE POLYNOMIALS

CODE SELECT			POLYNOMIAL	
X	Y	Z		
0	0	0	CRCC-16 (Fwd)	$X^{16} + X^{15} + X^2 + 1$
0	0	1	CRCC-16 (Bkwd)	$X^{16} + X^{14} + X + 1$
1	1	0	CRCC-CCITT (Fwd)	$X^{16} + X^{12} + X^5 + 1$
1	1	1	CRCC-CCITT (Bkwd)	$X^{16} + X^{11} + X^4 + 1$
0	1	0	LRCC-16	$X^{16} + 1$
1	0	1	LRCC-8	$X^8 + 1$

LOGIC DIAGRAM


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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.5 to +7.0	Vdc
Input Voltage	V_{in}	-1.0 to +5.5	Vdc
Output Voltage	V_{OH}	-0.5 to +7.0	Vdc
Thermal Resistance	θ_{JA}	65	$^{\circ}C/W$
Operating Temperature Range	T_A	0 to +75	$^{\circ}C$
Storage Temperature Range	T_{stg}	-55 to +165	$^{\circ}C$

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5.0$ Vdc $\pm 5\%$, $T_A = 0$ to $75^{\circ}C$ unless otherwise noted.)

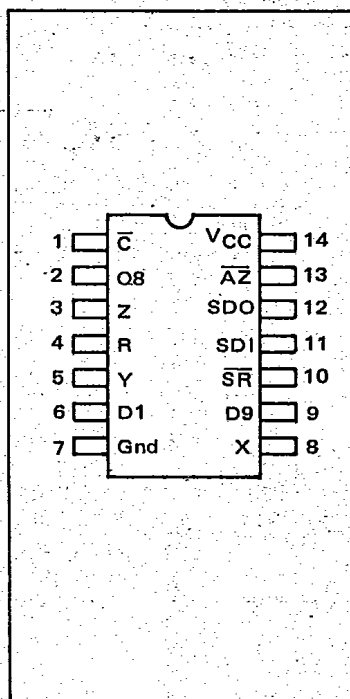
Characteristic	Symbol	Min	Max	Unit
Input Forward Current ($V_{IL} = 0$, $V_{CC} = 5.25$ Vdc, All Inputs)	I_{IL}	-	-75	μA_{dc}
Input Leakage Current ($V_{IH} = 2.4$ Vdc, $V_{CC} = 5.25$ Vdc, All Inputs)	I_{IH}	-	120	μA_{dc}
Logic "0" Output Voltage ($I_{OL} = 1.6$ mA _{dc} , $V_{ILT} = 0.8$ Vdc, $V_{IHT} = 2.0$ Vdc, $V_{CC} = 4.75$ Vdc)	V_{OL}	-	0.5	Vdc
Logic "1" Output Voltage ($I_{OH} = -0.3$ mA _{dc} , $V_{ILT} = 0.8$ Vdc, $V_{IHT} = 2.0$ Vdc, $V_{CC} = 4.75$ Vdc)	V_{OH}	2.4	-	Vdc
Output Leakage Current ($V_{CC} = V_{CEX} = 5.25$ Vdc)	I_{CEX}	-	100	μA_{dc}
Power Supply Drain Current ($V_{CC} = 5.0$ Vdc, All Inputs Open)	I_{CC}	-	117	mA _{dc}

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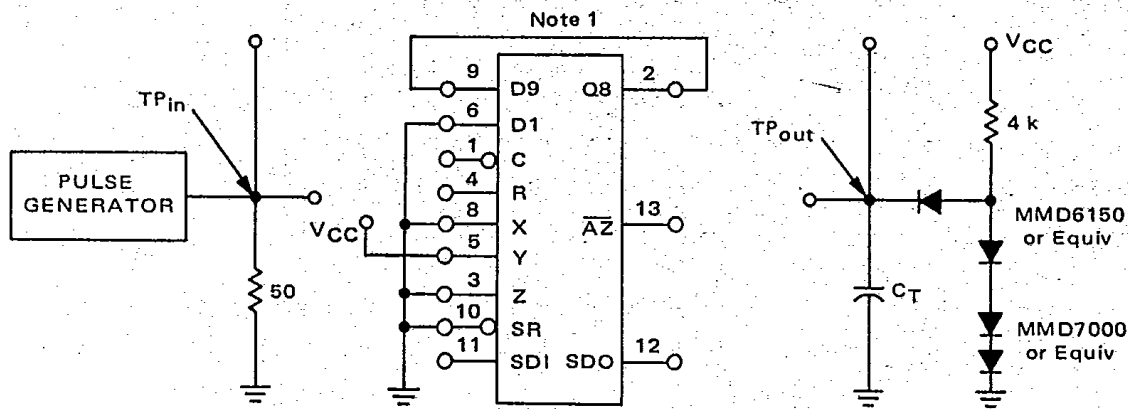
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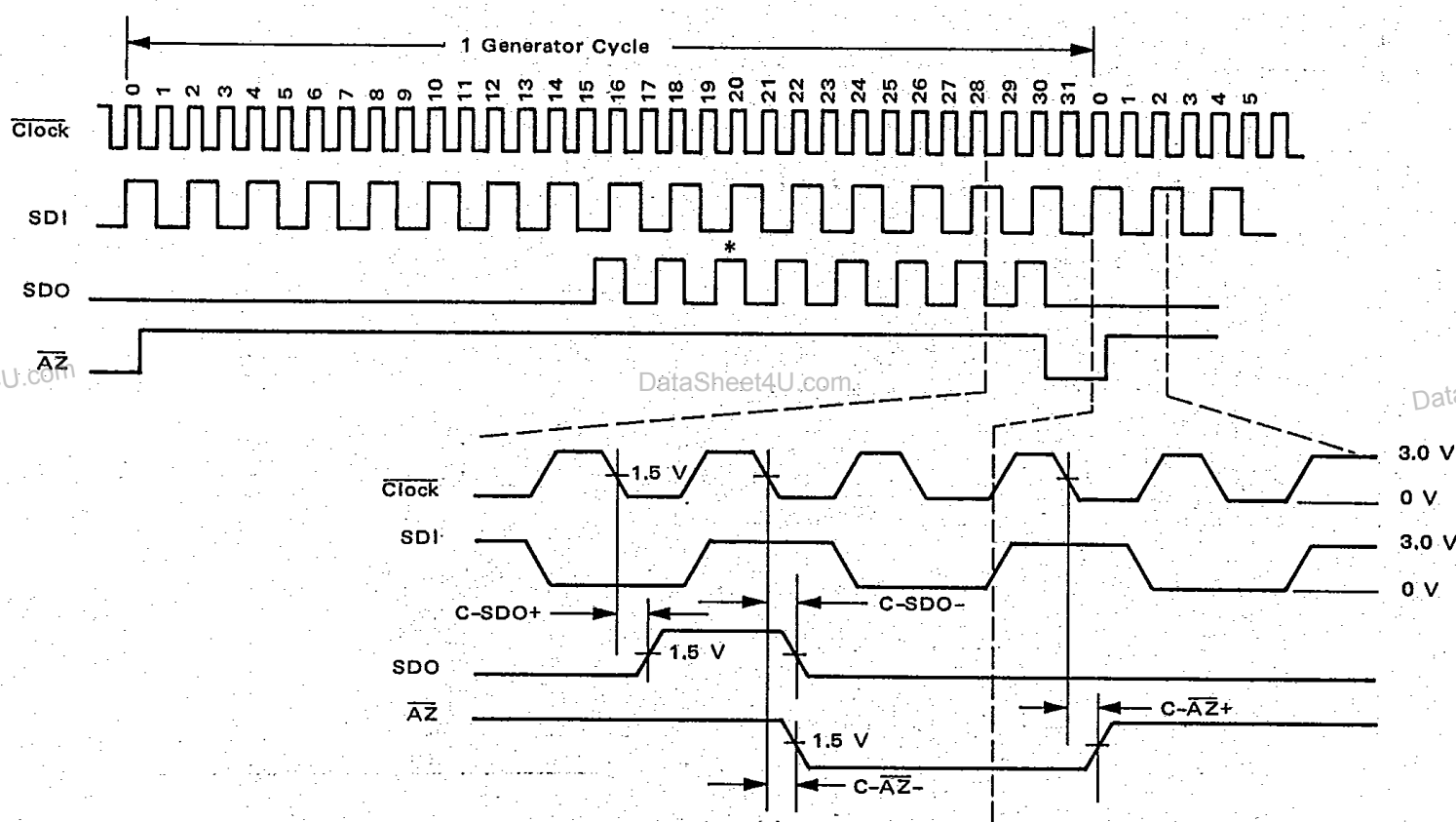
PIN ASSIGNMENT



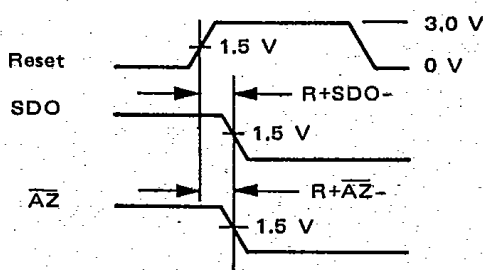
MOTOROLA Semiconductor Products Inc.



High-impedance probes (> 1.0 megohm) must be used.
 $C_T = 15$ pF = total parasitic capacitance, which includes probe, wiring, and load capacitances.
 Note 1: Use minimum wire length to connect Q8 to D9.



* RESET TEST TO BE MADE AT THIS POINT



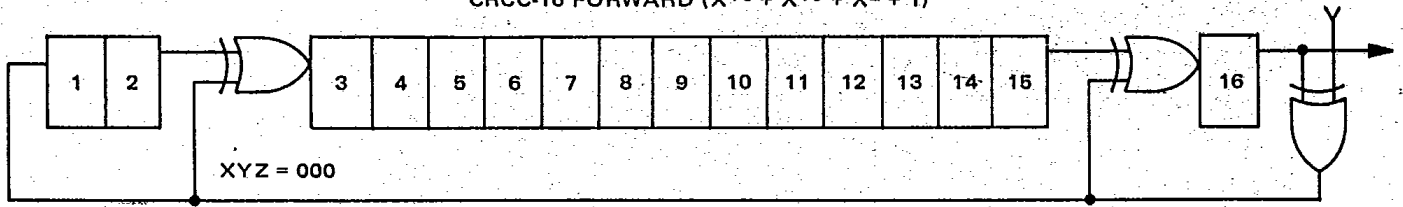
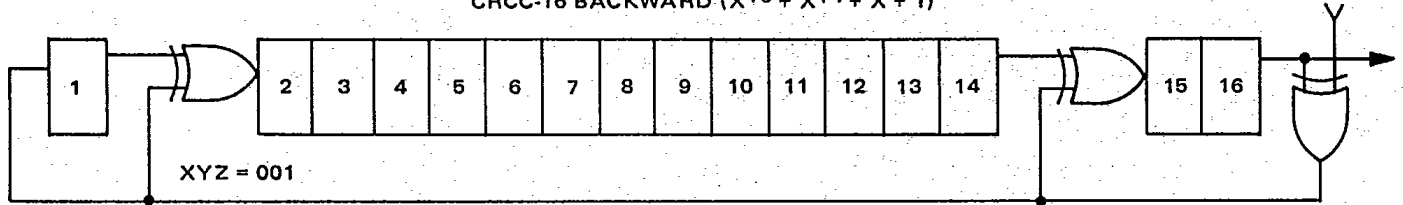
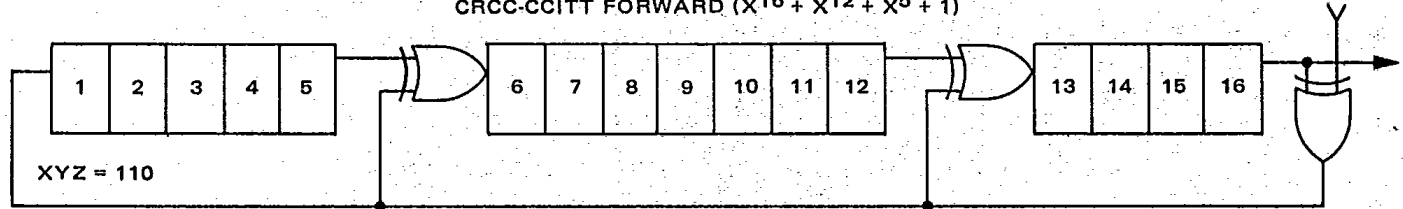
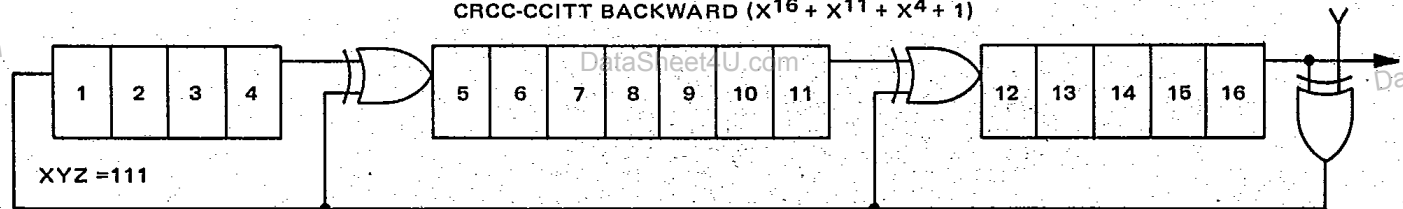
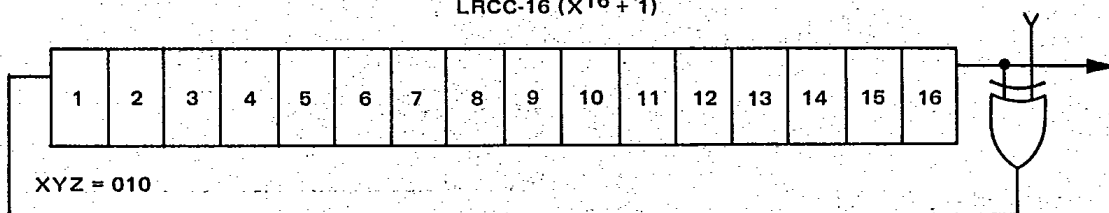
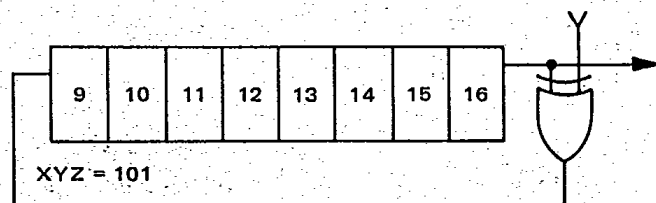
SWITCHING TIMES ($V_{CC} = 5.0$ Vdc, $T_A = 25^\circ$ C)

Characteristic	Symbol	Max	Unit
Clock to SDO Output – Turn-On Delay Time	t_{C-SDO-}	150	ns
	t_{C-SDO+}	125	ns
Clock to \bar{AZ} Output – Turn-On Delay Time	$t_{C-\bar{AZ}-}$	130	ns
	$t_{C-\bar{AZ}+}$	175	ns
Reset to SDO Output – Turn-On Delay Time	t_{R+SDO-}	160	ns
Reset to \bar{AZ} Output – Turn-On Delay Time	$t_{R+\bar{AZ}-}$	140	ns
Data Setup Time	t_{setup}	100 ns max	
Data Hold Time	t_{hold}	0 ns; min	
Minimum Reset Pulse Width	t_{pw}	100 ns; min	

Note: AC test in LRCC-16 Mode.



FIGURE 2 – ERROR CONTROL FUNCTIONS

CRCC-16 FORWARD ($X^{16} + X^{15} + X^2 + 1$)CRCC-16 BACKWARD ($X^{16} + X^{14} + X + 1$)CRCC-CCITT FORWARD ($X^{16} + X^{12} + X^5 + 1$)CRCC-CCITT BACKWARD ($X^{16} + X^{11} + X^4 + 1$)LRCC-16 ($X^{16} + 1$)LRCC-8 ($X^8 + 1$)

OPERATING CHARACTERISTICS

The MC8503 Polynomial Generator may be used to implement any of the error control functions shown in Figure 2. These circuits are used in a variety of digital recording systems, and are used to both generate and check the check characters transmitted with a serial data stream.

Both the data and the encoding character are termed "polynomials" in the sense that each bit position of a serial data stream can be thought of as a coefficient of the general polynomial $f(X) = a_0 + a_1X + a_2X^2 + \dots + a_{k-1}X^{k-1} + a_kX^k$. For the binary case, each coefficient must be either one or zero. In this context the polynomial $X^{16} + X^{15} + X^2 + 1$ is represented by the binary word 1100000000000101.

The check characters are generated by "dividing" the data by the encoding polynomial. The remainder resulting from the division is then appended to the message stream as a check character. During reception of the data it is again divided by the same polynomial. If no errors have occurred in transmission, the result of this division should be "zero" since adding the check character (remainder) to the message has the effect of making the received message evenly divisible by the code polynomial.

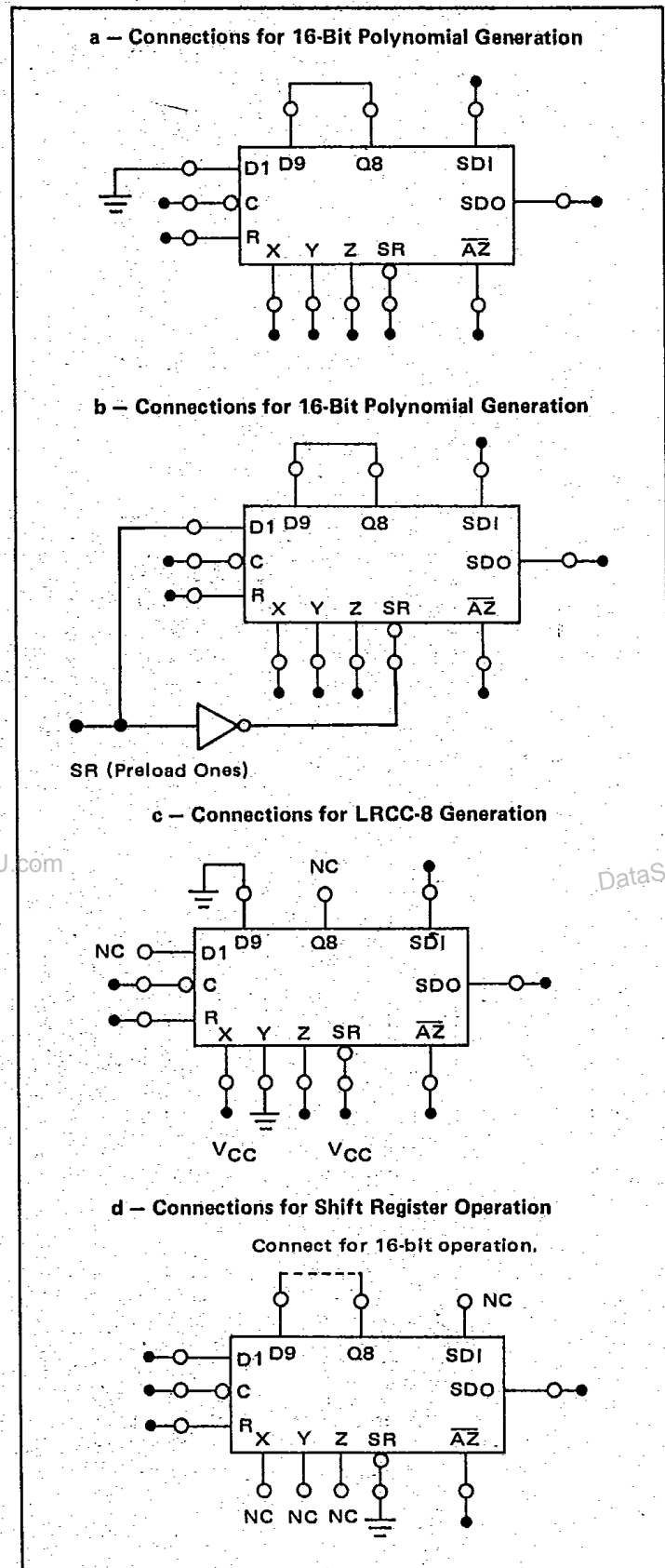
The MC8503 generates the check characters by entering each bit of the data stream into the Serial Data In terminal. This process effectively divides the data stream by the code selected by means of control lines X, Y, and Z as indicated in Figure 2. After the last data bit is entered, the check character is stored in the MC8503; it is then added to the data stream by taking the Shift Right control low and clocking the generator.

During reception the data is passed through an identical circuit and if no errors have occurred the internal All Zeros detector provides an indication that the data was correctly received. While the encoding techniques used provide some capability for error correction, the most common procedure is to request a re-transmission if errors are detected.

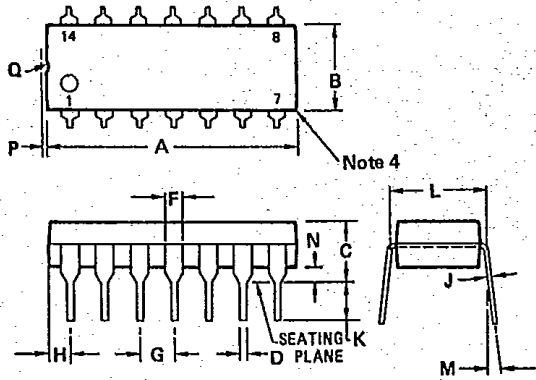
Figure 3 shows the external connections required for the various operating modes. Note that the circuit can be used as one sixteen-bit shift register, or as two synchronous eight-bit registers by holding Shift Right low and treating Data 1 and Data 9 as serial data inputs. Applications requiring the polynomial generator to be preset to all ones use the external connections shown in Figure 3b.

Operation of the MC8503 for each of the selectable codes is shown in Figures 4 thru 11. In Figure 4, the results of shifting a four byte data message into an MC8503 connected for CRCC-16 generation are shown (clock and control functions are omitted for clarity). After the last message bit has been entered by the 32nd shift pulse, the register contains the CRCC-16 check character. The check character would be shifted out (using the Shift Right control and 16 additional shift pulses) and transmitted as the last two data bytes of the message, with the least significant bit going first.

FIGURE 3 – EXTERNAL CONNECTIONS



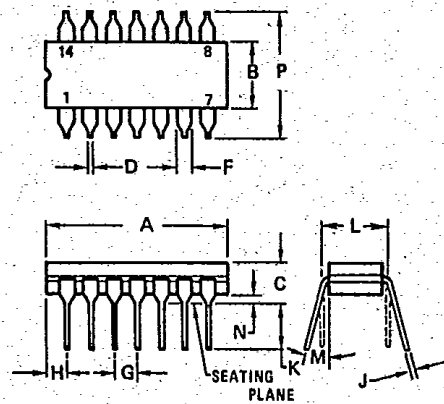
PACKAGE DIMENSIONS



- NOTES:
- LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
 - DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
 - DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
 - ROUNDED CORNERS OPTIONAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.16	19.56	0.715	0.770
B	6.10	6.60	0.240	0.260
C	4.06	5.08	0.160	0.200
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.32	2.41	0.052	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.51	1.02	0.020	0.040

CERAMIC PACKAGE
CASE 632-07



- NOTES:
- ALL RULES AND NOTES ASSOCIATED WITH MO-001 AA OUTLINE SHALL APPLY.
 - DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
 - DIMENSION "A" AND "B" (632-07) DO NOT INCLUDE GLASS RUN-OUT.
 - LEADS WITHIN 0.25 mm (0.010) DIA OF TRUE POSITION AT SEATING PLANE AND MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.94	0.750	0.785
B	6.10	7.49	0.240	0.295
C	-	5.08	-	0.200
D	0.38	0.58	0.015	0.023
F	1.40	1.77	0.055	0.070
G	2.54 BSC		0.100 BSC	
H	1.91	2.29	0.075	0.090
J	0.20	0.38	0.008	0.015
K	3.18	4.32	0.125	0.170
L	7.62 BSC		0.300 BSC	
M	-	15°	-	15°
N	0.51	1.02	0.020	0.040

PLASTIC PACKAGE
CASE 646-05