

Digital-to-Analog Converters with Serial Interface

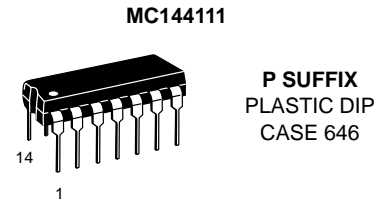
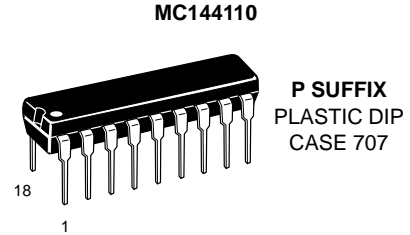
CMOS LSI

The MC144110 and MC144111 are low-cost 6-bit D/A converters with serial interface ports to provide communication with CMOS microprocessors and microcomputers. The MC144110 contains six static D/A converters; the MC144111 contains four converters.

Due to a unique feature of these DACs, the user is permitted easy scaling of the analog outputs of a system. Over a 5 to 15 V supply range, these DACs may be directly interfaced to CMOS MPUs operating at 5 V.

- Direct R-2R Network Outputs
- Buffered Emitter-Follower Outputs
- Serial Data Input
- Digital Data Output Facilitates Cascading
- Direct Interface to CMOS μ P
- Wide Operating Voltage Range: 4.5 to 15 V
- Wide Operating Temperature Range: 0 to 85°C
- Software Information is Contained in Document M68HC11RM/AD

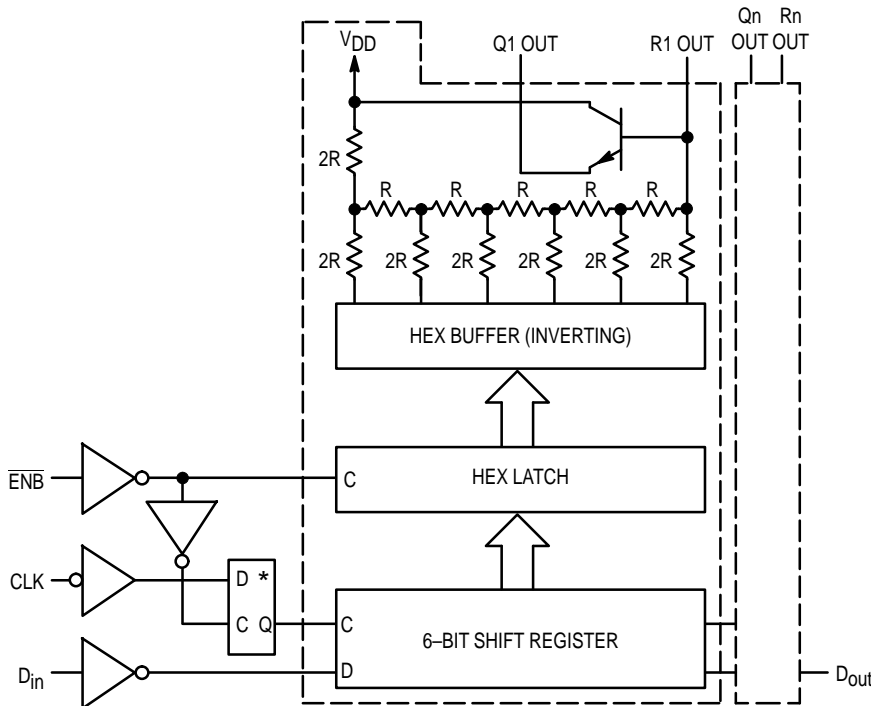
MC144110 MC144111



ORDERING INFORMATION

MC144110P	Plastic DIP
MC144110DW	SOG Package
MC144111P	Plastic DIP
MC144111DW	SOG Package

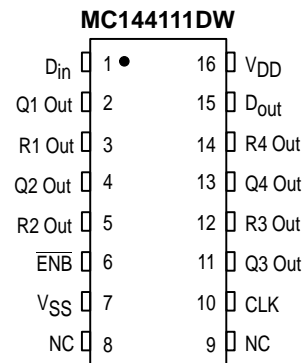
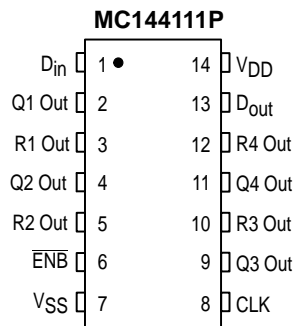
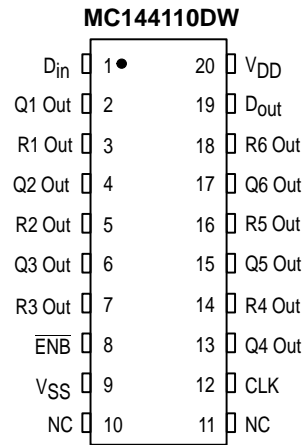
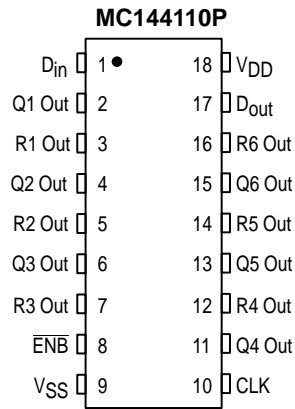
BLOCK DIAGRAM



* Transparent Latch

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PIN ASSIGNMENTS



NC = NO CONNECTION

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MAXIMUM RATINGS* (Voltages referenced to V_{SS})

Parameter	Symbol	Value	Unit	
DC Supply Voltage	V _{DD}	- 0.5 to + 18	V	
Input Voltage, All Inputs	V _{in}	- 0.5 to V _{DD} + 0.5	V	
DC Input Current, per Pin	I	± 10	mA	
Power Dissipation (Per Output)	P _{OH}		mW	
T _A = 70°C, MC144110				30
MC144111				50
T _A = 85°C, MC144110				10
MC144111	20			
Power Dissipation (Per Package)	P _D		mW	
T _A = 70°C, MC144110				100
MC144111				150
T _A = 85°C, MC144110				25
MC144111	50			
Storage Temperature Range	T _{stg}	- 65 to + 150	°C	

* Maximum Ratings are those values beyond which damage to the device may occur.

This device contains protection circuitry to guard against damage due to high static voltages or electric fields; however, it is advised that precautions be taken to avoid application of voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range V_{SS} ≤ (V_{in} or V_{out}) ≤ V_{DD}.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

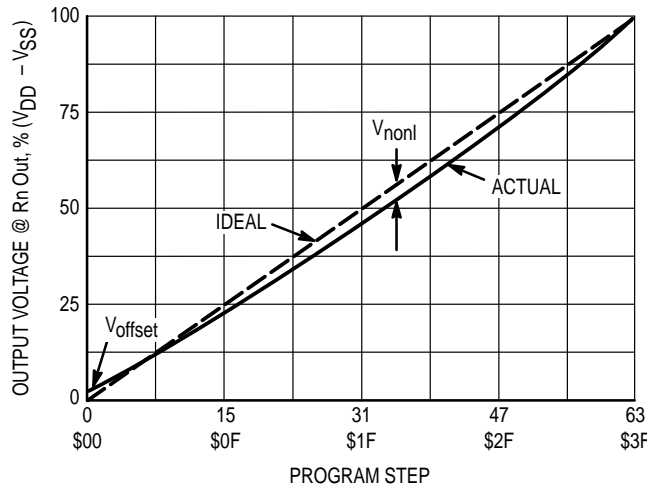
ELECTRICAL CHARACTERISTICS (Voltages referenced to V_{SS}, T_A = 0 to 85°C unless otherwise indicated)

Symbol	Parameter	Test Conditions	V _{DD}	Min	Max	Unit
V _{IH}	High-Level Input Voltage (D _{in} , $\overline{\text{ENB}}$, CLK)		5 10 15	3.0 3.5 4	—	V
V _{IL}	Low-Level Input Voltage (D _{in} , $\overline{\text{ENB}}$, CLK)		5 10 15	— — —	0.8 0.8 0.8	V
I _{OH}	High-Level Output Current (D _{out})	V _{out} = V _{DD} - 0.5 V	5	- 200	—	μA
I _{OL}	Low-Level Output Current (D _{out})	V _{out} = 0.5 V	5	200	—	μA
I _{DD}	Quiescent Supply Current	MC144110 MC144111 I _{out} = 0 μA	15 15	— —	12 8	mA
I _{in}	Input Leakage Current (D _{in} , $\overline{\text{ENB}}$, CLK)	V _{in} = V _{DD} or 0 V	15	—	± 1	μA
V _{nonl}	Nonlinearity Voltage (R _n Out)	See Figure 1	5 10 15	— — —	100 200 300	mV
V _{step}	Step Size (R _n Out)	See Figure 2	5 10 15	19 39 58	137 274 411	mV
V _{offset}	Offset Voltage from V _{SS}	D _{in} = \$00, See Figure 1	—	—	1	LSB
I _E	Emitter Leakage Current	V _{Rn Out} = 0 V	15	—	10	μA
h _{FE}	DC Current Gain	I _E = 0.1 to 10.0 mA T _A = 25°C	—	40	—	—
V _{BE}	Base-to-Emitter Voltage Drop	I _E = 1.0 mA	—	0.4	0.7	V

SWITCHING CHARACTERISTICS

(Voltages referenced to V_{SS} , $T_A = 0$ to 85°C , $C_L = 50$ pF, Input $t_r = t_f = 20$ ns unless otherwise indicated)

Symbol	Parameter	V_{DD}	Min	Max	Unit
t_{wH}	Positive Pulse Width, CLK (Figures 3 and 4)	5	2	—	μs
		10	1.5	—	
		15	1	—	
t_{wL}	Negative Pulse Width, CLK (Figure 3 and 4)	5	5	—	μs
		10	3.5	—	
		15	2	—	
t_{su}	Setup Time, $\overline{\text{ENB}}$ to CLK (Figures 3 and 4)	5	5	—	μs
		10	3.5	—	
		15	2	—	
t_{su}	Setup Time, D_{in} to CLK (Figures 3 and 4)	5	1000	—	ns
		10	750	—	
		15	500	—	
t_h	Hold Time, CLK to $\overline{\text{ENB}}$ (Figures 3 and 4)	5	5	—	μs
		10	3.5	—	
		15	2	—	
t_h	Hold Time, CLK to D_{in} (Figures 3 and 4)	5	5	—	μs
		10	3.5	—	
		15	2	—	
t_r, t_f	Input Rise and Fall Times	5 – 15	—	2	μs
C_{in}	Input Capacitance	5 – 15	—	7.5	pF



LINEARITY ERROR (integral linearity). A measure of how straight a device's transfer function is, it indicates the worst-case deviation of linearity of the actual transfer function from the best-fit straight line. It is normally specified in parts of an LSB.

Figure 1. D/A Transfer Function

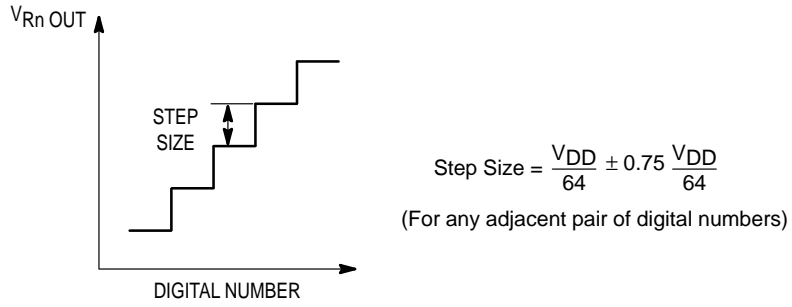


Figure 2. Definition of Step Size

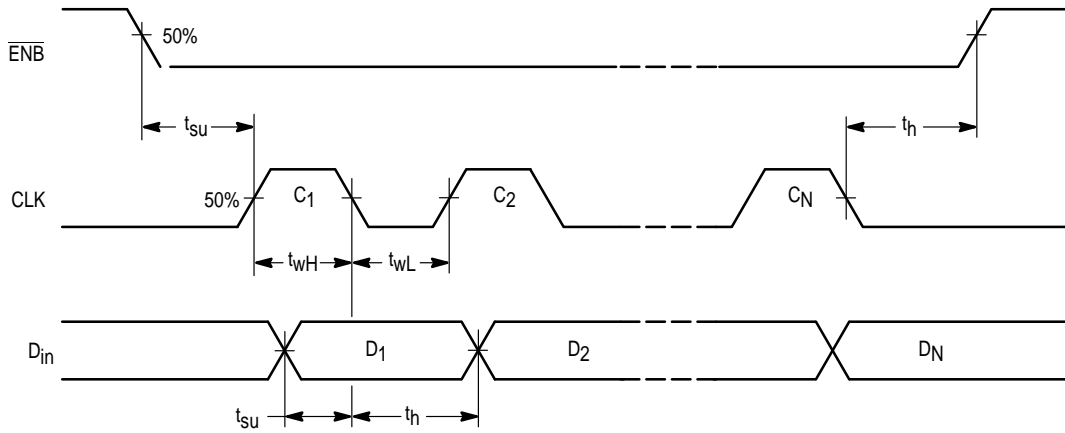


Figure 3. Serial Input, Positive Clock

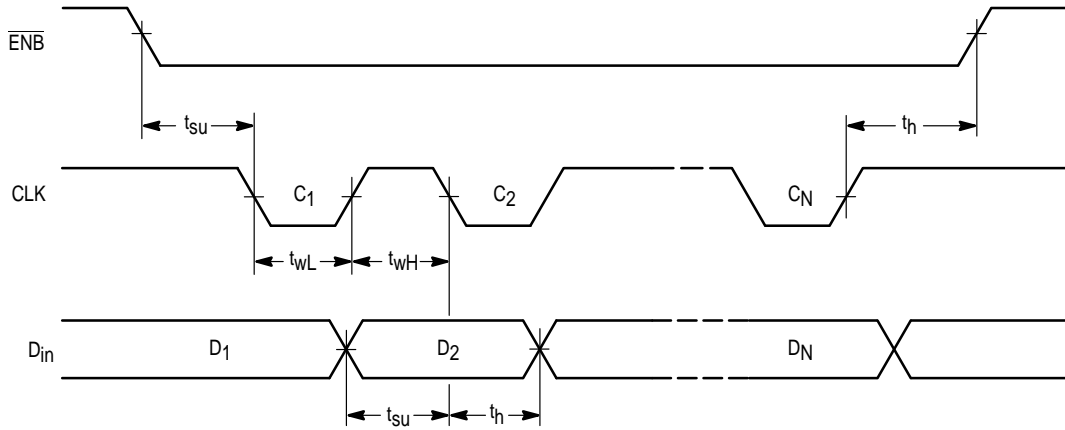


Figure 4. Serial Input, Negative Clock

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PIN DESCRIPTIONS

INPUTS

D_{in} Data Input

Six-bit words are entered serially, MSB first, into digital data input, D_{in}. Six words are loaded into the MC144110 during each D/A cycle; four words are loaded into the MC144111.

The last 6-bit word shifted in determines the output level of pins Q1 Out and R1 Out. The next-to-last 6-bit word affects pins Q2 Out and R2 Out, etc.

$\overline{\text{ENB}}$

Negative Logic Enable

The $\overline{\text{ENB}}$ pin must be low (active) during the serial load. On the low-to-high transition of $\overline{\text{ENB}}$, data contained in the shift register is loaded into the latch.

CLK

Shift Register Clock

Data is shifted into the register on the high-to-low transition of CLK. CLK is fed into the D-input of a transparent latch, which is used for inhibiting the clocking of the shift register when $\overline{\text{ENB}}$ is high.

The number of clock cycles required for the MC144110 is usually 36. The MC144111 usually uses 24 cycles. See Table 1 for additional information.

OUTPUTS

D_{out} Data Output

The digital data output is primarily used for cascading the DACs and may be fed into D_{in} of the next stage.

R1 Out through R_n Out Resistor Network Outputs

These are the R-2R resistor network outputs. These outputs may be fed to high-impedance input FET op amps to bypass the on-chip bipolar transistors. The R value of the resistor network ranges from 7 to 15 k Ω .

Q1 Out through Q_n Out NPN Transistor Outputs

Buffered DAC outputs utilize an emitter-follower configuration for current-gain, thereby allowing interface to low-impedance circuits.

SUPPLY PINS

V_{SS} Negative Supply Voltage

This pin is usually ground.

V_{DD} Positive Supply Voltage

The voltage applied to this pin is used to scale the analog output swing from 4.5 to 15 V p-p.

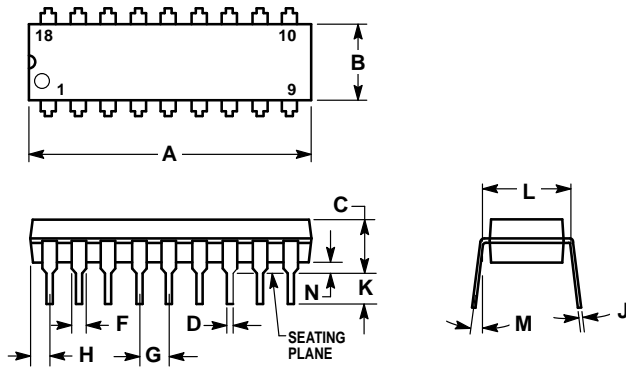
Table 1. Number of Channels vs Clocks Required

Number of Channels Required	Number of Clock Cycles	Outputs Used on MC144110	Outputs Used on MC144111
1	6	Q1/R1	Q1/R1
2	12	Q1/R1, Q2/R2	Q1/R1, Q2/R2
3	18	Q1/R1, Q2/R2, Q3/R3	Q1/R1, Q2/R2, Q3/R3
4	24	Q1/R1, Q2/R2, Q3/R3, Q4/R4	Q1/R1, Q2/R2, Q3/R3, Q4/R4
5	30	Q1/R1, Q2/R2, Q3/R3, Q4/R4, Q5/R5	Not Applicable
6	36	Q1/R1, Q2/R2, Q3/R3, Q4/R4, Q5/R5, Q6/R6	Not Applicable

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PACKAGE DIMENSIONS

P SUFFIX PLASTIC DIP CASE 707-02

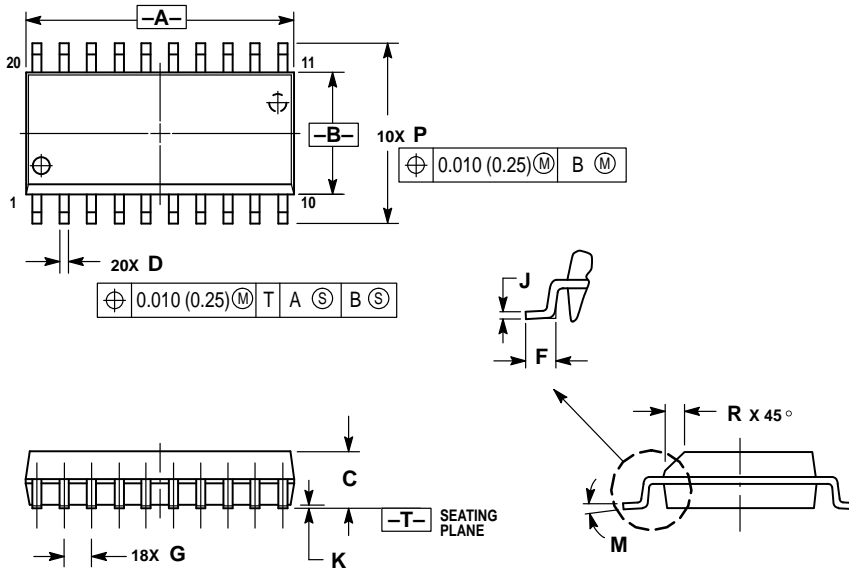


NOTES:

1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.22	23.24	0.875	0.915
B	6.10	6.60	0.240	0.260
C	3.56	4.57	0.140	0.180
D	0.36	0.56	0.014	0.022
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

DW SUFFIX SOG PACKAGE CASE 751D-04



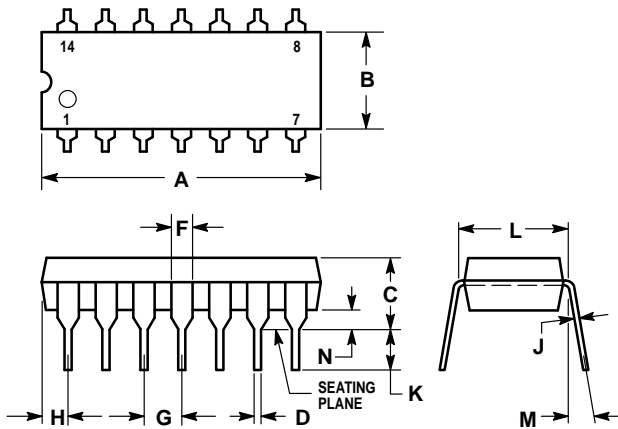
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.150 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	12.65	12.95	0.499	0.510
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.50	0.90	0.020	0.035
G	1.27 BSC		0.050 BSC	
J	0.25	0.32	0.010	0.012
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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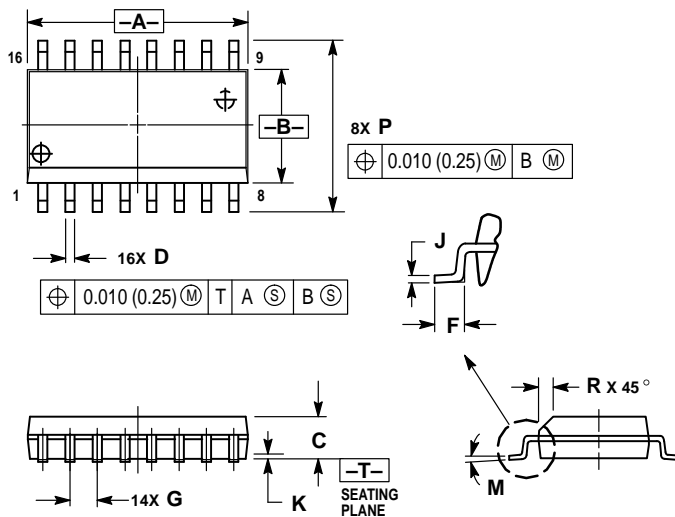
P SUFFIX PLASTIC DIP CASE 646-06



- NOTES:
- LEADS WITHIN 0.13 (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	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

DW SUFFIX SOG PACKAGE CASE 751G-02



- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 - CONTROLLING DIMENSION: MILLIMETER.
 - DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
 - MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 - DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.15	10.45	0.400	0.411
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.50	0.90	0.020	0.035
G	1.27 BSC		0.050 BSC	
J	0.25	0.32	0.010	0.012
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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MC144110/D