

**Legacy Device:** *Motorola MC145407*

The ML145407 is a silicon-gate CMOS IC that combines three drivers and three receivers to fulfill the electrical specifications of RS232 EIA-232-E and CCITT V.28 while operating from a single + 5 V power supply. A voltage doubler and inverter convert the + 5V to  $\pm 10$  V. This is accomplished through an on-board 20 kHz oscillator and four inexpensive external electrolytic capacitors. The three drivers and three receivers of the ML145407 are virtually identical to those of the ML145406. Therefore, for applications requiring more than three drivers and/or three receivers, an ML145406 can be powered from an ML145407, since the ML145407 charge pumps have been designed to guarantee  $\pm 5$  V at the output of up to six drivers. Thus, the ML145407 provides a high-performance, low-power, stand-alone solution or, with the ML145406, a + 5 V only, high-performance two-chip solution.

**This device offers the following performance features:**

- Operating Temperature Range =  $T_A$   $-40^\circ$  to  $+85^\circ\text{C}$

#### Drivers

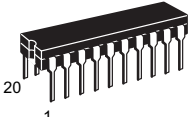
- $\pm 7.5$  V Output Swing
- $300\Omega$  Power-Off Impedance
- Output Current Limiting
- TTL and CMOS Compatible Inputs
- Slew Rate Range Limited from  $4\text{ V}/\mu\text{s}$  to  $30\text{ V}/\mu\text{s}$

#### Receivers

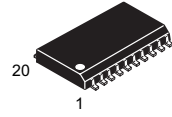
- + 25 V Input Range
- 3 to  $7\text{ k}\Omega$  Input Impedance
- 0.8 V Hysteresis for Enhanced Noise Immunity

#### Charge Pumps

- + 5 V to  $\pm 10$  V Dual Charge Pump Architecture
- Supply Outputs Capable of Driving Three On-Chip Drivers and Three Drivers on the ML145406 Simultaneously
- Requires Four Inexpensive Electrolytic Capacitors
- On-Chip 20 kHz Oscillator



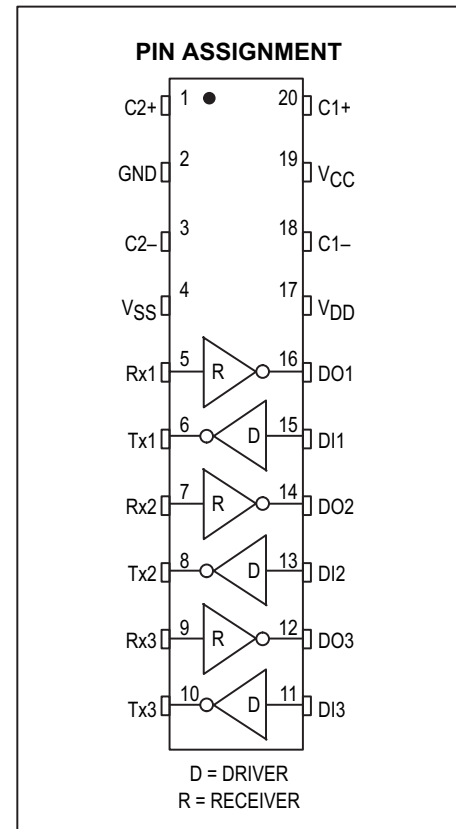
**P DIP 20 = RP**  
PLASTIC DIP  
CASE 738



**SOG 20 = -6P**  
SOG PACKAGE  
CASE 751D

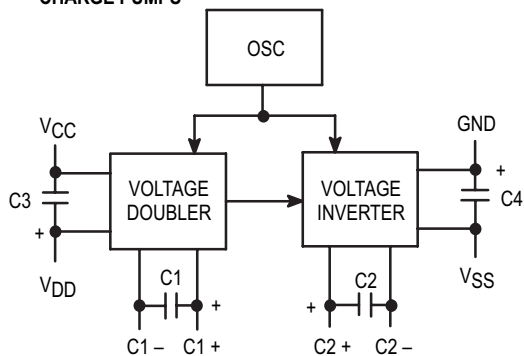
PACKAGE	MOTOROLA	LANSDALE
P DIP 20	MC145407P	ML145407RP
SOG 20	MC145407DW	ML145407-6P

**Note:** Lansdale lead free (Pb) product, as it becomes available, will be identified by a part number prefix change from **ML** to **MLE**.

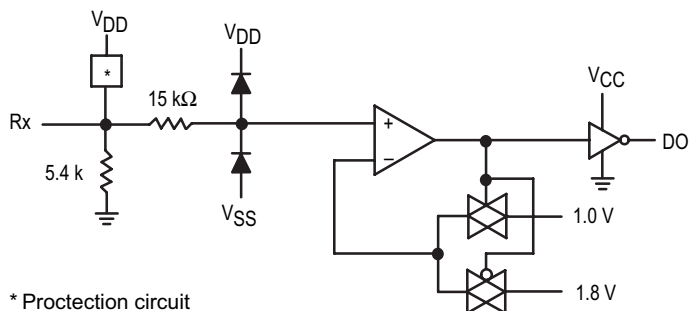


FUNCTION DIAGRAM

CHARGE PUMPS

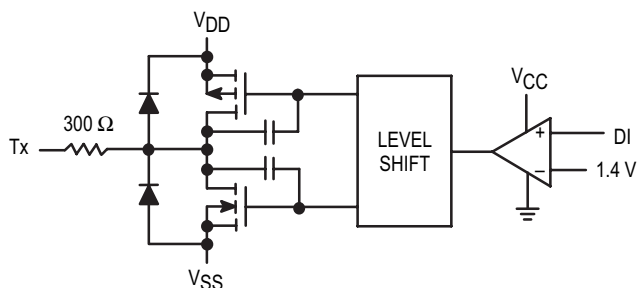


RECEIVER



\* Protection circuit

DRIVER



**MAXIMUM RATINGS** (Voltage polarities referenced to GND)

Rating	Symbol	Value	Unit
DC Supply Voltages	$V_{CC}$	- 0.5 to + 6.0	V
Input Voltage Range Rx1 – Rx3 Inputs DI1 – DI3 Inputs	$V_{IR}$	$V_{SS} - 15$ to $V_{DD} + 15$ - 0.5 to $(V_{CC} + 0.5)$	V
DC Current per Pin	I	$\pm 100$	mA
Power Dissipation	$P_D$	1	W
Operating Temperature Range	$T_A$	- 40 to + 85	C
Storage Temperature Range	$T_{stg}$	- 85 to + 150	C

This device contains protection circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation, it is recommended that the voltages at the DI and DO pins be constrained to the range  $GND \leq V_{DI} \leq V_{CC}$  and  $GND \leq V_{DO} \leq V_{CC}$ . Also, the voltage at the Rx pin should be constrained to  $(V_{SS} - 15 V) \leq V_{Rx1} - Rx3 \leq (V_{DD} + 15 V)$ , and Tx should be constrained to  $V_{SS} \leq V_{Tx1} - Tx3 \leq V_{DD}$ .

Unused inputs must always be tied to appropriate logic voltage level (e.g., GND or  $V_{CC}$  for DI, and GND for Rx).

**DC ELECTRICAL CHARACTERISTICS** (All polarities referenced to GND = 0 V; C1, C2, C3, C4 = 10 F;  $T_A = -40$  to + 85 C)

Parameter	Symbol	Min	Typ	Max	Unit	
DC Supply Voltage	$V_{CC}$	4.5	5	5.5	V	
Quiescent Supply Current (Outputs unloaded, inputs low)	$I_{CC}$	—	1.2	3.0	mA	
Output Voltage	$V_{DD}$	$I_{load} = 0$ mA	8.5	10	11	V
		$I_{load} = 5$ mA	7.5	9.5	—	
		$I_{load} = 10$ mA	6	9	—	
	$V_{SS}$	$I_{load} = 0$ mA	- 8.5	- 10	-11	
		$I_{load} = 5$ mA	- 7.5	- 9.2	—	
		$I_{load} = 10$ mA	- 6	- 8.6	—	

**RECEIVER ELECTRICAL SPECIFICATIONS**

(Voltage polarities referenced to GND = 0 V;  $V_{CC} = + 5 V \pm 10\%$ ; C1, C2, C3, C4 = 10 F;  $T_A = -40$  to + 85 C)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Turn-on Threshold $V_{DO1} - DO3 = V_{OL}$	$V_{on}$	1.35	1.8	2.35	V
Input Turn-off Threshold $V_{DO1} - DO3 = V_{OH}$	$V_{off}$	0.75	1.0	1.25	V
Input Threshold Hysteresis ( $V_{on} - V_{off}$ )	$V_{hys}$	0.6	0.8	—	V
Input Resistance	$R_{in}$	3.0	5.4	7.0	k $\Omega$
High-Level Output Voltage $V_{Rx1} - Rx3 = - 3 V$ to $- 25 V$ $I_{OH} = - 20$ A $I_{OH} = - 1$ mA	$V_{OH}$	$V_{CC} - 0.1$ $V_{CC} - 0.7$	— 4.3	—	V
Low-Level Output Voltage $V_{Rx1} - Rx3 = + 3 V$ to $+ 25 V$ $I_{OL} = + 20$ A $I_{OL} = + 1.6$ mA	$V_{OL}$	— —	0.01 0.5	0.1 0.7	V

**DRIVER ELECTRICAL SPECIFICATIONS**(Voltage polarities referenced to GND = 0 V;  $V_{CC} = +5\text{ V} \pm 10\%$ ; C1, C2, C3, C4 = 10 F;  $T_A = -40$  to  $+85\text{ C}$ )

Characteristic	Symbol	Min	Typ	Max	Unit
Digital Input Voltage Logic 0 Logic 1	DI1 – DI3 $V_{IL}$ $V_{IH}$	— 2.0	— —	0.8 —	V
Input Current $GND \leq V_{DI1} - DI3 \leq V_{CC}$	DI1 – DI3 $I_{in}$	—	—	$\pm 1.0$	A
Output High Voltage $V_{DI1} - DI3 = \text{Logic } 0, R_L = 3.0\text{ k}\Omega$	Tx1 – Tx3 Tx1 – Tx6*	6 5	7.5 6.5	— —	V
Output Low Voltage $V_{DI1} - DI3 = \text{Logic } 1, R_L = 3.0\text{ k}\Omega$	Tx1 – Tx3 Tx1 – Tx6*	-6 -5	-7.5 -6.5	— —	V
Off Source Impedance (Figure 1)	Tx1 – Tx3 $Z_{off}$	300	—	—	$\Omega$
Output Short-Circuit Current $V_{CC} = +5.5\text{ V}$	Tx1 – Tx3 Tx1 – Tx3 shorted to GND** Tx1 – Tx3 shorted to $\pm 15\text{ V}$ **	— —	— —	$\pm 60$ $\pm 100$	mA

\* Specifications for an ML145407 powering an ML145406 with three additional drivers/receivers.

\*\* Specification is for one Tx output pin to be shorted at a time. Should all three driver outputs be shorted simultaneously, device power dissipation limits could be exceeded.

\*\*\* This condition could exceed package limitations.

**SWITCHING CHARACTERISTICS** ( $V_{CC} = +5\text{ V} \pm 10\%$ ; C1, C2, C3, C4 = 10 F;  $T_A = -40$  to  $+85\text{ C}$ ; See Figures 2 and 3)

Characteristic	Symbol	Min	Typ	Max	Unit
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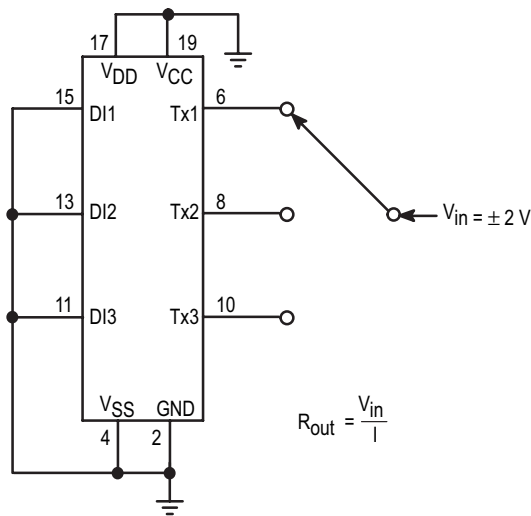
**Drivers**

Propagation Delay Time Low-to-High $R_L = 3\text{ k}\Omega, C_L = 50\text{ pF}$ or $2500\text{ pF}$ High-to-Low $R_L = 3\text{ k}\Omega, C_L = 50\text{ pF}$ or $2500\text{ pF}$	Tx1 – Tx3 $t_{PLH}$	—	0.5	1	s
	$t_{PHL}$	—	0.5	1	
Output Slew Rate Minimum Load: $R_L = 7\text{ k}\Omega, C_L = 0\text{ pF}$ Maximum Load: $R_L = 3\text{ k}\Omega, C_L = 2500\text{ pF}$	Tx1 – Tx3 SR	—	9.0	$\pm 30$	V/ s
		4.0	—	—	

**Receivers** ( $C_L = 50\text{ pF}$ )

Propagation Delay Time Low-to-High High-to-Low	DO1 – DO3 $t_{PLH}$	—	—	1	s
	$t_{PHL}$	—	—	1	
Output Rise Time	DO1 – DO3 $t_r$	—	250	400	ns
Output Fall Time	DO1 – DO3 $t_f$	—	40	100	ns

**PIN DESCRIPTIONS**



**Figure 1. Power-Off Source Resistance**

**VCC  
Digital Power Supply (Pin 19)**

The digital supply pin, which is connected to the logic power supply. This pin should have a 0.33 μF capacitor to ground.

**GND  
Ground (Pin 2)**

Ground return pin is typically connected to the signal ground pin of the EIA-232-E connector (Pin 7) as well as to the logic power supply ground.

**VDD  
Positive Power Supply (Pin 17)**

This is the positive output of the on-chip voltage doubler and the positive power supply input of the driver/receiver sections of the device. This pin requires an external storage capacitor to filter the 50% duty cycle voltage generated by the charge pump.

**VSS  
Negative Power Supply (Pin 4)**

This is the negative output of the on-chip voltage doubler/inverter and the negative power supply input of the driver/receiver sections of the device. This pin requires an external storage capacitor to filter the 50% duty cycle voltage generated by the charge pump.

**C2+, C2-, C1-, C1+  
Voltage Doubler and Inverter (Pins 1, 3, 18, 20)**

These are the connections to the internal voltage doubler and inverter, which generate the VDD and VSS voltages.

**Rx1, Rx2, Rx3  
Receive Data Input (Pins 5, 7, 9)**

These are the EIA-232-E receive signal inputs. A voltage between + 3 and + 25 V is decoded as a space and causes the corresponding DO pin to swing to ground (0 V). A voltage between - 3 and - 25 V is decoded as a mark, and causes the DO pin to swing up to VCC.

**DO1, DO2, DO3  
Data Output (Pins 16, 14, 12)**

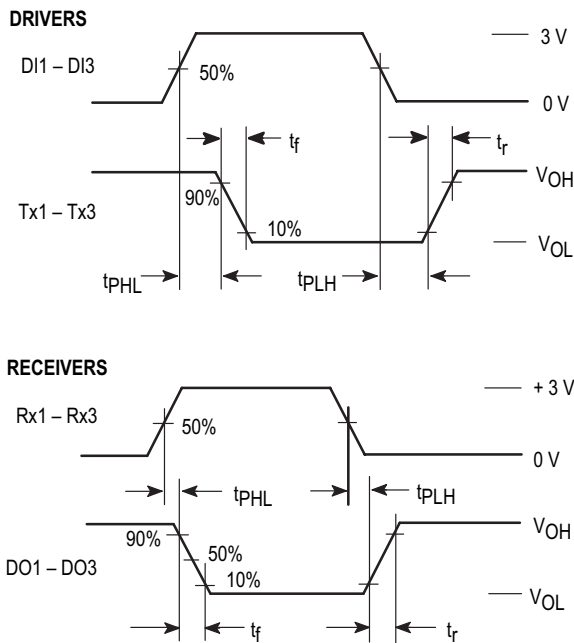
These are the receiver digital output pins, which swing from VCC to GND. Each output pin is capable of driving one LSTTL input load.

**DI1, DI2, DI3  
Data Input (Pins 15, 13, 11)**

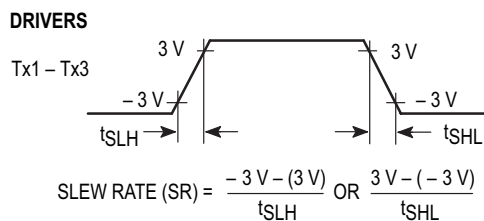
These are the high impedance digital input pins to the drivers. Input voltage levels on these pins must be between VCC and GND.

**Tx1, Tx2, Tx3  
Transmit Data Output (Pins 6, 8, 10)**

These are the EIA-232-E transmit signal output pins, which swing toward VDD and VSS. A logic 1 at a DI input causes the corresponding Tx output to swing toward VSS. A logic 0 causes the output to swing toward VDD. The actual levels and slew rate achieved will depend on the output loading (RL/CL).



**Figure 2. Switching Characteristics**



**Figure 3. Slew Rate Characterization**

**ESD CONSIDERATIONS**

ESD protection on IC devices that have their pins accessible to the outside world is essential. High static voltages applied to the pins when someone touches them either directly or indirectly can cause damage to gate oxides and transistor junctions by coupling a portion of the energy from the I/O pin to the power supply busses of the IC. This coupling will usually occur through the internal ESD protection diodes. The key to protecting the IC is to shunt as much of the energy to ground as possible before it enters the IC. Figure 7 shows a technique which will clamp the ESD voltage at approximately + 15 V using the MMBZ15VDLT1. Any residual voltage which appears on the supply pins is shunted to ground through the 0.1  $\mu$ F capacitors.

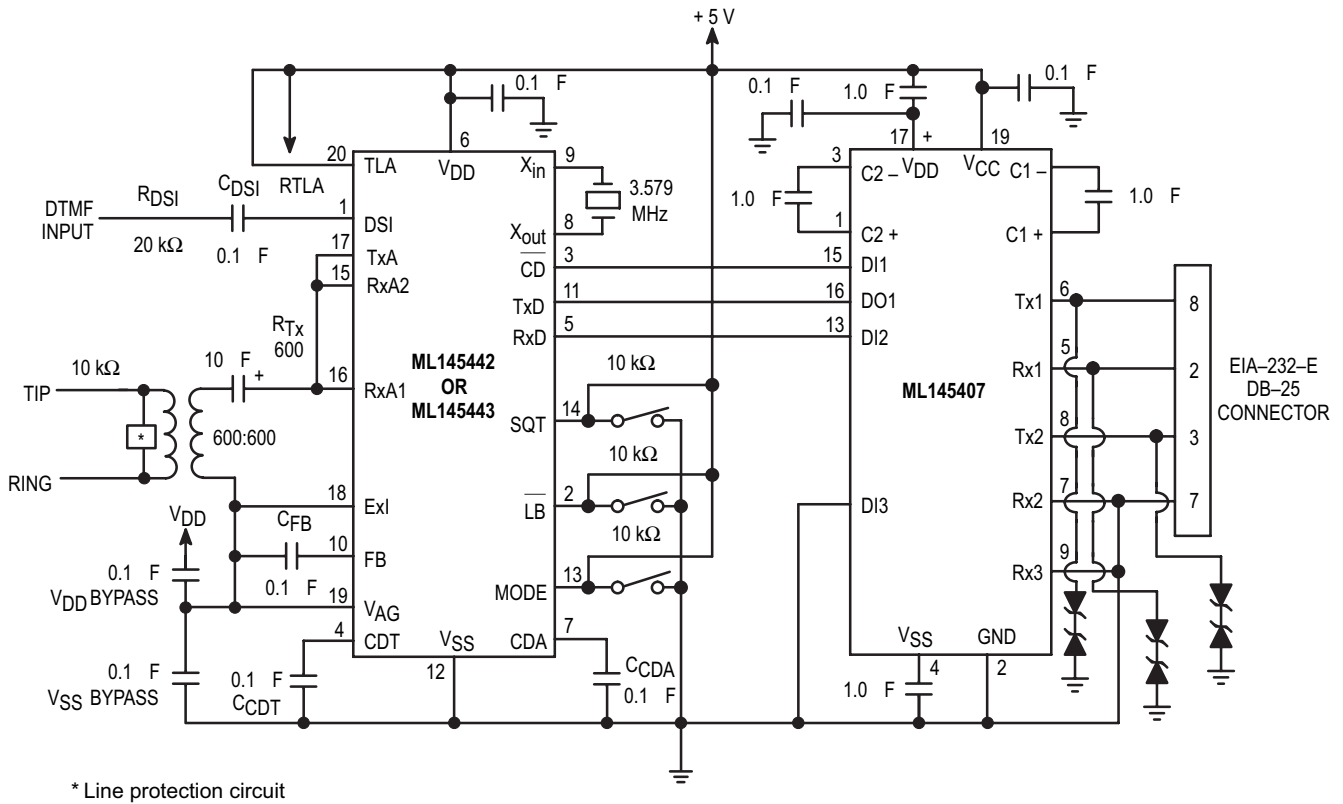
**OPERATION WITH SMALLER VALUE CHARGE PUMP CAPS**

The ML145407 is characterized in the electrical tables using

10  $\mu$ F charge pump caps to illustrate its capability in driving a companion ML145406 or ML145403. If there is no requirement to support a second interface device and/or the charge pump is not being used to power any other components, the ML145407 is capable of complying with EIA-232-E and V.28 with smaller value charge pump caps. Table 1 summarizes driver performance with both 2.2  $\mu$ F and 1.0  $\mu$ F charge pump caps.

**Table 1. Typical Performance**

Parameter	2.2 F	1.0 F
Tx VOH @ 25 C	7.3	7.2
Tx VOH @ 85 C	7.2	7.1
Tx VOL @ 25 C	- 6.5	- 6.4
Tx VOL @ 85 C	- 6.1	- 6.0
Tx Slew Rate @ 25 C	8.0 V/ s	8.0 V/ s
Tx Slew Rate @ 85 C	7.0 V/ s	7.0 V/ s



**Figure 4. 5 V, 300 Baud Modem with EIA-232-E Interface**

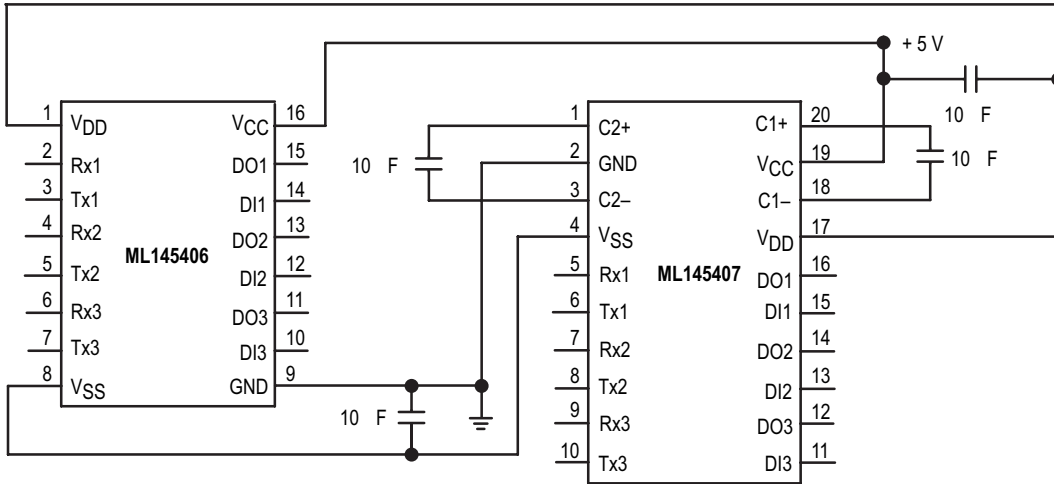


Figure 5. ML145406/ML145407 5 V Only Solution for up to Six EIA-232-E Drivers and Receivers

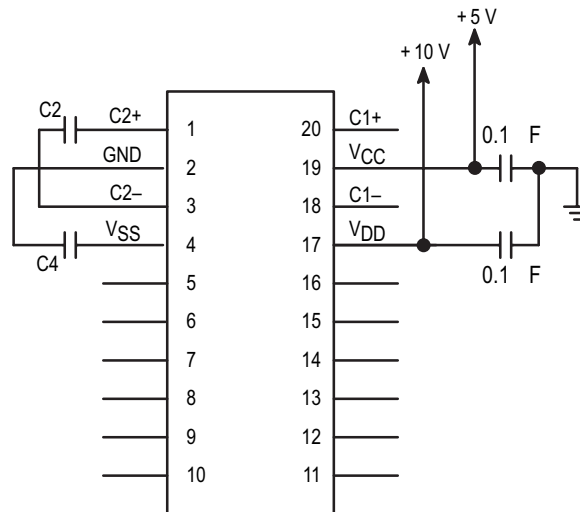


Figure 6. Two Supply Configuration (ML145407 Generates VSS Only)

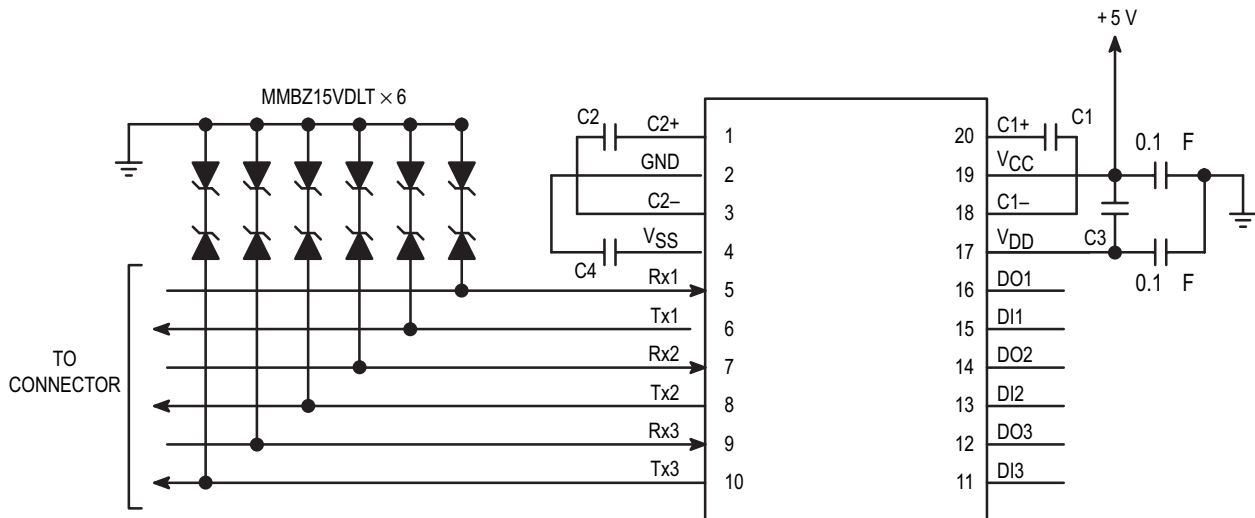
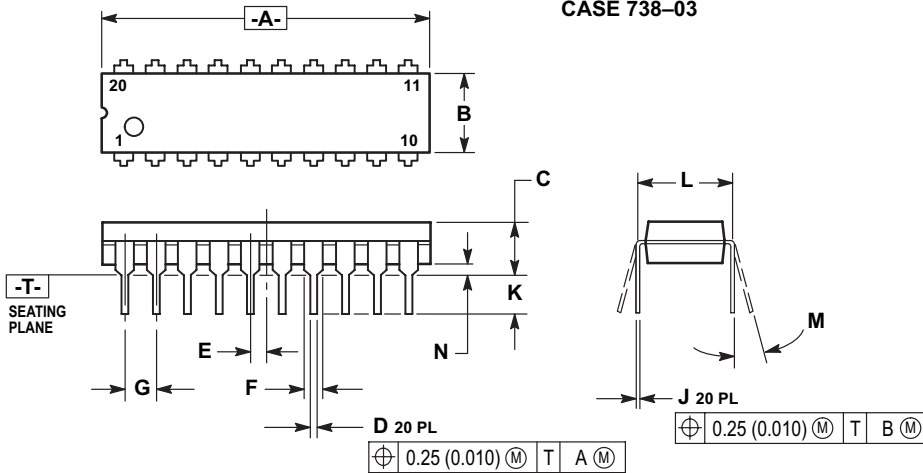


Figure 7. ESD Protection Scheme

OUTLINE DIMENSIONS

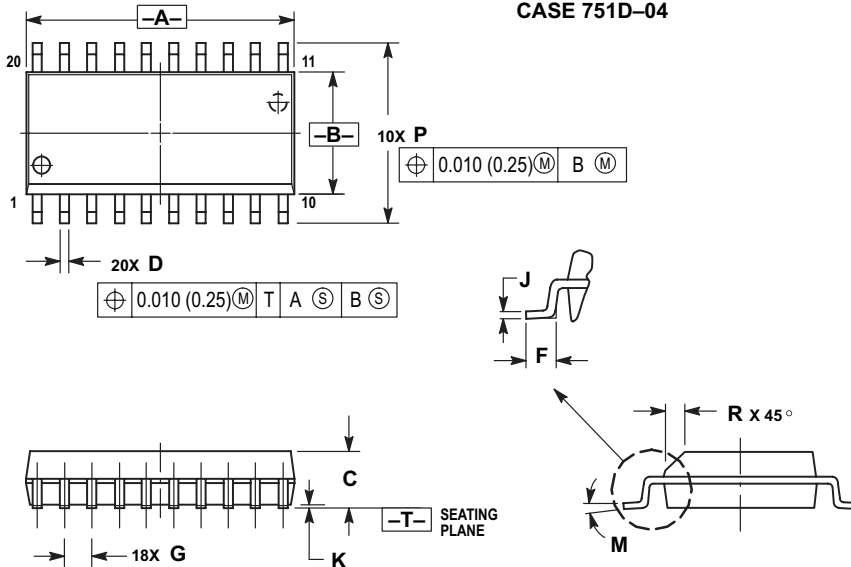
**P DIP 20 = RP  
(ML145407RP)  
PLASTIC DIP  
CASE 738-03**



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
  4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.010	1.070	25.66	27.17
B	0.240	0.260	6.10	6.60
C	0.150	0.180	3.81	4.57
D	0.015	0.022	0.39	0.55
E	0.050 BSC		1.27 BSC	
F	0.050	0.070	1.27	1.77
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.140	2.80	3.55
L	0.300 BSC		7.62 BSC	
M	0	15	0	15
N	0.020	0.040	0.51	1.01

**SOG 20 = -6P  
(ML145407-6P)  
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	INCHES		MILLIMETERS	
	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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