

Logic Diagram

### FEATURES:

- 14-bit resolution and accuracy
- Total dose hardness:
  - > 100 krad (Si), depending upon space mission
- Single event effects:
  - SEL > 104 MeV/mg/cm<sup>2</sup>
  - SEU<sub>TH</sub> = 1.4 MeV/mg/cm<sup>2</sup>
  - SEU<sub>Sat</sub> = 1E-3 cm<sup>2</sup>/Device
- Package:
  - 16 pin RAD-PAK® flat package
  - 16 pin RAD-PAK® dual-in-line package
- Fast Conversion Times: 10 μs
- Low 50 mW typical power consumption
- High speed LC<sup>2</sup>MOS technology
  - Analog input range of ±3V
  - 83 KSPS throughput rate
  - Operates with +5V/-5V power supplies
  - 80 dB SNR at 10 kHz input frequency
  - 2 s complement coding
  - Serial output

### DESCRIPTION:

Maxwell Technologies' 7872 high-speed 14-bit ADC microcircuit features a greater than 100 krad (Si) total dose tolerance; depending upon orbit. The 7872 consists of a track/hold amplifier, successive-approximation ADC, 3V buried Zener reference and versatile interface logic. It features a self-contained, laser-trimmed internal clock, so no external clock timing components are required. For minimum noise possible, the on-chip clock may be overridden to synchronize the device operation to the digital system. The 7872 is a serial output device. It is capable of interfacing to all modern microprocessors and digital signal processors. The 7872 operates from ±5V power supplies, accepts bipolar input signals of ±3V and is able to convert full power signals up to 41.5 kHz. It is also fully specified for dynamic performance parameters including distortion and signal-to-noise ratio.

Maxwell Technologies' patented RAD-PAK® packaging technology incorporates radiation shielding in the microcircuit package. It eliminates the need for box shielding while providing the required radiation shielding for a lifetime in orbit or space mission. In a GEO orbit, RAD-PAK provides greater than 100 krad (Si) radiation dose tolerance. This product is available with screening up to Class S.

TABLE 1. 7872 PIN DESCRIPTION

PIN	SIGNAL	DESCRIPTION
1	CONTROL	Control Function
2	$\overline{\text{CONVST}}$	Convert Start
3	CLK	Clock Input
4	$\overline{\text{SSTRB}}$	Serial Strobe
5	SCLK	Serial Clock
6	SDATA	Serial Data
7	NC	Non Connect
8	DGND	Digital Ground
9	V <sub>DD</sub>	Positive Supply
10	NC	No Connect
11	C <sub>REF</sub>	Reference Capacitor
12	AGND	Analog Ground
13	REF <sub>OUT</sub>	Voltage Reference Output
14	V <sub>IN</sub>	Analog Input
15	V <sub>SS</sub>	Negative Supply
16	V <sub>DD</sub>	Positive Supply

TABLE 2. 7872 ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Positive Supply Voltage; Relative to GND	V <sub>DD</sub>	-0.3	7.0	V
Negative Supply Voltage; Relative to GND	V <sub>SS</sub>	0.3	7.0	V
AGND to DGND; Relative to GND	--	-0.3	V <sub>DD</sub> +0.3	V
REF <sub>OUT</sub> , C <sub>REF</sub> to AGND	--	0	V <sub>DD</sub>	V
V <sub>IN</sub> to AGND	--	V <sub>SS</sub> -0.3	V <sub>DD</sub> +0.3	V
Digital Input Voltage	V <sub>IN</sub>	-0.3	V <sub>DD</sub> +0.3	V
Digital Output Voltage	V <sub>OUT</sub>	-0.3	V <sub>DD</sub> +0.3	V
Thermal Impedance	$\Theta_{\text{JC}}$	--	2.44	°C/W
Storage Temperature Range	T <sub>S</sub>	-65	150	°C
Operating Temperature Range	T <sub>A</sub>	-55	125	°C

TABLE 3. 7872 DC ELECTRICAL CHARACTERISTICS FOR DYNAMIC PERFORMANCE <sup>1</sup>  
 ( $V_{DD} = 5V \pm 5\%$ ,  $V_{SS} = -5V \pm 5\%$ ,  $AGND = DGND = 0V$ ,  $f_{CLK} = 2\text{ MHz EXTERNAL}$ ,  $f_{SAMPLE} = 83\text{ kHz}$ ,  $-55\text{ TO }125\text{ }^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Signal to Noise Ratio $V_{IN} = 10\text{kHz Sine Wave}$ , $T_{MIN}$ to $T_{MAX}$ SNR is typically 82dB for $V_{IN} < 41.5\text{kHz}$ <sup>2</sup>	SNR	79	--	--	dB
Total Harmonic Distortion $V_{IN} = 10\text{kHz Sine Wave}$	THD	--	-86	--	dB
Peak Harmonic or Spurious Noise	--	--	-86	--	dB
Intermodulation Distortion Second Order Terms: $f_a = 9\text{ kHz}$ , $f_b = 9.5\text{ kHz}$ , $f_{SAMPLE} = 50\text{ kHz}$ Third Order Terms: $f_a = 9\text{ kHz}$ , $f_b = 9.5\text{ kHz}$ , $f_{SAMPLE} = 50\text{ kHz}$	IMD	--	-86	--	dB
Track/Hold Acquisition Time	--	--	--	2	$\mu\text{s}$

1.  $V_{IN} = \pm 3V$ . Guaranteed by design.
2. SNR calculation includes distortion and noise components.

TABLE 4. 7872 DC ELECTRICAL CHARACTERISTICS FOR ACCURACY  
 ( $V_{DD} = 5V \pm 5\%$ ,  $V_{SS} = -5V \pm 5\%$ ,  $T_A = -55\text{ TO }125\text{ }^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Resolution	--	14	--	--	Bits
Resolution for Which No Missing Codes are Guaranteed	--	14	--	--	Bits
Integral Nonlinearity @ $25\text{ }^\circ\text{C}$	--	--	$\pm 1$	--	LSB
Integral Nonlinearity $T_{MIN}$ to $T_{MAX}$	--	--	--	$\pm 2$	LSB
Bipolar Zero Error	--	--	--	$\pm 12$	LSB
Positive Gain Error <sup>1</sup>	--	--	--	$\pm 12$	LSB
Negative Gain Error <sup>1</sup>	--	--	--	$\pm 12$	LSB

1. Measured with respect to internal reference.

TABLE 5. 7872 DC ELECTRICAL CHARACTERISTICS FOR ANALOG INPUT  
 ( $V_{DD} = 5V \pm 5\%$ ,  $V_{SS} = -5V \pm 5\%$ ,  $T_A = -55\text{ TO }125\text{ }^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	MAX	UNITS
Input Voltage Range	--	-3	3	V
Input Current	--	-500	500	$\mu\text{A}$

TABLE 6. 7872 DC ELECTRICAL CHARACTERISTICS FOR REFERENCE OUTPUT

 $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ } ^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	MAX	UNIT
REF <sub>OUT</sub> @ +25 °C	--	2.99	3.01	V
REF <sub>OUT</sub> T <sub>MIN</sub> to T <sub>MAX</sub>	--	2.98	3.02	V
REF <sub>OUT</sub> Tempco: Typically 35ppm	--	--	±40	ppm/°C
Reference Load Sensitivity (DREF <sub>OUT</sub> /DI) Reference Load Current Change (0-300 µA); Reference Load Should Not Be Changed During Conversion	--	--	1.2	mV

TABLE 7. 7872 DC ELECTRICAL CHARACTERISTICS FOR LOGIC INPUTS

 $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ } ^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Input High Voltage: V <sub>DD</sub> 5 V ± 5%	V <sub>INH</sub>	2.4	--	V
Input Low Voltage: V <sub>DD</sub> 5 V ± 5%	V <sub>INL</sub>	--	0.8	V
Input Current: V <sub>IN</sub> = 0 V to V <sub>DD</sub>	I <sub>IN</sub>	-10	10	µA
Input Current: (14/8/CLK input only) VIN = VSS to VDD	--	-10	10	µA
Input Capacitance <sup>1</sup>	C <sub>IN</sub>	--	10	pF

1. Not tested.

TABLE 8. 7872 DC ELECTRICAL CHARACTERISTICS FOR LOGIC OUTPUTS

 $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ } ^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Output High Voltage I <sub>SOURCE</sub> = 40 µA	V <sub>OH</sub>	4.0	--	V
Output Low Voltage I <sub>SINK</sub> = 1.6 mA	V <sub>OL</sub>	--	0.4	V
Floating-State Leakage Current	--	--	10	µA
Floating-State Output Capacitance <sup>1</sup>	--	--	15	pF

1. Not tested.

TABLE 9. 7872 DC ELECTRICAL CHARACTERISTICS FOR CONVERSION TIME

 $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ } ^\circ\text{C}$  UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	MIN	MAX	UNIT
External Clock	--	--	10	µs
Internal Clock: Nominal Value = 2 MHz	--	--	11	µs

TABLE 10. 7872 DC ELECTRICAL CHARACTERISTICS FOR POWER REQUIREMENTS

 $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ }^\circ\text{C UNLESS OTHERWISE SPECIFIED})$ 

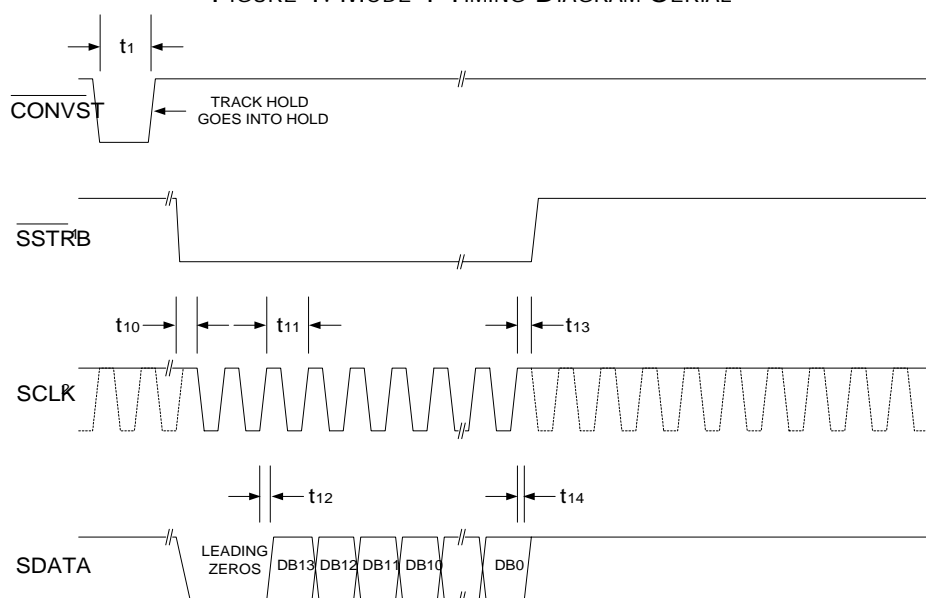
PARAMETER	SYMBOL	CONDITIONS	REQUIREMENTS	UNITS
Positive Supply Voltage	$V_{DD}$	5% for Specified Performance	5	V
Negative Supply Voltage	$V_{SS}$	5% for Specified Performance	-5	V
Positive Supply Current	$I_{DD}$	Typically 6mA	13	mA max
Negative Supply Current	$I_{SS}$	Typically 4mA	6	mA max
Power Dissipation	$P_D$	Typically 50mW	95	mW max

TABLE 11. 7872 TIMING CHARACTERISTICS <sup>1,2</sup> $(V_{DD} = 5V \pm 5\%, V_{SS} = -5V \pm 5\%, T_A = -55 \text{ TO } 125 \text{ }^\circ\text{C UNLESS OTHERWISE SPECIFIED})$ 

PARAMETER/CONDITION	SYMBOL	MIN	MAX	UNITS
$\overline{\text{CONVST}}$ Pulse Width	$t_1$	50	--	ns
$\overline{\text{SSTRB}}$ to SCLK Falling Edge Setup Time	$t_{10}$	100	--	ns
SCLK Cycle Time <sup>3</sup>	$t_{11}$	440	--	ns
SCLK to Valid Data Delay: $C_L = 35 \text{ pF}$ <sup>4</sup>	$t_{12}$	--	155	ns
SCLD Rising Edge to $\overline{\text{SSTRB}}$	$t_{13}$	20	150	ns
Bus Relinquish Time After SCLK	$t_{14}$	4	100	ns

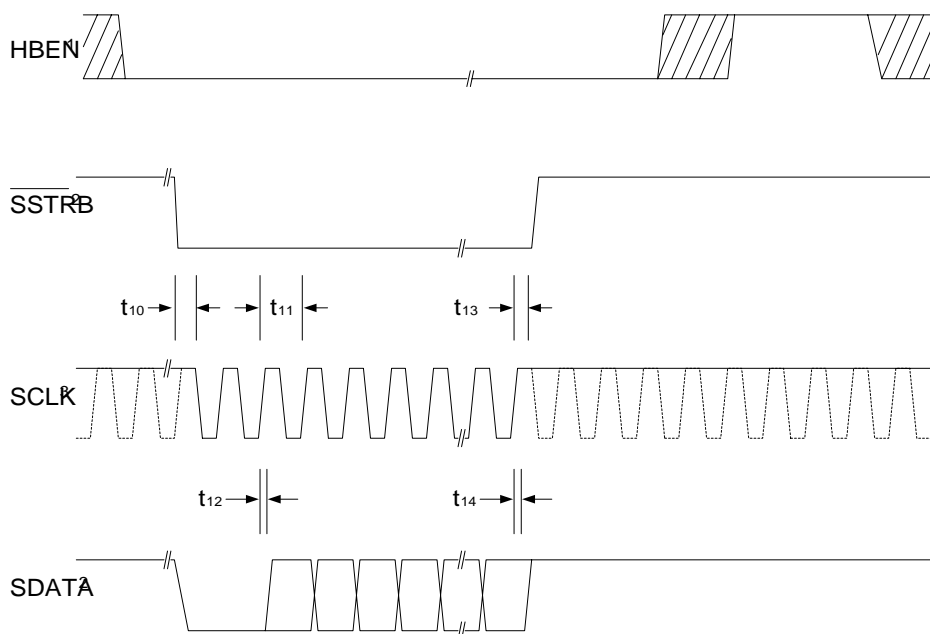
1. All input signals are specified with  $t_r = t_f = 5 \text{ ns}$  (10% to 90% of 5 V) and timed from a voltage level of 1.6 V.
2. Serial timing is measured with a  $4.7 \text{ k}\Omega$  pull-up resistor on SDATA and  $\overline{\text{SSTRB}}$  and a  $2 \text{ k}\Omega$  pull-up resistor on SCLK. The capacitance on all three outputs is 35 pF.
3. SCLK mark/space ration (measured from a voltage level of 1.6 V) is 40/60 to 60/40.
4. SDATA will drive higher capacitive loads, but this will add to  $t_{12}$  since it increases the external RC time constant ( $4.7\text{k}\Omega/C_L$ ) and hence, the time to reach 2.4 V.

### FIGURE 1. MODE 1 TIMING DIAGRAM SERIAL



1. External 4.7 k $\Omega$  pull-up resistor.
2. External 2 k $\Omega$  pull-up resistor continuous SCLK (DASHED LINE) when 14/8/CLK (CONTROL) = -5 V; noncontinuous when 14/8/CLK (CONTROL) = 0 V.

### FIGURE 2. MODE 2 TIMING DIAGRAM, SERIAL READ



1. Times t15, t18, t19 and t20 are the same for a high byte read as for a low byte read.
2. External 4.7 k $\Omega$  pull-up resistor.
3. Continuous SCLK (DASHED LINE) when 14/8/CLK (CONTROL) = -5 V; noncontinuous when 14/8/CLK (CONTROL) = 0 V. External 2 k $\Omega$  pull-up resistor.

FIGURE 3. LOAD CIRCUIT FOR ACCESS TIME

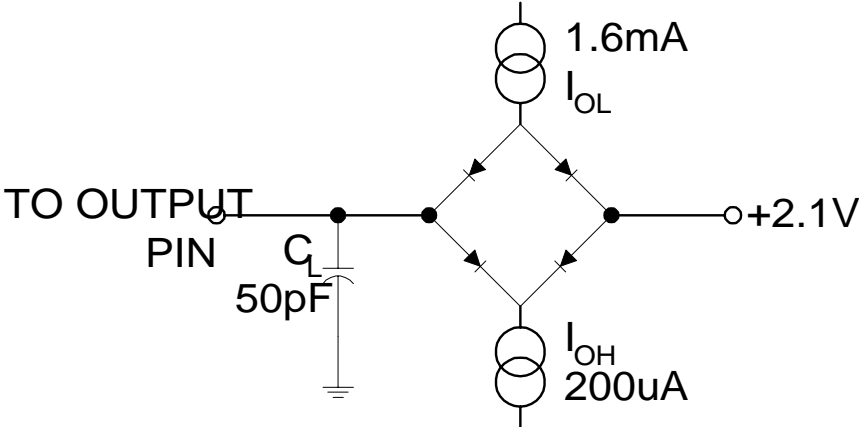
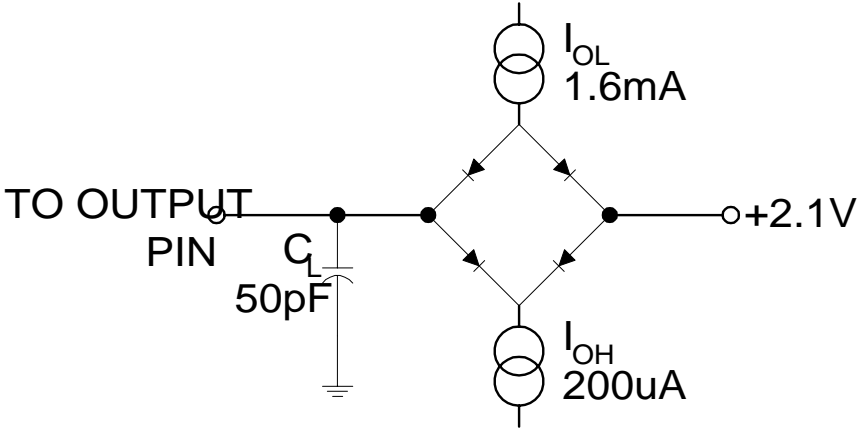
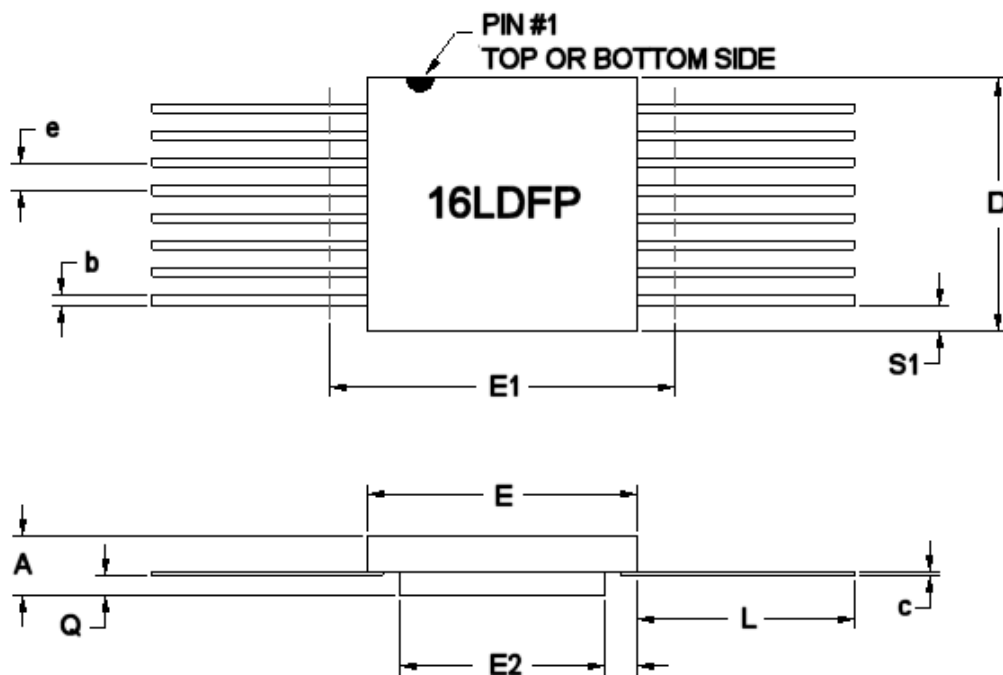


FIGURE 4. LOAD CIRCUIT FOR OUTPUT FLOAT DELAY





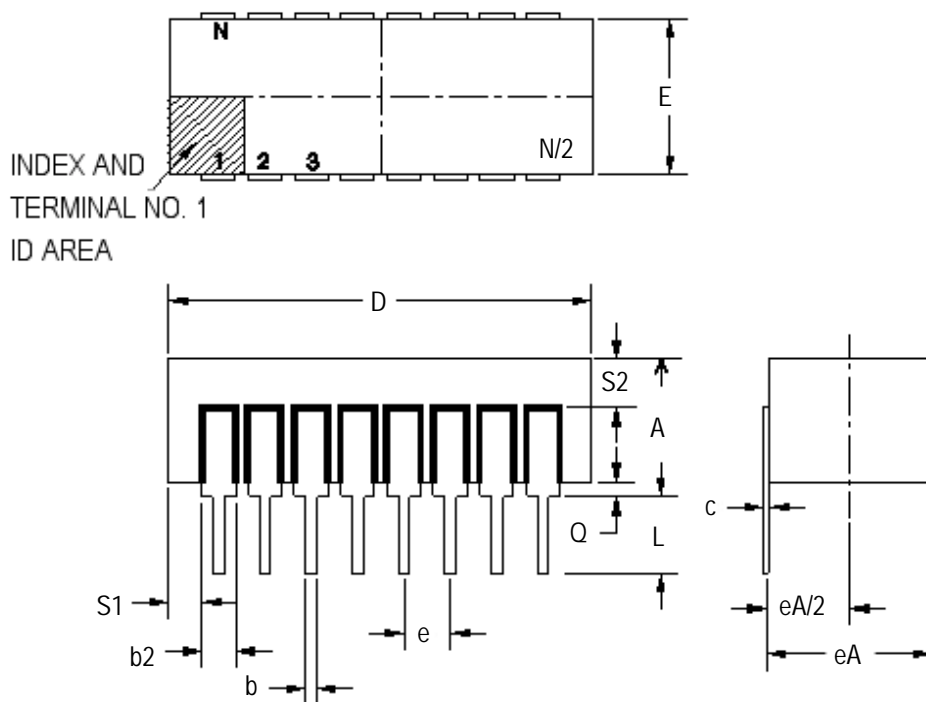
16 PIN RAD-PAK® FLAT PACKAGE

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	0.116	0.130	0.143
b	0.015	0.017	0.022
c	0.004	0.005	0.009
D	--	0.415	0.440
E	0.245	0.280	0.285
E1	--	--	0.315
E2	0.130	0.156	--
E3	0.030	0.062	--
e	0.050 BSC		
L	0.325	0.335	0.345
Q	0.020	0.033	0.045
S1	0.005	0.024	--
N	16		

F16-01

Note: All dimensions in inches





16 PIN RAD-PAK® DUAL IN LINE PACKAGE

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	--	0.157	0.200
b	0.014	0.018	0.026
b2	0.045	0.047	0.065
c	0.008	0.010	0.018
D	--	0.800	0.840
E	0.220	0.295	0.310
eA	0.300 BSC		
eA/2	0.150 BSC		
e	0.100 BSC		
L	0.135	0.145	0.155
Q	0.000	0.002	0.060
S1	0.005	0.027	--
S2	0.005	--	--
N	16		

D16-01

Note: All dimensions in inches

## Important Notice:

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