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74LCX821

Low Voltage 10-Bit D-Type Flip-Flop with 5V Tolerant Inputs and Outputs

General Description

The LCX821 consists of ten D-type Flip-Flops with 3-STATE outputs for bus organized system applications. The device is designed for low voltage (2.5V or 3.3V) V_{CC} applications with capability of interfacing to a 5V signal environment.

The LCX821 is fabricated with an advanced CMOS technology to achieve high speed operation while maintaining CMOS low power dissipation.

Features

- 5V tolerant inputs and outputs
- 2.3V–3.6V V_{CC} specifications provided
- 7.0 ns t_{PD} max ($V_{CC} = 3.3V$), 10 μA I_{CC} max
- Power-down high impedance inputs and outputs
- Supports live insertion/withdrawal (Note 1)
- ± 24 mA output drive ($V_{CC} = 3.0V$)
- Implements patented noise/EMI reduction circuitry
- Latch-up performance exceeds 500 mA
- ESD performance:
 - Human Body Model > 2000V
 - Machine Model > 200V

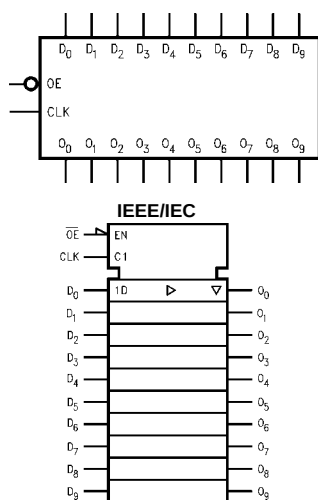
Note 1: To ensure the high-impedance state during power up or down, $\overline{OE}$ should be tied to V_{CC} through a pull-up resistor; the minimum value or the resistor is determined by the current-sourcing capability of the driver.

Ordering Code:

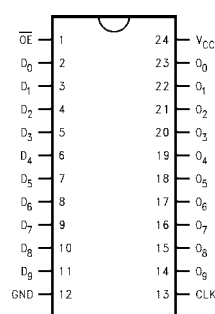
Order Number	Package Number	Package Description
74LCX821WM	M24B	24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
74LCX821MSA	MSA24	24-Lead Shrink Small Outline Package (SSOP), EIAJ TYPE II, 5.3mm Wide
74LCX821MTC	MTC24	24-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide

Devices also available in Tape and Reel. Specify by appending the suffix "X" to the ordering code.

Logic Symbols



Connection Diagram



Pin Descriptions

Pin Names	Description
D ₀ –D ₉	Data Inputs
CLK	Clock Input
$\overline{OE}$	Output Enable Input
O ₀ –O ₉	3-STATE Latch Outputs

Function Table

Inputs			Internal	Outputs	Function
$\overline{OE}$	CLK	D	Q	O _n	
H	H	L	NC	Z	Hold
H	H	H	NC	Z	Hold
H	$\nearrow$	L	L	Z	Load
H	$\nearrow$	H	H	Z	Load
L	$\nearrow$	L	L	L	Data Available
L	$\nearrow$	H	H	H	Data Available
L	H	L	NC	NC	No Change in Data
L	H	H	NC	NC	No Change in Data

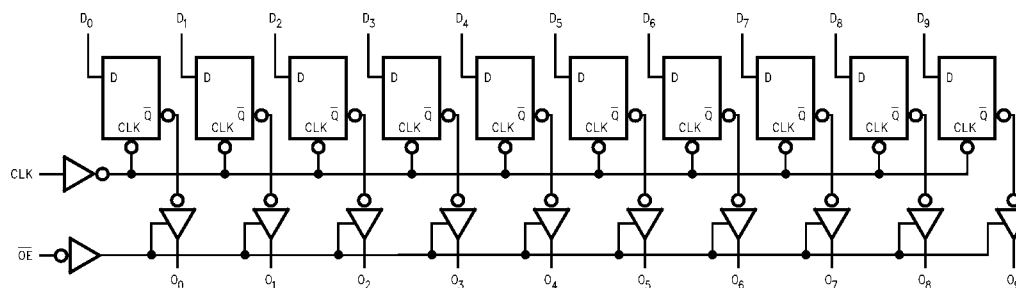
H = HIGH Voltage Level
 L = LOW Voltage Level
 X = Immaterial
 Z = High Impedance
 $\nearrow$ = LOW-to-HIGH Transition
 NC = No Change

Functional Description

The LCX821 consists of ten edge-triggered flip-flops with individual D-type inputs with 3-STATE true outputs. The buffered clock and buffered Output Enable are common to all flip-flops. The ten flip-flops will store the state of their individual D inputs that meet the setup and hold time

requirements on the LOW-to-HIGH Clock (CLK) transition. With the Output Enable ($\overline{OE}$) LOW, the contents of the ten flip-flops are available at the outputs. When $\overline{OE}$ is HIGH, the outputs go to the high impedance state. Operation of the $\overline{OE}$ input does not affect the state of the flip-flops.

Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings ^(Note 2)				
Symbol	Parameter	Value	Conditions	Units
V _{CC}	Supply Voltage	−0.5 to +7.0		V
V _I	DC Input Voltage	−0.5 to +7.0		V
V _O	DC Output Voltage	−0.5 to +7.0 −0.5 to V _{CC} + 0.5	Output in 3-STATE Output in HIGH or LOW State (Note 3)	V
I _{IK}	DC Input Diode Current	−50	V _I < GND	mA
I _{OK}	DC Output Diode Current	−50 +50	V _O < GND V _O > V _{CC}	mA
I _O	DC Output Source/Sink Current	±50		mA
I _{CC}	DC Supply Current per Supply Pin	±100		mA
I _{GND}	DC Ground Current per Ground Pin	±100		mA
T _{STG}	Storage Temperature	−65 to +150		°C

Recommended Operating Conditions ^(Note 4)

Symbol	Parameter	Min	Max	Units	
V _{CC}	Supply Voltage	Operating	2.0	3.6	V
		Data Retention	1.5	3.6	
V _I	Input Voltage	0	5.5	V	
V _O	Output Voltage	HIGH or LOW State	0	V _{CC}	V
		3-STATE	0	5.5	
I _{OH} /I _{OL}	Output Current	V _{CC} = 3.0V – 3.6V V _{CC} = 2.7V – 3.0V V _{CC} = 2.3V – 2.7V		±24 ±12 ±8	mA
T _A	Free-Air Operating Temperature	−40	85	°C	
Δt/ΔV	Input Edge Rate, V _{IN} = 0.8V – 2.0V, V _{CC} = 3.0V	0	10	ns/V	

Note 2: The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the Absolute Maximum Ratings. The “Recommended Operating Conditions” table will define the conditions for actual device operation.

Note 3: I_O Absolute Maximum Rating must be observed.

Note 4: Unused inputs must be held HIGH or LOW. They may not float.

DC Electrical Characteristics

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = −40°C to +85°C		Units
				Min	Max	
V _{IH}	HIGH Level Input Voltage		2.3 – 2.7	1.7		V
			2.7 – 3.6	2.0		
V _{IL}	LOW Level Input Voltage		2.3 – 2.7		0.7	V
			2.7 – 3.6		0.8	
V _{OH}	HIGH Level Output Voltage	I _{OH} = −100 μA	2.3 – 3.6	V _{CC} − 0.2		V
		I _{OH} = −8 mA	2.3	1.8		
		I _{OH} = −12 mA	2.7	2.2		
		I _{OH} = −18 mA	3.0	2.4		
		I _{OH} = −24 mA	3.0	2.2		
V _{OL}	LOW Level Output Voltage	I _{OL} = 100 μA	2.3 – 3.6		0.2	V
		I _{OL} = 8 mA	2.3		0.6	
		I _{OL} = 12 mA	2.7		0.4	
		I _{OL} = 16 mA	3.0		0.4	
		I _{OL} = 24 mA	3.0		0.55	
I _I	Input Leakage Current	0 ≤ V _I ≤ 5.5V	2.3 – 3.6		±5.0	μA
I _{OZ}	3-STATE Output Leakage	0 ≤ V _O ≤ 5.5V V _I = V _{IH} or V _{IL}	2.3 – 3.6		±5.0	μA
I _{OFF}	Power-Off Leakage Current	V _I or V _O = 5.5V	0		10	μA

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	V _{CC} (V)	T _A = -40°C to +85°C		Units
				Min	Max	
I _{CC}	Quiescent Supply Current	V _I = V _{CC} or GND	2.3 – 3.6		10	μA
		3.6V ≤ V _I , V _O ≤ 5.5V (Note 5)	2.3 – 3.6		±10	
ΔI _{CC}	Increase in I _{CC} per Input	V _{IH} = V _{CC} – 0.6V	2.3 – 3.6		500	μA

Note 5: Outputs disabled or 3-STATE only.

AC Electrical Characteristics

Symbol	Parameter	T _A = -40°C to +85°C, R _L = 500Ω						Units
		V _{CC} = 3.3V ± 0.3V		V _{CC} = 2.7V		V _{CC} = 2.5V ± 0.2V		
		C _L = 50 pF		C _L = 50 pF		C _L = 30 pF		
		Min	Max	Min	Max	Min	Max	
f _{MAX}	Maximum Clock Frequency	150						MHz
t _{PHL}	Propagation Delay	1.5	7.0	1.5	7.5	1.5	8.4	ns
t _{PLH}	CLK to O _n	1.5	7.0	1.5	7.5	1.5	8.4	
t _{PZL}	Output Enable Time	1.5	7.5	1.5	8.0	1.5	9.8	ns
t _{PZH}		1.5	7.5	1.5	8.0	1.5	9.8	
t _{PLZ}	Output Disable Time	1.5	6.5	1.5	7.0	1.5	7.8	ns
t _{PHZ}		1.5	6.5	1.5	7.0	1.5	7.8	
t _{OSHL}	Output to Output Skew		1.0					ns
t _{OSLH}	(Note 6)		1.0					
t _S	Setup Time, D _n to CLK	2.5		2.5		4.0		ns
t _H	Hold Time, D _n to CLK	1.5		1.5		2.0		ns
t _W	CLK Pulse Width	3.3		3.3		4.0		ns

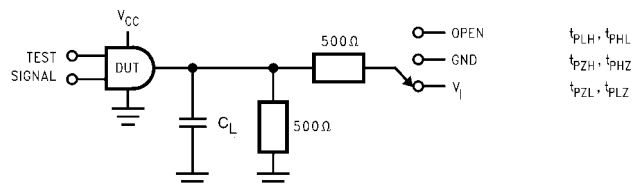
Note 6: Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device. The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}).

Dynamic Switching Characteristics

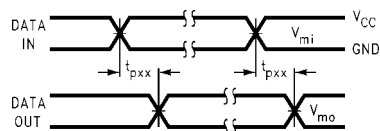
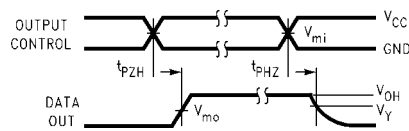
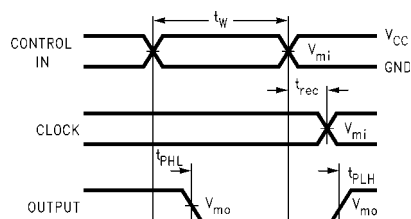
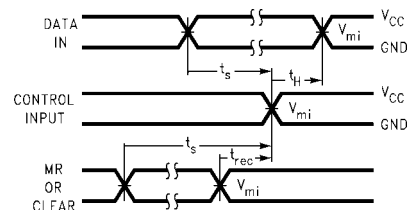
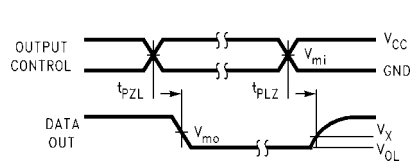
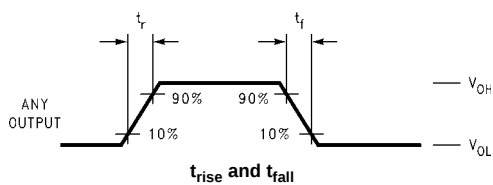
Symbol	Parameter	Conditions	V _{CC} (V)	T _A = 25°C	Units
				Typical	
V _{OLP}	Quiet Output Dynamic Peak V _{OL}	C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V	3.3	0.8	V
		C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V	2.5	0.6	
V _{OLV}	Quiet Output Dynamic Valley V _{OL}	C _L = 50 pF, V _{IH} = 3.3V, V _{IL} = 0V	3.3	-0.8	V
		C _L = 30 pF, V _{IH} = 2.5V, V _{IL} = 0V	2.5	-0.6	

Capacitance

Symbol	Parameter	Conditions	Typical	Units
C _{IN}	Input Capacitance	V _{CC} = Open, V _I = 0V or V _{CC}	7	pF
C _O	Output Capacitance	V _{CC} = 3.3V, V _I = 0V or V _{CC}	8	pF
C _{PD}	Power Dissipation Capacitance	V _{CC} = 3.3V, V _I = 0V or V _{CC} , f = 10 MHz	20	pF

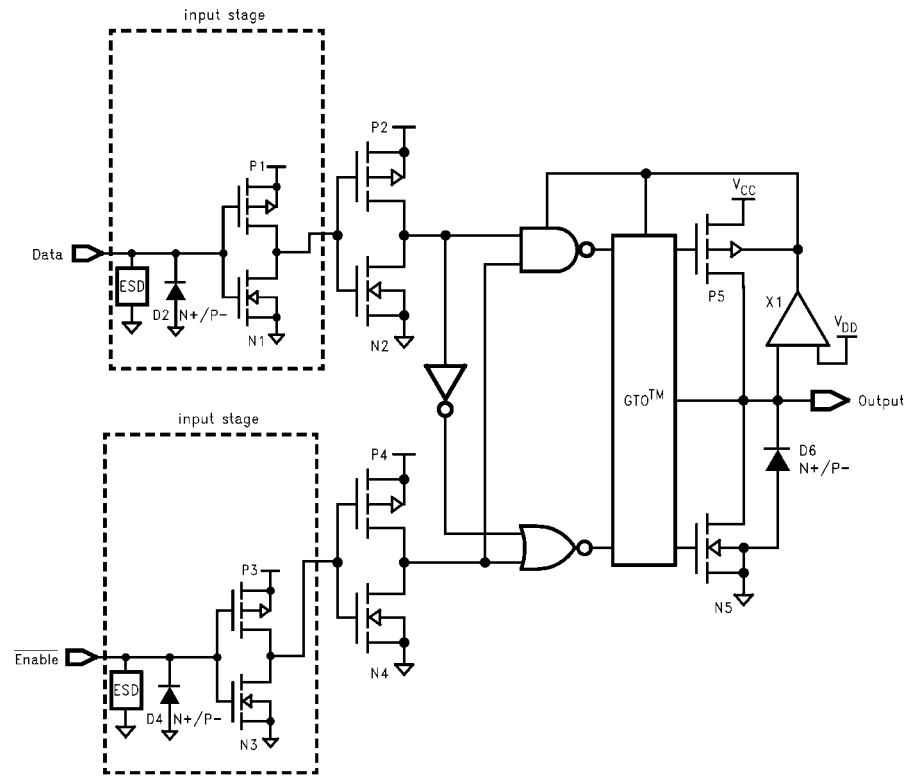
AC LOADING and WAVEFORMS Generic for LCX Family**FIGURE 1. AC Test Circuit** (C_L includes probe and jig capacitance)

Test	Switch
t_{PLH} , t_{PHL}	Open
t_{PZL} , t_{PLZ}	6V at $V_{CC} = 3.3 \pm 0.3V$ $V_{CC} \times 2$ at $V_{CC} = 2.5 \pm 0.2V$
t_{PZH} , t_{PHZ}	GND

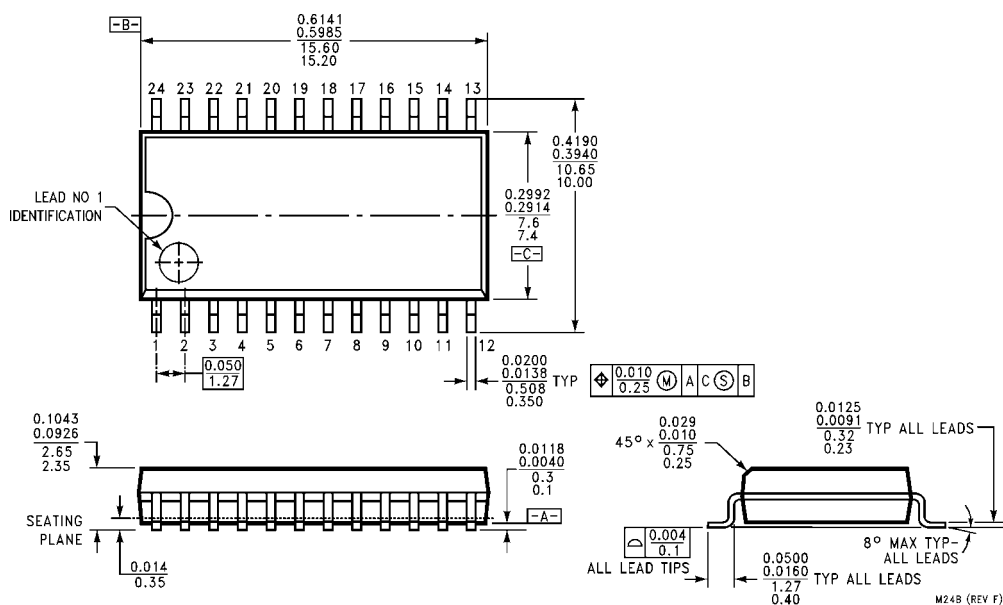
**Waveform for Inverting and Non-Inverting Functions****3-STATE Output High Enable and Disable Times for Logic****Propagation Delay, Pulse Width and t_{rec} Waveforms****Setup Time, Hold Time and Recovery Time for Logic****3-STATE Output Low Enable and Disable Times for Logic****FIGURE 2. Waveforms**
(Input Characteristics; $f = 1\text{MHz}$, $t_r = t_f = 3\text{ns}$)

Symbol	V_{CC}		
	$3.3V \pm 0.3V$	$2.7V$	$2.5V \pm 0.2V$
V_{mi}	$1.5V$	$1.5V$	$V_{CC}/2$
V_{mo}	$1.5V$	$1.5V$	$V_{CC}/2$
V_x	$V_{OL} + 0.3V$	$V_{OL} + 0.3V$	$V_{OL} + 0.15V$
V_y	$V_{OH} - 0.3V$	$V_{OH} - 0.3V$	$V_{OH} - 0.15V$

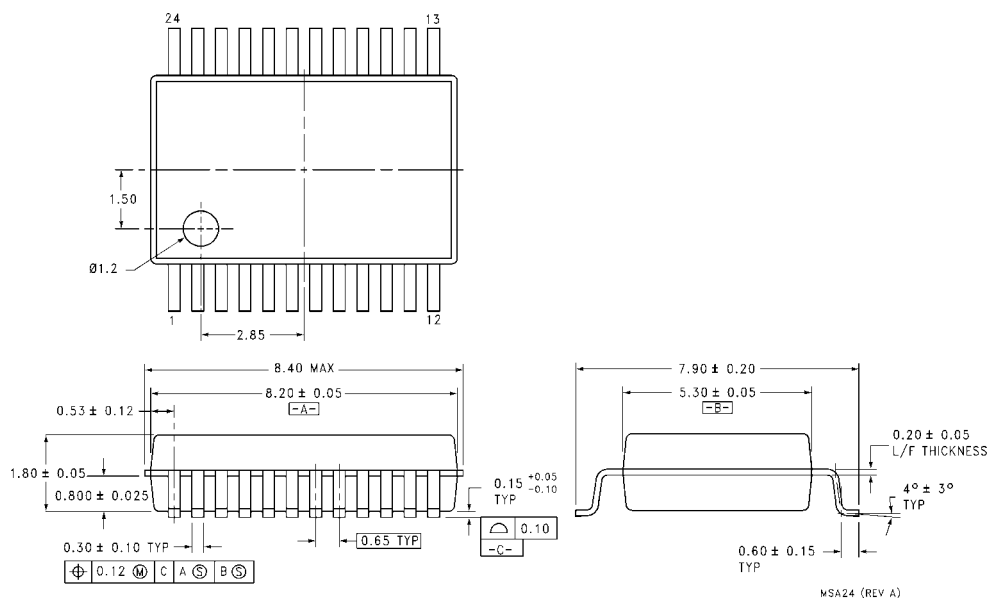
Schematic Diagram Generic for LCX Family



Physical Dimensions inches (millimeters) unless otherwise noted



**24-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300 Wide
Package Number M24B**



**24-Lead Shrink Small Outline Package (SSOP), EIAJ TYPE II, 5.3mm Wide
Package Number MSA24**

The drawing illustrates the mechanical specifications for the MTC24 package. The top view shows a rectangular body with 24 pins (12 on each long side) and a width of 7.8 ± 0.1 . The side view shows a height of 6.4 and a pin height of 4.4 ± 0.1 . The bottom view shows a pin pitch of 0.65 TYP and a lead width of $0.19 - 0.30$ TYP. The drawing also includes a LAND PATTERN RECOMMENDATION and a DETAIL A showing the gage plane and seating plane.

Top View Dimensions:

- Width: 7.8 ± 0.1
- Pin 1 indicator
- Pin 24 and 13 labels
- Feature -A-

Side View Dimensions:

- Overall height: 6.4
- Pin height: 4.4 ± 0.1
- Feature -B-

Bottom View Dimensions:

- Pin pitch: 0.65 TYP
- Lead width: $0.19 - 0.30$ TYP
- Feature -C-
- Feature -D-
- Feature -E-
- Feature -F-
- Feature -G-
- Feature -H-
- Feature -I-
- Feature -J-
- Feature -K-
- Feature -L-
- Feature -M-
- Feature -N-
- Feature -O-
- Feature -P-
- Feature -Q-
- Feature -R-
- Feature -S-
- Feature -T-
- Feature -U-
- Feature -V-
- Feature -W-
- Feature -X-
- Feature -Y-
- Feature -Z-

LAND PATTERN RECOMMENDATION:

- Pin pitch: 1.78 TYP
- Pin width: 0.42 TYP
- Pin spacing: 0.65 TYP

DETAIL A:

- GAGE PLANE
- SEATING PLANE
- Angle: $0^\circ - 8^\circ$
- Dimension: 0.6 ± 0.1
- Dimension: 0.25

DETAIL B:

- SEE DETAIL D
- Dimension: $0.09 - 0.20$ TYP

Feature Legend:

- Feature -A-: 0.13 (M) A B (S) C (S)
- Feature -B-: 0.13 (M) A B (S) C (S)
- Feature -C-: 0.13 (M) A B (S) C (S)
- Feature -D-: 0.13 (M) A B (S) C (S)
- Feature -E-: 0.13 (M) A B (S) C (S)
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- Feature -J-: 0.13 (M) A B (S) C (S)
- Feature -K-: 0.13 (M) A B (S) C (S)
- Feature -L-: 0.13 (M) A B (S) C (S)
- Feature -M-: 0.13 (M) A B (S) C (S)
- Feature -N-: 0.13 (M) A B (S) C (S)
- Feature -O-: 0.13 (M) A B (S) C (S)
- Feature -P-: 0.13 (M) A B (S) C (S)
- Feature -Q-: 0.13 (M) A B (S) C (S)
- Feature -R-: 0.13 (M) A B (S) C (S)
- Feature -S-: 0.13 (M) A B (S) C (S)
- Feature -T-: 0.13 (M) A B (S) C (S)
- Feature -U-: 0.13 (M) A B (S) C (S)
- Feature -V-: 0.13 (M) A B (S) C (S)
- Feature -W-: 0.13 (M) A B (S) C (S)
- Feature -X-: 0.13 (M) A B (S) C (S)
- Feature -Y-: 0.13 (M) A B (S) C (S)
- Feature -Z-: 0.13 (M) A B (S) C (S)

Feature Legend (continued):

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- Feature -H-: 0.13 (M) A B (S) C (S)
- Feature -I-: 0.13 (M) A B (S) C (S)
- Feature -J-: 0.13 (M) A B (S) C (S)
- Feature -K-: 0.13 (M) A B (S) C (S)
- Feature -L-: 0.13 (M) A B (S) C (S)
- Feature -M-: 0.13 (M) A B (S) C (S)
- Feature -N-: 0.13 (M) A B (S) C (S)
- Feature -O-: 0.13 (M) A B (S) C (S)
- Feature -P-: 0.13 (M) A B (S) C (S)
- Feature -Q-: 0.13 (M) A B (S) C (S)
- Feature -R-: 0.13 (M) A B (S) C (S)
- Feature -S-: 0.13 (M) A B (S) C (S)
- Feature -T-: 0.13 (M) A B (S) C (S)
- Feature -U-: 0.13 (M

MTC24 (REV B)

LIFE SUPPORT POLICY

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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