МAXIM

4½ Digit Counter/Decoder/Driver

ICM7224/7225

General Description

The Maxim ICM7224(LCD) and ICM7225(LED) are high speed 4½ digit counters, featuring segment decoders, leading zero blanking, store and reset inputs, and a carry output that allows cascading of 8 or more digits. The ICM7224 directly drives a non-multiplexed liquid crystal display(LCD). The ICM7225 has 29 constant current outputs for driving a non-multiplexed common anode LED display.

These counters operate with inputs from DC to 25MHz while using only 10µA of supply current. A Schmitt trigger on the count input ensures reliable operation in noisy environments and in applications with slowly varying inputs.

The ICM7224 and ICM7225 are available in a 44 lead plastic chip carrier package in addition to the standard 40 lead plastic DIP.
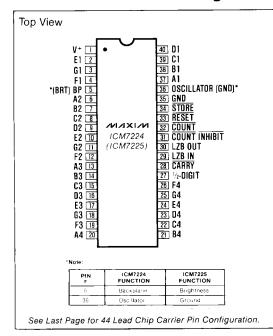
Applications

Unit Counter
Frequency Counter
Tachometer
Hour Meter
Totalizer

Features

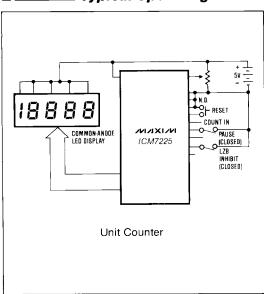♦ **Improved 2nd Source! (See 3rd page for "Maxim Advantage™").**

♦ **High Speed Up Counter: 25MHz Typ.**

♦ **Leading Zero Blanking**

♦ **Can Be Cascaded for 8 or More Digits**

♦ **STORE and RESET Inputs for Frequency Counter Applications**

♦ **On-Board Oscillator to Provide Backplane Frequency (ICM7224)**

♦ **Brightness Control Input (ICM7225)**

♦ **Low Power CMOS**

Ordering Information

PART	TEMP. RANGE	PACKAGE
ICM7224IPL	-20°C to +85°C	40 Lead Plastic DIP
ICM7224IQH	0°C to +70°C	44 Lead Plastic Chip Carrier
ICM7224C/D	0°C to +70°C	Dice
ICM7225IPL	-20°C to +85°C	40 Lead Plastic DIP
ICM7225IQH	0°C to +70°C	44 Lead Plastic Chip Carrier
ICM7225C/D	0°C to +70°C	Dice

Pin Configuration

Top View

PIN #	ICM7224 FUNCTION	ICM7225 FUNCTION
5	Backplane	Brightness
36	Oscillator	Ground

*Note:

See Last Page for 44 Lead Chip Carrier Pin Configuration.

Typical Operating Circuit

Unit Counter

МAXIM _____ *Maxim Integrated Products* 1

4½ Digit Counter/Decoder/Driver

ABSOLUTE MAXIMUM RATINGS

Supply Voltage 6.5V
Input Voltage (any terminal, Note 1) .... -0.3V to V+ +0.3V
Power Dissipation
   40 Lead Plastic Dip 1W
     (derate 10mW/°C above 25°C.)
   44 Lead Plastic Chip Carrier 1W
     (derate 10mW/°C above 25°C.)

Operating Temperature Range
   Plastic Package (IPL) .... -20°C to +85°C
   Plastic Chip Carrier (Quad) Package (Q) ..... 0°C to +70°C
Storage Temperature Range .... -65°C to +160°C
Lead Temperature (Soldering, 10 sec.) .... +300°C

Note 1: The input voltage may exceed this rating if the input current is limited to 1mA.
Connecting any terminal to a voltage greater than V+ or less than Ground and exceeding 1mA input current may activate the parasitic SCR inherent in the junction isolated CMOS process, causing destructive device latchup. For this reason, it is recommended that no inputs from sources operating on a different power supply be applied to the device before its supply is established, and that in multiple supply systems, the supply to the ICM7224/25 be turned on first.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS
(All parameters measured with V+ = 5V, unless otherwise indicated)

ICM7224 CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating current	I_{op}	Test circuit, Display blank		10	50	μA
Operating supply voltage range	V+		3	5	6	V
OSCILLATOR input current	I_{OSCi}	Pin 36		±2	±10	μA
Segment rise/fall time	t_{rfs}	C_{load} = 200pF		0.5		μs
Backplane rise/fall time	t_{rfb}	C_{load} = 5000pF		1.5		
Oscillator frequency	f_{osc}	Pin 36 Floating		19		kHz
Backplane frequency	f_{bp}	Pin 36 Floating		150		Hz

ICM7225 CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating current display off	I_{OPQ}	Pin 5 (BRighTness) at GROUND Pin 29, 31-34 at V+		10	50	μA
Operating supply voltage range	V+		4	5	6	V
Operating current	I_{OP}	Pin 5 at V+, Display 18888		200		mA
Segment leakage current	I_{SLK}	Segment Off		+0.01	±1	μA
Segment on current	I_{SEG}	Segment On, V_{out} = +3V	5	8		mA
Half-digit on current	I_H	Half-digit On, V_{out} = +3V	10	16		

FAMILY CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Pull-up Currents	I_P	Pins 29, 31, 33, 34 V_{out} = V+ - 3V		10		μA
Input High Voltage	V_{IH}	Pin 29, 31, 33, 34	3			V
Input Low Voltage	V_{IL}	Pin 29, 31, 33,			1	
COUNT Input Threshold	V_{CT}			2		
COUNT Input Hysteresis	V_{CH}			0.5		
Output High Current	I_{OH}	CARRY Pin 28 Leading Zero Blanking OUT Pin 30 V_{out} = V+ -3V	350	500		μA
Output Low Current	I_{OL}	CARRY Pin 28 Leading Zero Blanking OUT Pin 30 V_{out} = +3V	350	500		
Count Frequency	f_{count}	4.5V < V+ < 6V	0	DC-25	15	MHz
STORE, RESET Minimum Pulse Width	t_S, t_R		3			μs

The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted (1983/1984) data book. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.

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4½ Digit Counter/Decoder/Driver

- ◆ Key Parameters Guaranteed Over Temperature
- ◆ Increased Segment-On Current
- ◆ Low Power (Typically 25μW)
- ◆ Maxim Quality and Reliability

◆ Significantly Improved ESD Protection (Note 1)

ABSOLUTE MAXIMUM RATINGS: This device conforms to the Absolute Maximum Ratings on adjacent page.

ELECTRICAL CHARACTERISTICS: Specifications below satisfy or exceed all "tested" parameters on adjacent page.
(V^+ = 5V, T_A = 25°C unless otherwise noted)

ICM7224 ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating current	I_{op}	Display blank		5	25	μA
Operating supply voltage range	V^+	-20°C ≤ T_A ≤ +85°C	3	5	6	V
OSCILLATOR input current	I_{OSCI}	Pin 36		±2	±10	μA
Segment rise/fall time	t_{rfs}	C_{load} = 200pF		0.5		μs
Backplane rise/fall time	t_{rfb}	C_{load} = 5000pF		1.5		
Oscillator frequency	f_{osc}	Pin 36 Floating		19		kHz
Backplane frequency	f_{bp}	Pin 36 Floating		150		Hz

ICM7225 ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating current display off	I_{OPQ}	Pin 5 (BRighTness) at GROUND Pin 29, 31-34 at V^+		10	25	μA
Operating supply voltage range	V^+	-20°C ≤ T_A ≤ +85°C	4	5	6	V
Operating current	I_{OP}	Pin 5 at V^+, Display 18888		275		mA
Segment leakage current	I_{SLK}	Segment Off		±0.01	±1	μA
Segment on current	I_{SEG}	Segment On, V_{out} = +3V	6	9		mA
Half-digit on current	I_H	Half-digit On, V_{out} = +3V	12	18		

FAMILY DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Pull-up Currents	I_P	Pins 29, 31, 33, 34 V_{out} = V^+ - 3V	2	10	25	μA
Input High Voltage	V_{IH}	Pin 29, 31, 33, 34, -20°C ≤ T_A ≤ +85°C	3			V
Input Low Voltage	V_{IL}	Pin 29, 31, 33, 34, -20°C ≤ T_A ≤ +85°C			1	
$\overline{COUNT}$ Input Threshold	V_{CT}		1.5	2	3.25	
$\overline{COUNT}$ Input Hysteresis	V_{CH}		0.1	0.5	1.75	
Output High Current	I_{OH}	$\overline{CARRY}$ Pin 28 Leading Zero Blanking OUT Pin 30 V_{out} = V^+ -3V	350	500		μA
Output Low Current	I_{OL}	$\overline{CARRY}$ Pin 28 Leading Zero Blanking OUT Pin 30 V_{out} = +3V	350	500		

Note 1: All pins are designed to withstand electrostatic discharge (ESD) levels in excess of 2000V (Mil STD 883C Method 3015.2 Test Circuit).
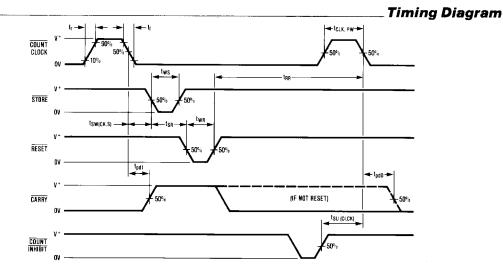
4½ Digit Counter/Decoder/Driver

ICM7224/7225

FAMILY AC ELECTRICAL CHARACTERISTICS (C_L = 50pF unless noted)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Propagation Delay Clock to Carry	t_{pd0}, t_{pd1}			0.6		μs
Maximum Clock Frequency	f_{CLK}		0	DC-25	15	MHz
Minimum Clock Pulse Width	$t_{CLK,PW}$			25		ns
Clock Input Rise or Fall Time	t_r, tf				No Limit	
Reset Pulse Width	t_{WR}			125		ns
Store Pulse Width	t_{WS}			1		μs
Clock to Store Set-Up Time	$t_{SU(CK,S)}$			0.4		μs
Store to Reset Wait Time	t_{SR}			1.3		μs
Inhibit to Clock Set-Up Time	$t_{SU(CI,CK)}$			0		ns
Reset Removal	t_{RR}			20		ns
Input Capacitance	C_{IN}	Logic Inputs (Note 1)		5		pF

Note 1: Does not apply to backplane and oscillator pins.

Timing Diagram

Typical Operating Characteristics

ICM 7224 OPERATING SUPPLY CURRENT VS. SUPPLY VOLTAGE

ICM 7224 BACKPLANE FREQUENCY VS. SUPPLY VOLTAGE

ICM 7225 LED SEGMENT CURRENT VS. OUTPUT VOLTAGE

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TABLE 1. PIN DESCRIPTIONS

PIN	FUNCTION	DESCRIPTION
1	V⁺	Positive power supply input.
2–4, 6–26, 37–40	Segment Outputs	These 28 pins directly drive LCD segments (ICM7224) or common anode LED segments (ICM7225). Segments A1–G1 drive the least significant digit, segments A4–G4 drive the 1000s digit.
27	½ Digit	This segment output drives both segments of the most significant half digit. This segment output turns on when the count reaches 10,000 and is reset only by a low level on the Reset input.
5 (ICM7224)	BP	The backplane pin is both an input and an output. As an output it drives the LCD backplane with an internally generated backplane signal. The backplane pin is an input when the slave mode is selected by grounding pin 36 (Oscillator).
5 (ICM7225)	BRT	An analog input voltage applied to the brightness (BRT) pin controls the output current of the LED segment drivers. Connecting this pin to ground shuts off the display. Connecting this pin to V⁺ drives the display with the maximum available output current. Intermediate voltage levels will adjust the brightness to any level between full off and full brightness.
28	$\overline{\text{CARRY}}$	Connect this logic output to the Count input of another ICM7224/5 to make an 8 digit counter/display driver. The Carry output goes high at count 6000 and goes low on the transition between count 9999 and count 10,000. The Carry output repeats this cycle every 10,000 counts.
29	LZB IN	The ICM7224 displays leading zeroes when this pin is grounded. Connecting this pin to V⁺ or leaving it floating enables leading zero blanking. The entire display will be blanked if this pin is high or floating, the count is 0000, and the half digit is reset. This pin has an internal 10μA pullup.
30	LZB OUT	This output allows the proper blanking of cascaded counters. The Leading Zero Blanking (LZB) output goes high when all digits are blanked.
31	$\overline{\text{COUNT INHIBIT}}$	A low level on this input pin disables the counter. Connecting this pin to V⁺ or floating this pin enables the counter. This pin has an internal 10μA pullup.
32	$\overline{\text{COUNT}}$	Every negative-going transition at the Count input clocks the counter. This input has 500 mV of hysteresis to prevent multiple clocking with slow rate-of-fall inputs.
33	$\overline{\text{RESET}}$	A low level on Reset will reset the counter. Reset also clears the half-digit flip-flop and turns off the half-digit output. This input has an internal 10μA pullup and is inactive when either connected to V⁺ or left floating.
34	$\overline{\text{STORE}}$	When the Store input is low, the latches are transparent and the counter contents are displayed. When Store is taken high or floated, the counter contents are latched and this latched data is displayed.
35	GND	The negative power supply input.
36 (ICM7225)	GND	An additional ground pin for the ICM7225. The ICM7225 has two ground pins to handle the high LED drive currents.
36 (ICM7224)	Oscillator	When this pin is left floating, the ICM7224 oscillates at approximately 19kHz. Connecting an external capacitor between this pin and either V⁺ or GND lowers the oscillator frequency as shown in the Typical Characteristics graphs. The Oscillator can be externally driven using the circuit of Figure 4. Grounding this pin puts the ICM7224 into the slave mode, turning pin 5, BP, into an input.

Table 2. TYPICAL LCD DISPLAYS

Manufacturer	PART #	HEIGHT	# DIGITS
Epson (213) 534-0360	LD-H7924	0.350"	4½
	LD-H7916	0.500"	4
	LD-K7994	0.700"	4
LXD (216) 292-3300	44D3F-85	0.800"	4½
	44D3F-45	0.400"	4½
Hamlin (414) 648-2361	3909	0.400"	4½
	3912	0.800"	4½
AND (415) 347-9916	FE0202W-DU	0.500"	4
	FE0206W-DU	0.400"	4½

Table 3. TYPICAL LED DISPLAYS

Manufacturer	PART #	HEIGHT	COLOR
Hewlett Packard (Contact local sales office)	5082-7731	0.3"	Red
	5082-7611	0.3"	Red (Hi Eff.)
	5082-7621	0.3"	Yellow
	5082-7631	0.3"	Green
General Inst. (415) 493-0400	MAN 71A	0.3"	Red
	MAN 3910A	0.3"	Red (Hi Eff.)
	MAN 3810A	0.3"	Yellow
	MAN 3410A	0.3"	Green
Siemens Opto (408) 257-7910	HD1075R	0.3"	Red
	HD1075O	0.3"	Red (Hi Eff.)
	HD1075Y	0.3"	Yellow
	HD1075G	0.3"	Green

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4½ Digit Counter/Decoder/Driver

Detailed Description

The ICM7224 and ICM7225 have identical counter and control sections, but have different display driver sections. The ICM7224 is designed to drive a non-multiplexed liquid crystal display (LCD). The ICM7225 is designed to drive a non-multiplexed, common anode LED display.

Counter and Control Logic

The counter in both the ICM7224 and ICM7225 is a 4 decade up counter with a Carry output. An overflow flip-flop, which is clocked by Carry, controls the half-digit output. This half-digit output can be used as an overflow indicator or as a half-digit to extend the count range to 19,999. Once set by Carry, the overflow flip-flop will remain set until the counter is reset by taking the Reset pin low.

The counter advances with each negative going transition on the Count input, provided the Count Inhibit and Reset inputs are high.

The Count Inhibit input disables the counter when it is low. The Count Inhibit input is similar to the J-K inputs of a J-K flip-flop; transitions on Count Inhibit do not increment the counter.

Reset is an active low input that resets the 4 digit counter and the overflow (½ digit) flip-flop. Reset does not clear the data in the display latches unless Store is low.

Store controls the flow of data into the display latches. When Store is low the latches are transparent and the counter data is displayed. When Store goes high the display latches go into the hold mode and the displayed count no longer follows the counter.
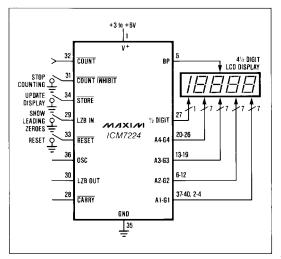
The LZB IN pin determines whether leading zeroes are blanked. Leading zeroes are displayed when LZB IN is low. Leading zeroes are blanked when LZB IN is high or floating. The LZB OUT allows proper leading zero blanking when cascading two ICM7224/ICM7225 devices to make an 8 digit counter/display driver (Figure 3). LZB OUT will go high only when LZB IN is high or floating, the count is 0000, and the overflow flip-flop is reset.

When the ICM7224/25 is used in electrically noisy environments (around solenoids, motor starters, etc.), do NOT rely upon the internal 10μA pullups on Reset, Count Inhibit, LZB IN and Store inputs. Stray pickup of transients may momentarily override the weak, 10μA pullup. Connect these pins directly to V⁺, drive them with a logic gate, or parallel the internal pullup with a 4.7kΩ resistor to V⁺.

ICM7224 LCD Driver Section

The LCD driver section of the ICM7224 is similar to the Maxim ICM7211 4 digit display driver. It includes an internal 19kHz oscillator with a backplane driver, and 29 segment drivers.

The 19kHz nominal output of the onboard oscillator is divided by 128 in the 7 stage divider chain to generate a 150Hz backplane frequency. The Backplane output, pin 5, is a low impedance (200Ω typical) output that swings from ground to V⁺ at the backplane frequency with a 50% duty cycle. The 29 segment drivers also swing from ground to V⁺ and have an output impedance of approximately 2kΩ. The ICM7224 drives an LCD segment in phase with the backplane to turn the

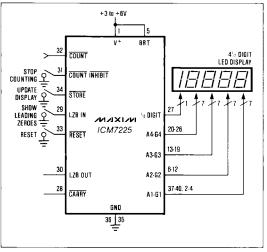Figure 1. Simple 4½ Digit Event or Unit Counter with LCD Display

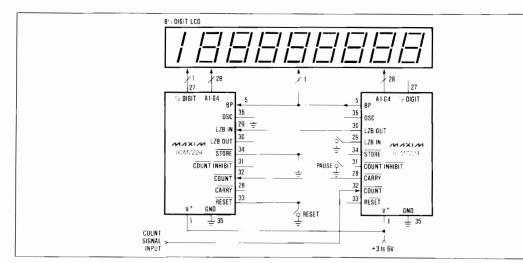Figure 2. Simple 4½ Digit Event or Unit Counter with LED Display

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Figure 3. 8½ Digit Totalizer

segment off, and drives the LCD segment 180° out of phase with the backplane to turn the segment on.

The internal oscillator has a nominal oscillation frequency of 19kHz with no external components. This frequency can be lowered by connecting a capacitor from pin 36 (Oscillator) to either ground or V⁺. See Typical Characteristics graph, Backplane Frequency vs. Supply Voltage. The oscillator can also be overdriven by an external source as shown in Figure 4. The two resistors connected from the driver to pin 36 keep the voltage at pin 36 (Oscillator) above the 1.5V threshold of the backplane slaving detector which is internally connected to pin 36.

When two or more ICM7224 counter/display drivers drive one LCD with a single backplane, the backplane outputs of the ICM7224 counter/display drivers must
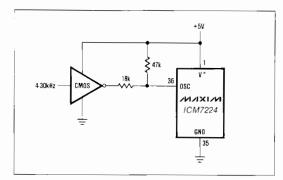
be synchronized. This is performed by grounding the Oscillator (pin 36) on all but one device; and connecting together the Backplanes (pin 5) of all devices. The one device with the Oscillator input not grounded will drive both its own Backplane pin and the Backplane pins of the other devices. The devices with the Oscillator input grounded disable their backplane drivers and use the Backplane pin as an input. See Figure 3.

ICM7225 LED Display Interface

The ICM7225 has 29 open drain N channel segment drivers. These drivers are constant current sinks, whose sink current varies from 0 to 9mA as the voltage on BRT (pin 5) varies from ground to V⁺ (0 to 18mA for pin 27, the ½ digit output). Segment current limiting resistors are not needed.
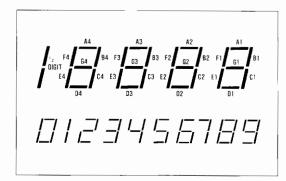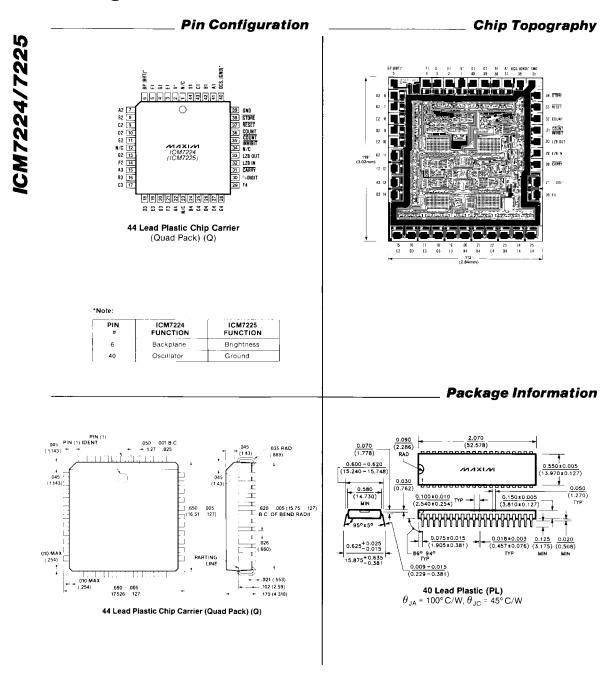

Figure 4. External Clock Drive.

Figure 5. Segment Assignment and Display Font

4½ Digit Counter/Decoder/Driver

ICM7224/7225

Pin Configuration

44 Lead Plastic Chip Carrier
(Quad Pack) (Q)

*Note:

PIN #	ICM7224 FUNCTION	ICM7225 FUNCTION
6	Backplane	Brightness
40	Oscillator	Ground

Chip Topography

Package Information

44 Lead Plastic Chip Carrier (Quad Pack) (Q)

40 Lead Plastic (PL)
$\theta_{JA} = 100°\,C/W$, $\theta_{JC} = 45°\,C/W$

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ICM7224, ICM7225
4 1/2 Digit, LCD, High-Speed Counter Decoder Driver

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Ordering Information

Notes:

1. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
2. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
3. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: SeeFull Data Sheet or Part Naming Conventions.
4. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

Devices: 1-13 of 13

ICM7224	Free Sample	Buy	Package: TYPE PINS FOOTPRINT DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
ICM7224I/D					RoHS/Lead-Free: See data sheet
ICM7224IPL			PDIP;40 pin;837 mm Dwg: 21-0044B (PDF) Use pkgcode/variation: P40-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7224RIPL			PDIP;40 pin;837 mm Dwg: 21-0044B (PDF) Use pkgcode/variation: P40-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7224IPL+			PDIP;40 pin;837 mm Dwg: 21-0044B (PDF) Use pkgcode/variation: P40+1*	-20C to +85C	RoHS/Lead-Free: Lead Free Materials Analysis
ICM7224IQH-D			PLCC;44 pin;312 mm Dwg: 21-0049D (PDF) Use pkgcode/variation: Q44-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7224IQH-TD			PLCC;44 pin;312 mm Dwg: 21-0049D (PDF) Use pkgcode/variation: Q44-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7225	**Free Sample**	**Buy**	**Package: TYPE PINS FOOTPRINT DRAWING CODE/VAR ***	**Temp**	**RoHS/Lead-Free? Materials Analysis**
ICM7225IQH+TD			PLCC;44 pin;312 mm Dwg: 21-0049D (PDF) Use pkgcode/variation: Q44+1*	-20C to +85C	RoHS/Lead-Free: Lead Free Materials Analysis
ICM7225IQH-TD			PLCC;44 pin;312 mm Dwg: 21-0049D (PDF) Use pkgcode/variation: Q44-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7225I/D					RoHS/Lead-Free: See data sheet
ICM7225RIPL			PDIP;40 pin;837 mm Dwg: 21-0044B (PDF) Use pkgcode/variation: P40-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7225IPL			PDIP;40 pin;837 mm Dwg: 21-0044B (PDF) Use pkgcode/variation: P40-1*	-20C to +85C	RoHS/Lead-Free: No Materials Analysis
ICM7225IQH+D			PLCC;44 pin;312 mm Dwg: 21-0049D (PDF) Use pkgcode/variation: Q44+1*	-20C to +85C	RoHS/Lead-Free: Lead Free Materials Analysis

| ICM7225IQH-D | | | PLCC;44 pin;312 mm
Dwg: 21-0049D (PDF)
Use pkgcode/variation: Q44-1* | -20C to +85C | RoHS/Lead-Free: No
Materials Analysis |

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