Preliminary Information

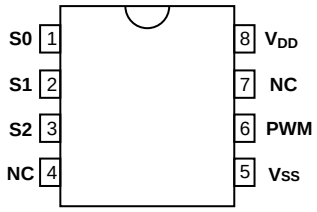
Rolling Code Encoder
A SureLok™ Security Product

FEATURES

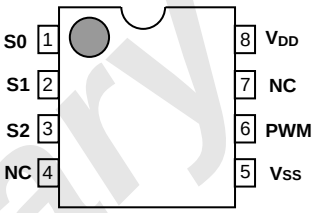
- **Low Cost Rolling Code Encoder**
- **Code encryption using a 64-bit key**
- **65-bit transmission code**
  - **— 32 rolling code bits**
  - **— 28 fixed code bits**
  - **— low power status bit**
  - **— rolling code cycle bit**
- **Supports up to seven switches/functions**
- **Inputs internally debounced/pulled down**
- **Dual selectable transmission baud rates**
- **Code Word Blanking**
- **E²PROM Programmable**
- **EIAJ standard PDIPs and SOICs**

PIN CONFIGURATION

Plastic Dual-in-line "P" Package



EIAJ Small Outline "RF" Package



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PIN NAMES

S0-S2	Switch Inputs
NC	No Connection
V_{DD}	Supply Voltage
PWM	Pulse Width Modulated Output
V_{SS}	Ground

DESCRIPTION

The XL134 is a rolling code encoder intended for secure remote control systems. It is ideal for remote control applications using infrared (IR), microwave or radio frequency (RF) transmitters.

The rolling code mechanism prevents unauthorized access through code grabbing while the 65 bit code length prevents code scanning.

The XL134 provides high-end rolling code security at a price comparable to fixed code encoders. The full feature device provides low power detect, to warn the receiver that the transmitter battery is low; two selectable transmission rates to work with a variety of wireless transmission circuits; rolling code cycle completion detection; and code word blanking for FCC power rating considerations.

Designing transmitters based on the XL134 is simple, requiring no peripheral components, only push-button switches and the transmission circuitry.

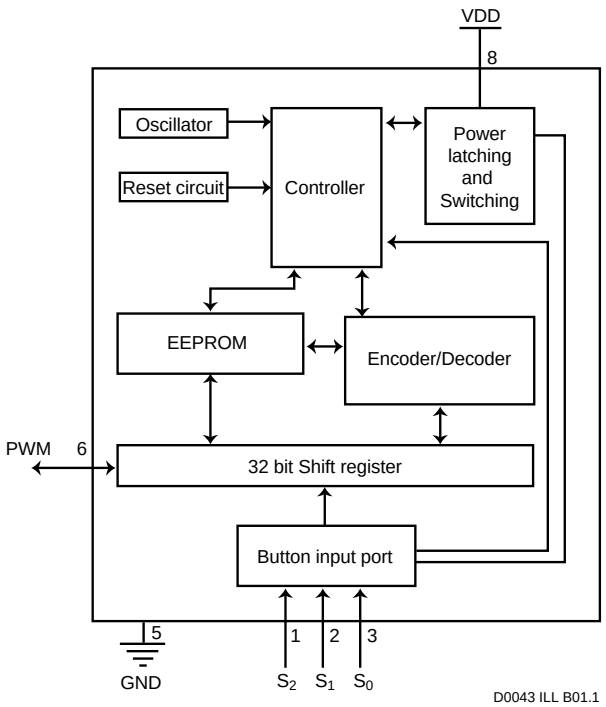
Typical applications

- Vehicle RKE
- Burglar alarm systems
- Garage door openers
- Gate openers
- Rolling code transponders

Security Considerations

Remote control via RF or IR is popular for the control of vehicle alarms, automatic garage doors and many other applications. Conventional remote control systems have two very important security shortcomings: The codes they transmit are fixed and the number of possible code combinations is relatively small. Either of these shortcomings can lead to unauthorized access. Such access can be obtained by scanning through all the possible code combinations or by the use of a code grabber. A code grabber is typically a small hand-held unit that captures transmissions and later replays them to gain access. Code grabbers present a serious threat to remote control system security.

Functional Block Diagram



Significantly enhanced security, without a cost increase can be realized using the EXEL series of rolling code encoders and decoders. The XL134 features a computationally secure rolling code encryption algorithm that uses a 64 bit key. The rolling code mechanism makes code grabbers useless as changing codes are required to gain access to a system.

The 65 bit transmission code provides for in excess of 37 billion billion combinations and thus prevents scanning (a complete scan would require around 120 billion years!).

It is impossible for someone without the 64 bit key and encryption algorithm to predict the next word in the sequence of transmission words. Even if these were disclosed, as each transmitter uses a different key, only a single transmitter would be compromised. All other transmitters/receivers remain secure. The 64 bit keys can be programmed into the XL134 but cannot be read out ensuring that keys remain secret.

Once a code has been transmitted, it will not be used again for more than 65,000 transmissions. An overflow indicator enables a decoder to exclude a specific transmitter after that transmitter has completed its sequence of 65,536 codes. If this option is used, no code will ever be accepted twice by a given decoder. The bit can also extend the transmitter's unique cycle to 131,072 transmissions.

This high level of security at prices comparable to fixed code systems is made possible by special hardware and algorithm design techniques along with full custom integrated circuit implementation on state of the art silicon processes.

Control input (S_0 to S_2) activation

S_2	S_1	S_0	Function	S_2	S_1	S_0	Function
0	0	0	Reset state	1	0	0	Function 4
0	0	1	Function 1	1	0	1	Function 5
0	1	0	Function 2	1	1	0	Function 6
0	1	1	Function 3	1	1	1	Function 7

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When any input (S_0 to S_2) is activated, the encoder enters a debounce period. After the debounce period, the inputs are sampled, and the function code is determined. A transmission commences, and is repeated until all buttons have been released.

If more buttons are pressed after the initial transmission has commenced, the encoder immediately resumes its power-on state, passes through the debounce period, and commences the new function code transmission. If buttons are released after the initial transmission has commenced, the transmission is not influenced. The encoder continues to repeat the same transmission until the last button is released.

As a practical example of transmitter operation, consider the case of a user that requires function 3 on a two button transmitter. The two transmitter buttons have to be pressed simultaneously. The user presses the first button first ($S_2S_1S_0 = 001$), and the transmitter commences with a function 1 transmission. When the second button is pressed ($S_2S_1S_0 = 011$) the device immediately re-enters the debounce period, without completing the current transmission, and function 3 is transmitted. Transmission will continue as long as the user is holding down at least one of the buttons.

In all cases, if all the buttons are released while a code word is being transmitted, the code word will be completed before the transmission is terminated.

Transmission rates

Two transmission rates are available. If the fast rate is selected, alternate code transmissions are blanked, resulting in a 50% reduction in duty cycle. Under U.S.A. FCC regulations, the peak transmitter output can then be doubled, hence allowing for greater transmission ranges with the same average power.

Overflow indicator

The overflow indicator bit is encrypted within the 32 bit rolling code and informs the decoder when the transmitter has completed its 65,536 rolling code cycle. The decoder can then reject further transmissions, extend the allowable cycle for the transmitter to 131,072, or ignore the overflow bit.

Low Power Indicator

A low power indicator bit is transmitted by the XL134 to inform the decoder that the transmitter battery is low and requires changing. This V_{BAT} status bit is zero (0) when above the battery threshold voltage and one (1) when below it.

Implementation

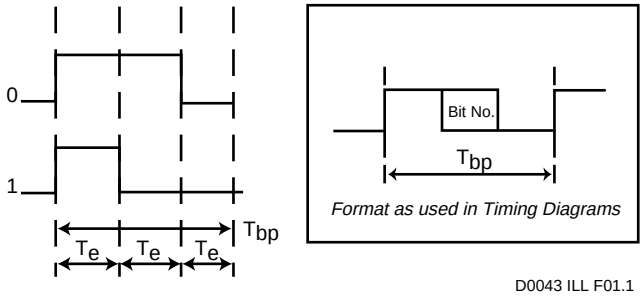
The application circuits clearly indicate the simplicity of implementations using the XL134. No DIP switches, cutting of tracks or soldering is needed. In addition, the small device footprint and no external components facilitate small PC board size and low component count. Only the XL134, transmitter circuitry and push button switches are required realizing significant savings in material and labor.

A PC based programming system is available to program each XL134 with a unique 28-bit serial number (fixed code portion of transmission), a unique 64-bit key and the transmission baud rate. A single probe connector is typically used to program an encoder and its matching decoders.

EXEL also supplies evaluation kits to assess the operational aspects of the devices.

Timing Diagrams

Pulse Width Modulation (PWM) Format



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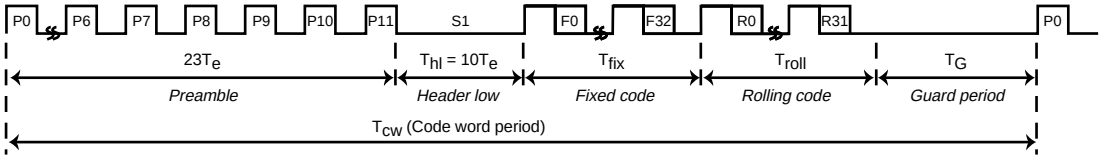
Transmission Format



P = preamble S = timing synchronization F = fixed code R = rolling code

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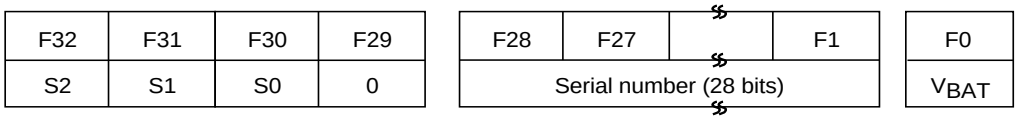
Fixed Code Format



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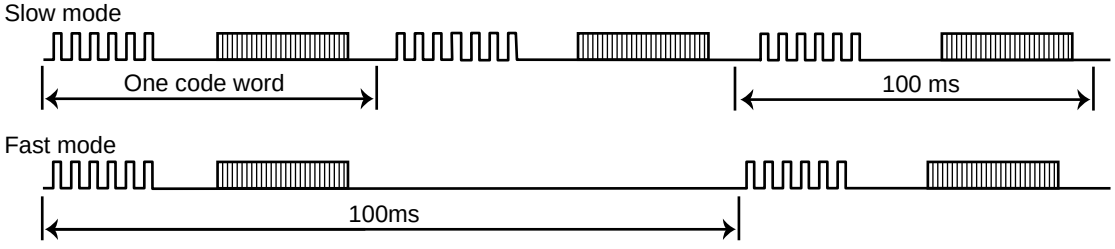
Output Transmission



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ABSOLUTE MAXIMUM RATINGS

Supply voltage ..... -0.3V to 6.5V
Voltage on any input ..... -0.3V to V_{DD} + 0.3V
Voltage on any output ..... -0.3V to V_{DD} + 0.3V
Storage temperature ..... -55°C to 125°C
Lead soldering temperature ..... 300°C
Electrostatic discharge rating 3000V

NOTE: These are STRESS ratings only. Appropriate conditions for operating these devices are given elsewhere in this specification. Stresses beyond those listed here may permanently damage the part. Prolonged exposure to maximum ratings may adversely affect device reliability.

Recommended Operating Conditions

Symbol	Description	Limits	Units
V_{DD}	Supply voltage	2.0 to 6.0	V
T_{OPR}	Operating temperature	-40 to 85	°C

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ELECTRICAL CHARACTERISTICS

DC ELECTRICAL CHARACTERISTICS

TA = -40°C to 85°C, V_{DD} = 2.0V to 6.0V

Symbol	Parameter	Test Condition	Minimum	Typical	Maximum	Units
I_{DD}	Operating supply current	V_{CC} = 5.0V		2.0	4.0	mA
		V_{CC} = 3.0V		1.0	3.0	mA
I_{res}	Standby current (reset condition)			50	1000	nA
V_{IH}	Minimum input voltage for high		0.7 V_{DD}			V
V_{IL}	Maximum input voltage for low				0.3 V_{DD}	V
V_{OH}	Minimum output voltage for high		V_{CC} -0.3			V
V_{OL}	Maximum output voltage for low				0.3	V
V_{BAT}	Battery low threshold voltage			2.4		V
R_S	Control input pulldown resistance			60		kΩ
R_{PWM}	PWM port pulldown resistance			120		kΩ
	Number of transmissions		300,000			
	E^2PROM retention (power off, end of life)		10			years

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AC ELECTRICAL CHARACTERISTICS, PWM OUTPUT
TA = -40°C to 85°C, V_{DD} = 2.0V to 6.0V

Symbol	Parameter	Min	Typical	Max	Units
T_e	Slow elemental period	340		500	µs
	Fast elemental period	170		250	µs
	Slow PWM data rate		780		bps
	Fast PWM data rate		1560		bps
T_{xx}	Power on to transmit		30		ms
T_{DB}	Debounce time		9		ms

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Symbol	Parameter	Slow	Fast	Units
T_{bp}	Bit period	3	3	T_e
	Preamble	23	23	T_e
T_{hl}	Header low	10	10	T_e
T_{fix}	Fixed code	99	99	T_e
T_{roll}	Rolling code	96	96	T_e
T_G	Guard period	6	240	T_e
T_{cw}	Code Word period	234	468	T_e
	Duty cycle minimum[2]	33	16	%
	maximum[2]	61	30	%

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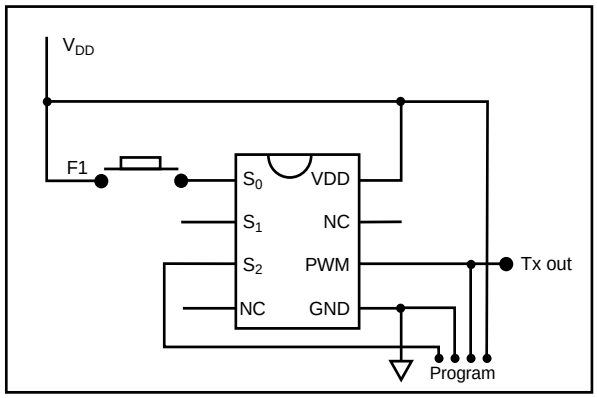
Notes:
1. Decoders must automatically compensate for data rate variations due to variation in encoder timing parameters.
2. Duty cycles are calculated by assuming 12 elements high during the preamble, and either 65 (bits all *1*) or 130 (bits all *0*) elements high during the transmitted code. For American FCC calculations, the highest duty cycle is 142 ÷ 234 (slow mode), or 142 ÷ 468 (fast mode).

Application Circuits



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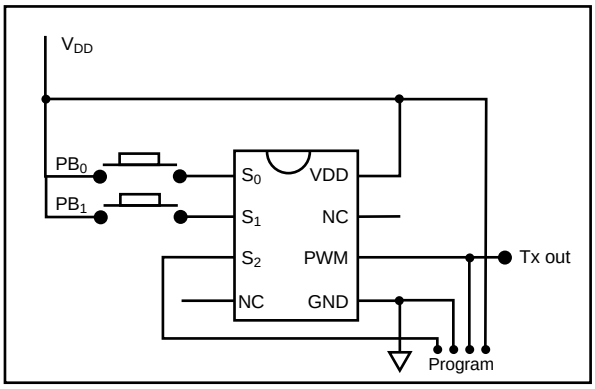
1 button remote control transmitter



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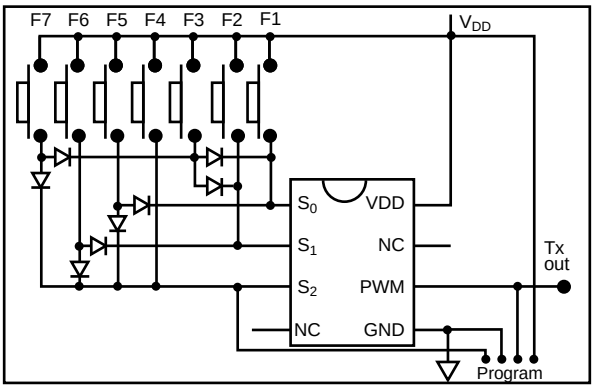
3 function remote control transmitter



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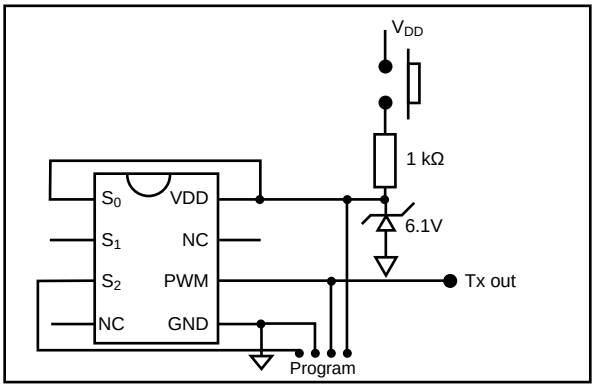
7 button remote control transmitter



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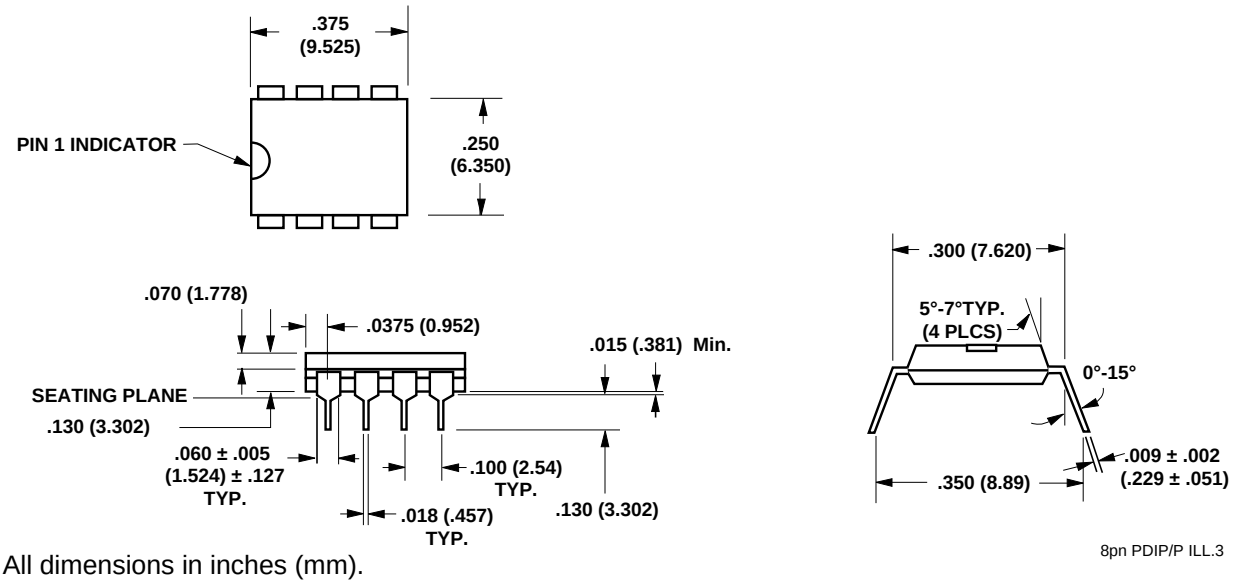
12 volt transmitter

Note: Any simpler transmitter is a subset of the circuit shown.

Note: 1. PWM may not be forced to more than 0.4 V from outside, except for communications during programming.
2. S_2 is used as a clock during programming.

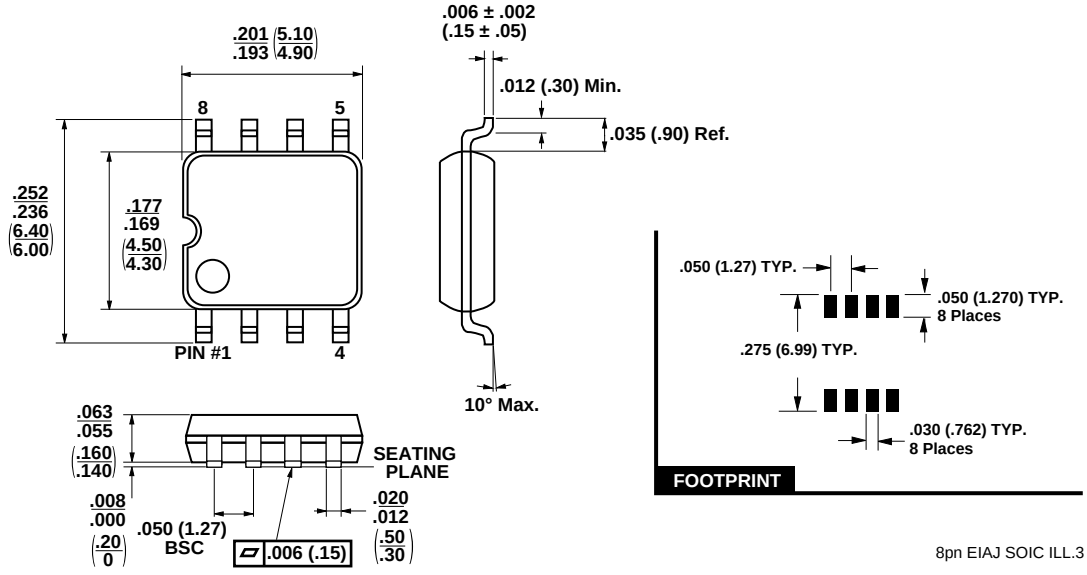
PACKAGE DIAGRAMS

Plastic Dual-in-line (Type "P") Package (PDIP)



All dimensions in inches (mm).

8 Pin SOIC (Type "F" "RF") Package EIAJ 175 mil. body width



All dimensions in inches (mm).

ORDERING INFORMATION

Standard Configurations

Prefix Type	Part Type	Package Type
XL	134	P, F

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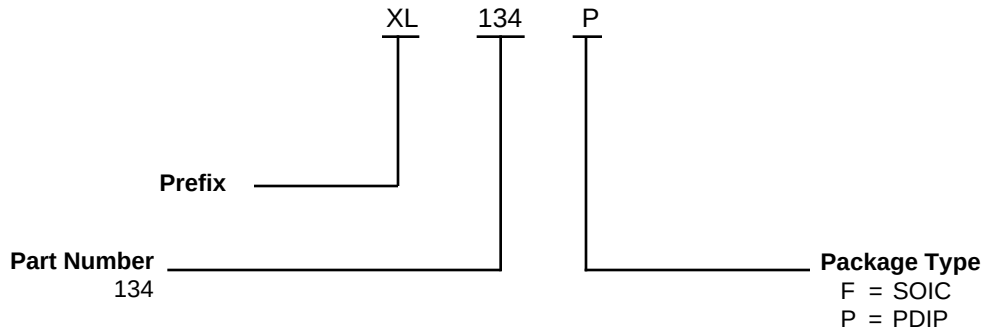
Part Numbers:

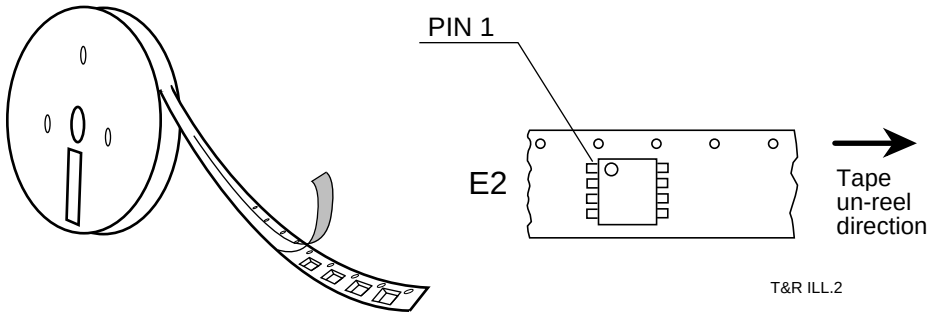


MARKING INFORMATION

D0043 ILL C01.1

TAPE AND REEL (EMBOSSED) INFORMATION

Surface mount devices, which are normally shipped in antistatic plastic tubes, are also available mounted on embossed tape for customers using automatic placement systems. The following diagram provides general information regarding the direction of the IC's. Tape "E2" shall be designated with PIN 1 at the trail direction.



T&R ILL.2

Quantity per reel: 2,500 parts

NOTES:

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