Linx
TECHNOLOGIES

MS Series
Remote Control Decoder
Data Guide

Wireless made simple®

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MS Series Remote Control Decoder

Data Guide

Description

MS Series encoders and decoders are designed for remote control applications. They allow the status of up to eight buttons or contacts to be securely transferred via a wireless link. The large twenty-four bit address size makes transmissions highly unique, minimizing the possibility of multiple devices having conflicting addresses. The MS Series decoder allows the recognition of individual output lines to be easily defined for each transmitter by the manufacturer or the end user. This enables the creation of unique user groups and relationships. The decoder also identifies and outputs the originating encoder ID for logging or identification. Housed in a tiny 20-pin SSOP package, MS Series encoders feature low supply voltage and current consumption. Selectable baud rates and latched or momentary outputs make the MS Series truly versatile.

0.309 (7.85)
0.207 (5.25)
0.026 (0.65)
0.013 (0.32)
0.284 (7.20)
LICAL-DEC-MS001
YYWWNNN
0.079 (2.00)
0.007 (0.18)
0.030 (0.75)
0.002 (0.05)
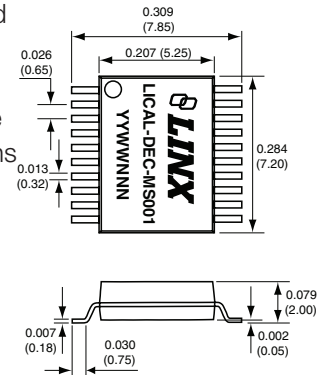
Figure 1: Package Dimensions

Features

- Secure 2^{24} possible addresses
- 8 data lines
- Direct serial interface
- Latched or momentary outputs
- Definable recognition authority
- Encoder ID output by decoder
- Low 2.0 to 5.5V operating voltage

- Low supply current (370µA @ 3V)
- Ultra-low 0.1µA standby current
- True serial encoding
- Excellent noise immunity
- Selectable baud rates
- No programming required
- Small SMD package

Applications

- Keyless entry
- Door and gate openers
- Security systems
- Remote device control

- Car alarms / starters
- Home / industrial automation
- Remote status monitoring
- Lighting control

Ordering Information

Ordering Information	
Part Number	**Description**
LICAL-ENC-MS001	MS Encoder
LICAL-DEC-MS001	MS Decoder
MDEV-LICAL-MS	MS Master Development System
MS decoders are shipped in reels of 1,600	

Figure 2: Ordering Information

Absolute Maximum Ratings

Absolute Maximum Ratings				
Supply Voltage V_{CC}	−0.3	to	+6.5	VDC
Any Input or Output Pin	−0.3	to	V_{CC} + 0.3	VDC
Max. Current Sourced by Output Pins		25		mA
Max. Current Sunk by Input Pins		25		mA
Max. Current Into V_{CC}		250		mA
Max. Current Out Of GND		300		mA
Operating Temperature	−40	to	+85	°C
Storage Temperature	−65	to	+150	°C

Exceeding any of the limits of this section may lead to permanent damage to the device. Furthermore, extended operation at these maximum ratings may reduce the life of this device.

Figure 3: Absolute Maximum Ratings

Timings

Encoder SEND to Decoder Activation Times (ms)			
Baud Rate	**Initial Start-Up**	**After Valid Rx**	**With RX_PDN (Worst Case)**
2,400	72.62	38.62	600 + 72.62
9,600	22.42	12.42	300 + 22.42
19,200	13.80	7.30	150 + 13.80
28,800	11.00	6.00	150 + 11.00

Figure 4: Encoder SEND to Decoder Activation Times (ms)

Electrical Specifications

MS Series Deccoder Specifications						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Notes**
Power Supply						
Operating Voltage	V_{CC}	2.0		5.5	VDC	
Supply Current	I_{CC}					
At 2.0V V_{CC}			240	300	µA	1
At 3.0V V_{CC}			370	470	µA	1
At 5.0V V_{CC}			670	780	µA	1
Power Down Current	I_{PDN}					
At 2.0V V_{CC}			0.10	0.80	µA	
At 3.0V V_{CC}			0.10	0.85	µA	
At 5.0V V_{CC}			0.20	0.95	µA	
Decoder Section						
Input Low	V_{IL}	0.0		0.15 x V_{CC}	V	2
Input High	V_{IH}	0.8 x V_{CC}		V_{CC}	V	3
Output Low	V_{OL}			0.6	V	
Output High	V_{OH}	V_{CC} − 0.7			V	
Input Sink Current				25	mA	
Output Drive Current				25	mA	
Environmental						
Operating Temperature Range		−40		+85	°C	

1. Current consumption with no active loads.
2. For 3V supply, (0.15 x 3.0) = 0.45V max.
3. For 3V supply, (0.8 x 3.0) = 2.4V min.

Figure 5: Electrical Specifications

Warning: This product incorporates numerous static-sensitive components. Always wear an ESD wrist strap and observe proper ESD handling procedures when working with this device. Failure to observe this precaution may result in module damage or failure.

Pin Assignments

Figure 6: MS Series Deccoder Pin Assignments

Pin Descriptions

Pin Number	Name	I/O	Description
1, 2, 13, 14, 17–20	DO–D7	O	Data Output Lines. These lines reproduce the state of the encoder's data lines upon reception of a valid packet.
3	SEL_BAUD0	I	Baud Rate Selection Line 0. This line along with SEL_BAUD1 sets the baud rate of the serial data stream to one of 4 possible rates. The rate must be set before power on.
4	SEL_BAUD1	I	Baud Rate Selection Line 1. This line along with SEL_BAUD0 sets the baud rate of the serial data stream to one of 4 possible rates. The rate must be set before power on.
5, 6	GND		Ground
7	LATCH	I	Set Latched Outputs. If this line is low, then the data outputs are momentary (active for as long as a valid signal is received). If this line is high, the outputs are latched (when a signal is received to make a particular data line high, it remains high until another transmission is received instructing it to go low).
8	RX_CNTL	I/O	External Receiver Control Line. This line can be used to automatically power on and off a receiver. It powers the receiver down for ten times as long as it is powered on. The times are determined by the selected baud rate.
9	TX_ID	O	Transmitter ID Output Line. A unique ID number for each transmitter is stored in the decoder's memory. A byte is output as serial data on this line to indicate which transmitter a transmission came from.
10	MODE_IND	O	Mode Indicator Output. This line switches when a valid transmission is received, when Learn Mode is entered, and when the memory is cleared. This allows for the connection of a LED to indicate to the user that these events have taken place.
11	LEARN	I	Learn Mode Activation Line. When this line goes high, the decoder enters Learn Mode to accept an Address from an encoder and store it in memory. If it is held high for ten seconds, the decoder clears all stored Addresses from memory.
12	DATA_IN	I	Data Input Line. This line accepts the encoded serial data stream from a receiver.
15, 16	V_{CC}		Supply Voltage

None of the input lines have internal pull-up or pull-down resistors. The input lines must always be in a known state (either GND or V_{CC}) at all times or the operation may not be predictable. The designer must ensure that the input lines are never floating, either by using external resistors, by tying the lines directly to GND or V_{CC}, or by use of other circuits to control the line state.

Figure 7: Pin Descriptions

Design Considerations

The Linx MS Series encoders and decoders are designed for remote control applications. They provide an easy way to securely register button presses or switch closures over a wireless link. The encoder side turns the status of eight parallel input lines into a secure, encoded, serial bit-stream output intended for transmission via an RF or infrared link. Once received, the decoder decodes, error checks, and analyzes the transmission. If the transmission is authenticated, the output lines are set to replicate the status of the lines on the encoder.

Prior to the arrival of the Linx MS Series, encoders and decoders typically fell into one of two categories. First were older generation, low-security devices that transmitted a fixed address code, usually set manually with a DIP switch. These address lines frequently caused the user confusion when trying to match a transmitter to a receiver. Another disadvantage was the possibility that address information could be captured and later used to compromise the system.

These concerns resulted in the development of a second type of encoder / decoder that focused on security and utilized encryption to guard against code cracking or code grabbing. Typically, the encoding of each transmission changes based on complex mathematical algorithms to prevent someone from replicating a transmission. These devices gained rapid popularity due to their high security and the elimination of manual switches; however, they imposed some limitations of their own. Such devices typically offer a limited number of inputs, the transmitter and receiver can become desynchronized, and creating relationships and associations between groups of transmitters and receivers is difficult.

The Linx product line, which includes the MS and HS Series, is the first product line to offer the best of all worlds. Both series accept up to eight inputs, allowing a large number of buttons or contacts to be connected. The devices also allow relationships among multiple encoders and decoders to be easily created. Security is well provided for. The MS Series uses a random fixed word with 2^{24} possible combinations to give a high level of uniqueness and a reasonable level of security. For applications requiring the highest security, the HS Series, which employs tri-level, maximum-security encryption, should be considered.

Encoder transmission protocol and methodology is a critical but often overlooked factor in range and noise immunity. The MS and HS products utilize a true serial data stream rather than the PWM schemes employed by many competitive devices. This allows products based on MS or HS devices to achieve superior range and immunity from interference, edge jitter, and other adverse external influences.

One of the most important features unique to the MS and HS products is their ability to establish a unique user identity and profile for the device containing the encoder. In conventional designs, all encoded transmissions are either recognized or denied based on the address. In cases where encoder and decoder addresses match, the state of all data lines is recognized and output. Linx products uniquely allow a user or manufacturer to define which encoder inputs are acknowledged by each decoder. MS series decoders can store up to 40 system users and unique profiles for each. This allows for an incredible variety of unique relationships among multiple system components and opens the door to product features not previously possible.

A Practical Example

Consider this practical example: a three door garage houses Dad's Corvette, Mom's Mercedes and Son's Yugo. With most competitive products, any user's keyfob could open any garage door as long as the addresses match. In a Linx MS-based system, the keyfobs could easily be configured to open only certain doors (guess which one Son gets to open!) The MS Series also allows for component grouping. Imagine a remote control designed for use in a woodshop. One button could turn on a vacuum, one an air cleaner, and another a light, yet another button could then be user configured to turn on all of them with a single touch. The MS Series uniquely combines security and simplicity with the power to create groups and relationships. Figure 8 compares the advantages and disadvantages of different encoders.

Encoder Comparison Table	
Manual Address Encoders	
Advantages High number of button inputs	**Disadvantages** Low-security fixed code Confusing manual addressing Low number of addresses PWM data output High security vulnerabilities
"Rolling Code" Encoders	
Advantages Highly secure Eliminates manual address settings	**Disadvantages** Low number of button inputs Encoder and decoder can become unsynchronized Difficult or impossible to create relationships Security vulnerabilities
Linx Encoders	
Advantages High number of button inputs Highly unique (MS) Highest security available on the market (HS) Eliminates manual address settings Allows for associative relationships Cannot unsynchronize Serial data output Encoder ID is output by the decoder Latched or momentary outputs (MS) External transmitter and receiver control lines	**Disadvantages** Slightly higher cost for some basic applications Security vulnerabilities (MS only)

Figure 8: Encoder Comparison Table

Baud Rate Selection

SEL_BAUD0 and SEL_BAUD1 are used to select the baud rate of the serial data stream. The state of the lines allows the selection of one of four possible baud rates, as shown in Figure 9.

Baud Rate Selection Table		
SEL_BAUD1	SEL_BAUD0	Baud Rate (bps)
0	0	2,400
0	1	9,600
1	0	19,200
1	1	28,800

Figure 9: Baud Rate Selection Table

The baud rate must be set before power up. The encoder will not recognize a change in the baud rate setting after it is on.

Decoder Operation
When the decoder first powers up, it sets the baud rate and checks the state of the RX_CNTL line. If this line is pulled high, then the decoder goes into Receiver Control Mode. If the line is low, it goes to sleep until a rising edge (low to high transition) on the DATA_IN line puts it into Receive Mode or a high signal on the LEARN line puts it into Learn Mode.

Receive Mode
When a rising edge is seen on the DATA_IN line, the decoder enters Receive Mode. The decoder looks for a valid packet, meaning that there are no errors and that the received Address matches one that is saved in memory. If there is a match, then the decoder reproduces the states of the encoder's data lines on its own data lines. It also outputs the ID of the encoder once, on reception of the first valid packet. It then looks for the next valid data packet. If, at any time, an error or an unknown Address is detected, the decoder ignores the packet and looks for the next one.

If the timer runs out, then the decoder goes back to sleep. This time is dependent upon the baud rate selected by the user. It is 131ms for 2,400bps and 9,600bps, and 65ms for 19,200bps and 28,800bps.

Learn Mode
In order for the decoder to accept transmissions from an encoder, it must first learn the encoder's Address. This is done by taking the LEARN line high to place the decoder into Learn Mode. The MODE_IND line starts switching, allowing for connection of an LED to provide visual indication that the decoder is ready to accept a new Address. This continues until the LEARN line goes high again, or until a time-out after 17 seconds.

The decoder looks for a valid transmission from an MS Series encoder. It can store up to 40 Addresses in its memory. When the 40th encoder is learned, the decoder flashes the MODE_IND line five times as an indication that the memory is full. The next address learned overwrites the first address in memory. The memory retains all of the learned Addresses if power is removed.

If the LEARN line is held high for ten seconds, then the decoder erases all of the stored Addresses from memory. The MODE_IND line is high for as long as the LEARN line is high, but after the ten seconds it goes low. Once the LEARN line is pulled low again, the MODE_IND line goes high for two seconds to indicate that the memory has been cleared.

Latch Mode

The MS Series decoder has two output options based on the state of the LATCH line. If it is low, then the data lines are momentary, meaning that they are only high for as long as a valid signal is received. Once the signal stops and the decoder times out, the lines are pulled low.

If the LATCH line is high, the decoder pulls a data line high upon reception of a valid signal and holds it high until the signal is received a second time, at which point the decoder pulls it low. The decoder must see a break and time out between valid transmissions before it toggles the outputs. The minimum required time-out periods are listed in the Receive Mode section.

Receiver Control Mode

If the RX_CNTL line is pulled high when the decoder initially powers on, then the decoder enters Receiver Control Mode. Once in this mode, the RX_CNTL line becomes an output that can be attached to the PDN or V_{CC} line of a Linx receiver or a similar input on another receiver. This allows the decoder to power down the receiver when it is not required, thereby reducing current consumption and prolonging battery life. The decoder draws full current in this mode, but an active receiver typically draws much more than the decoder, so a savings is realized.

The decoder activates the receiver for approximately one packet's time plus 10ms for the receiver to power up, so the actual "on" time depends on the baud rate chosen by the user. This time can be calculated in milliseconds as (60/Baud Rate)(1000) + 10. The "off" time is nine times the "on" time, resulting in a 10% duty cycle, greatly reducing the receiver's current consumption. However, there may be a lag time from when the encoder activates to when the decoder responds. The decoder enters Receive Mode when it sees a valid packet, so there would only be a lag for the first packet. This can be reduced by selecting a higher baud rate.

If this feature is not going to be used, then this pin should be tied to ground. If it is tied to V_{CC}, then the decoder will create a short when it pulls the line to ground while trying to power down the receiver. This mode is appropriate for receivers that have a high internal pull-up resistance, such as those offered by Linx. If the intended receiver does not have a pull-up, then a 100kΩ or larger resistor to V_{CC} can be added to the RX_CNTL line to activate this mode.

TX ID

The TX_ID line outputs an eight-bit binary number to identify which learned encoder sent the transmission. The number is output at the baud rate set by the SEL_BAUD lines and normally corresponds to the order in which the decoder learned the encoder, so the first encoder learned gets number '1', the second gets number '2', and so on. An exception arises when the memory is full, in which case the first numbers are overwritten as described in the Learn Mode section. Application Note AN-00156 shows some example software to read the TX_ID and associate it with a particular encoder. The C and Visual Basic code is well documented so that it can be modified for a specific application.

System Example

The first step in using the decoder is to set the baud rate and determine if the outputs should be latched or momentary. Next, the decoder needs to learn the encoder's Address. This is done by momentarily pressing the button connected to the LEARN line. The LED connected to the MODE_IND line begins to flash to indicate that the decoder is ready to learn a new Address. One of the buttons on the transmitter is pressed to send a signal to the decoder. Once this is done, the LEARN button is pressed again to exit Learn Mode.

Now, when a button is pressed on the encoder, the corresponding line on the decoder activates. If the LATCH line is high, the data line remains high until the encoder button is pressed again, telling the decoder to pull the line low.

To clear the decoder's memory, the LEARN button is pressed and held for ten seconds until the MODE_IND line goes low. Once the button is released, the LED lights for two seconds to indicate that the memory has been cleared.

Typical Applications

The MS decoder is ideal for replicating button presses for remote control applications. An example application circuit is shown in Figure 10.
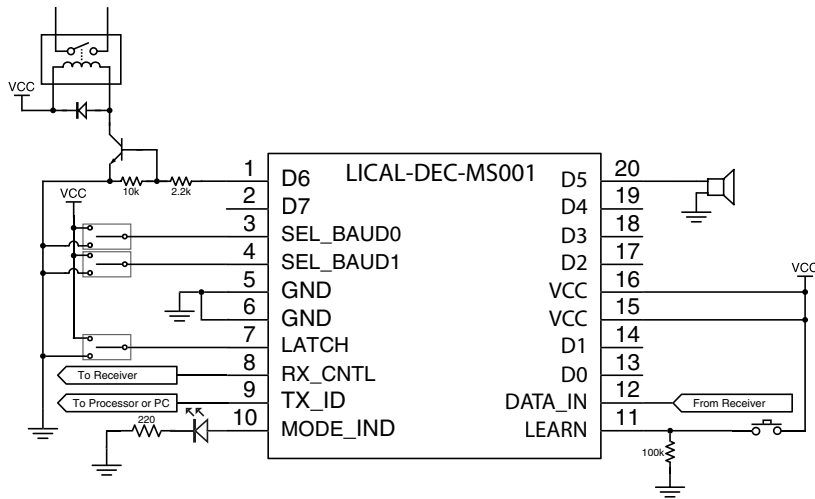

Figure 10: MS Series Decoder Application Circuit

SPDT switches are used to select the baud rate and set the latch mode so that pull-down resistors are not needed.

The RX_CNTL line can be connected to the PDN line of the receiver or it can be connected directly to ground.

TX_ID can be connected to a microprocessor or a PC to record the transmitter identity. Application Note AN-00156 has sample code that reads the transmitter ID and displays the ID number on a LCD screen.

An LED indicator is attached to the MODE_IND line to provide visual feedback to the user that an operation is taking place. This line sources a maximum of 25mA.

The LEARN line is connected to a button that pulls the line high when pressed. Since the line does not have an internal pull-down resistor, a 100kΩ resistor is used to pull the line to ground when the button is not pressed.

The DATA_IN line is connected directly to the data output of the receiver.

Data Lines D0 through D7 can be connected directly to the external circuitry that needs to be activated remotely. In this example, D5 is connected directly to a piezoelectric buzzer. This causes the buzzer to sound when the D5 line on the encoder goes high. Line D6 activates a relay through a transistor buffer when it goes high. A buffer like this may be needed if the load requires more than 25mA of current or a higher voltage source to activate. The decoder turns on the transistor, which can be selected to provide the appropriate drive levels to activate the relay.

Figure 11: MS Series Decoder Flowchart
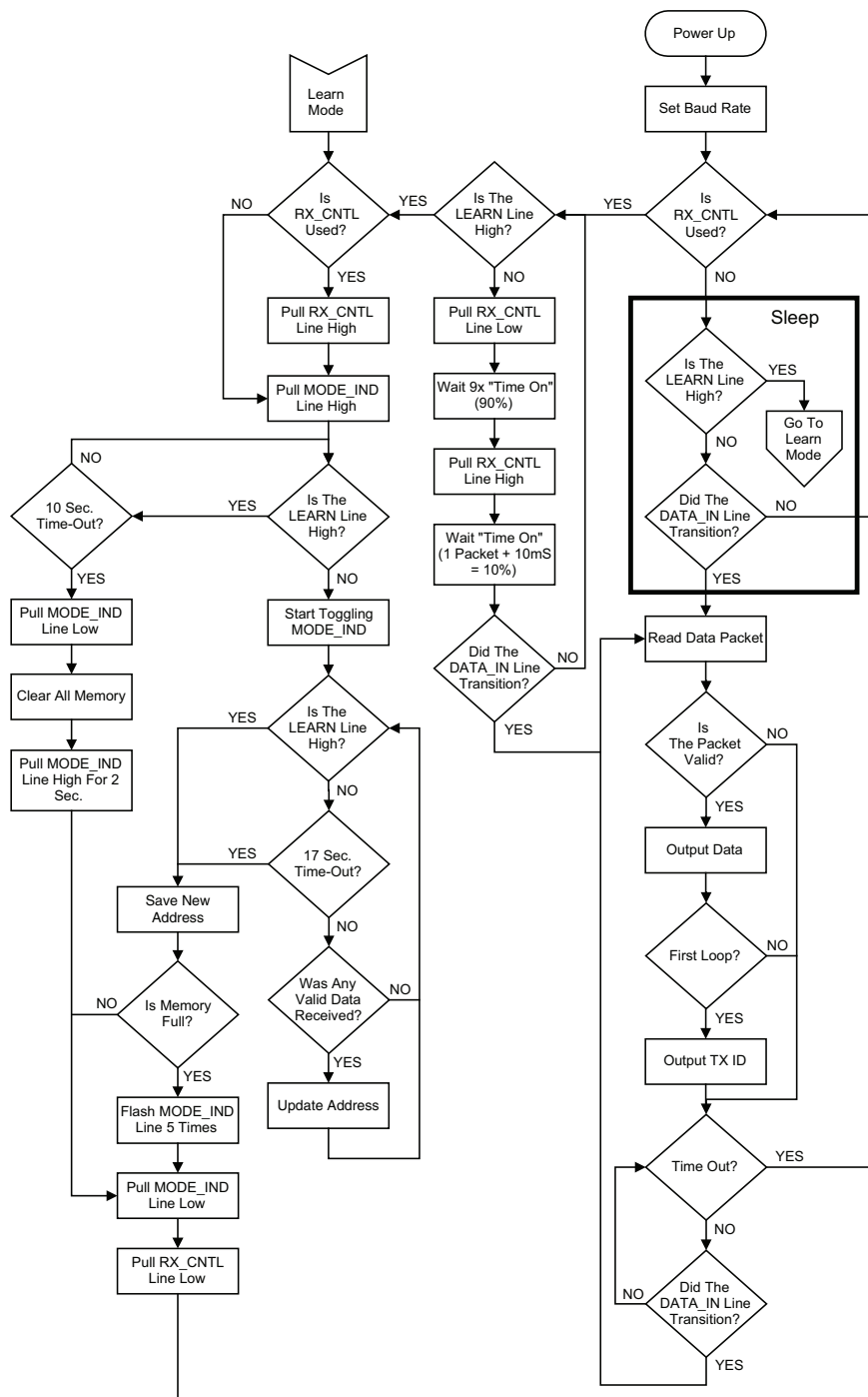
Recommended Pad Layout

The MS Series encoders and decoders are implemented in an industry standard 20-pin Shrink Small Outline Package (20-SSOP). The recommended layout dimensions are shown in Figure 12.
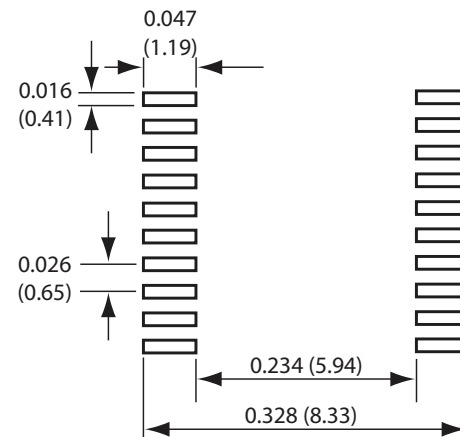

Figure 12: PCB Layout Dimensions

Production Considerations

These surface-mount components are designed to comply with standard reflow production methods. The recommended reflow profile is shown in Figure 13 and should not be exceeded, as permanent damage to the part may result.
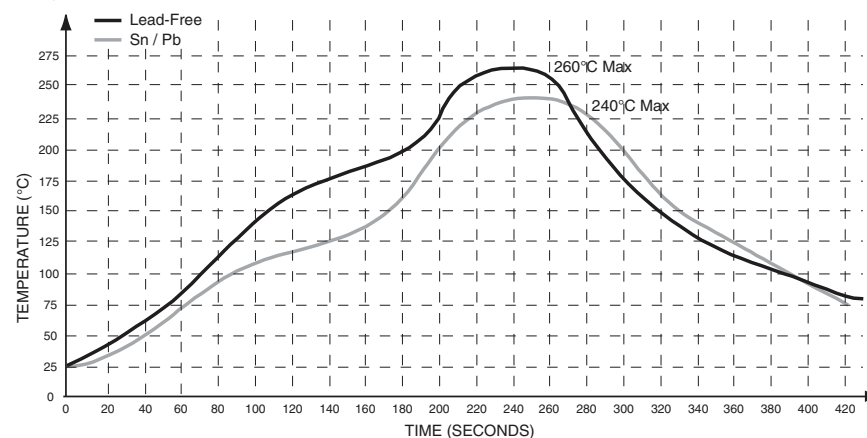

Figure 13: MS Series Reflow Profile

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- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
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