



LC-100 TagReader

March 2005



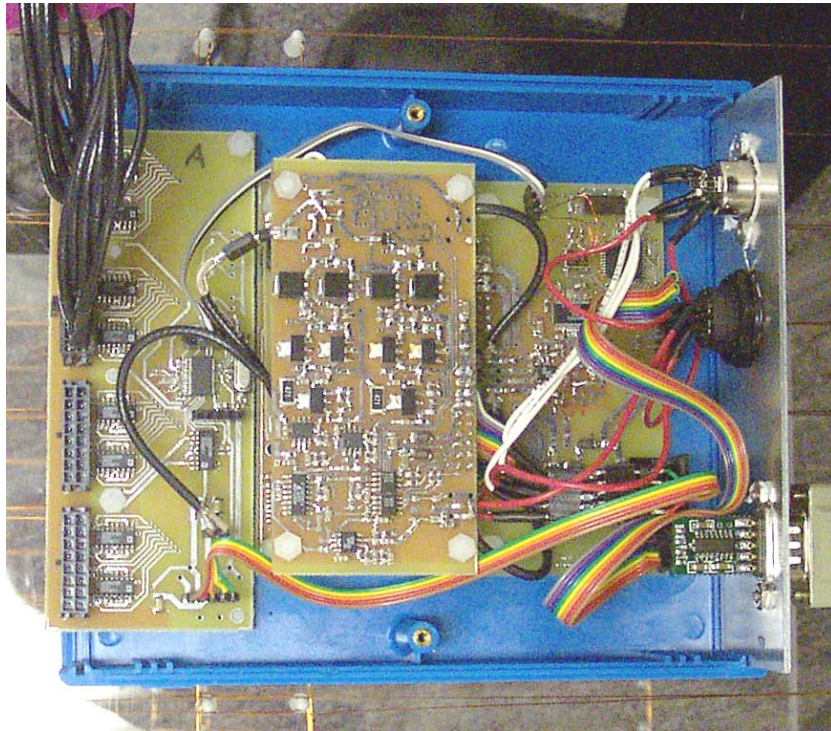
The LC-100 is a 32-channel tag reader that is designed for driving antenna arrays. This reader is suited for applications such as smart shelves, where a single reader must be shared among many antennas.

The LC-100 is designed to detect chipless tags in the form of planar LC labels. The operating frequency is approximately 1-20 MHz; however the usable frequency range depends on the characteristics of the specific antenna array that is being used.

TagSense, Inc.

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- **Operating Frequency: 1-20 MHz**
- **Operating Voltage: 12 V**
- **Operating Current:**
 - 200 mA @ 12V
- **Supports 32 antennas**
 - individually-addressed or autoscan
 - supports grouping of antennas

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LC-100 COMMAND SUMMARY

The LC-100 uses RS-232 TTL-level communication. This enables the tag reader module to easily communicate with any external electronic circuit or device such as a microcontroller using an RS-232 serial UART. TagSense also offers RS-232, RS-485, and USB serial adapters that allow the LC-100 to communicate with an external computer or remote network.

<u>ASCII Command</u>	<u>Description</u>
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Operating Modes

The LC-100 has 2 basic modes of operation: manual mode and inventory mode.

manual mode:

In *manual mode*, the reader frequency scan is controlled by specific settings such as the start frequency, stop frequency and frequency step. This operating mode enables full manual control of the tag reader functions. The reader can automatically sweep a continuous range of frequencies or can be set to a single frequency.

inventory mode:

In *inventory mode*, the reader automatically scans a specific list of frequencies that correspond to a specific set of tags. This mode is used for applications where a specific set of tags are being tracked or monitored.

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LC-100 COMMAND SUMMARY

Operational Commands

COMMAND	ARGUMENT	DESCRIPTION
M		converts output data stream to machine readable non-ASC format. Using this binary data enables more compact and faster data communications with an external host device.
m		Converts output data to human readable format, which is ASC text characters. This is the default mode.
X		Pause the reader (scanning and data flow will stop)
x		Resume reader operation
E		Enables polling mode. In this mode, the reader will perform a single scan when the polling trigger command ("z") is received. Upon completing the single scan, the reader will pause until the next polling command is received.
e		Disables polling mode. In this mode, the reader will continuously scan and stream data.
z		This is the polling command. This command will trigger the reader to do a one-time scan or sweep.

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Additional operational commands:

COMMAND	ARGUMENT	DESCRIPTION
D	none	Enable continuous data streaming output
d	none	Output data only if the detected tag signal is greater than the threshold.
t	<int 8>	Set the detection threshold
R	<int 32>	set 32-bit identifier for the reader. This is used when many readers are being networked together.

Frequency control commands for MANUAL mode:

COMMAND	ARGUMENT	DESCRIPTION
a	<int 32>	Set the start frequency for sweeping
b	<int 32>	Set the stop frequency for sweeping
c	<int 32>	Set the frequency step size
f	<int 32>	Set the output frequency when in single-frequency mode
k	<int 8>	sets the delay (in units of 10 us) that the reader will wait before sampling the antenna signal. This delay is used to allow any transient signals to decay.
W		turn ON frequency sweeping
w		turn OFF frequency sweeping. This sets reader into single-frequency mode. The single frequency can be set by using the command f.

In *Manual mode*, the reader can be used as a simple signal analyzer. In this mode, the user has complete control over the reader operation. The user can set the reader to scan a signal frequency continuously, or the reader can be set to automatically sweep over a continuous range of frequencies; in this latter case, the user can specify the start frequency, the stop frequency, and the frequency step size. In manual mode, the data output is the frequency value followed by the detected signal level.

In *Inventory mode*, the reader is used to automatically scan a particular set of tags. Rather than scanning a frequency range, the reader in inventory mode will discontinuously jump to specific frequencies that are specified in its tag memory table. This table is essentially a list of tags and their corresponding frequencies. Users are able to add or delete entries to this table using specified commands.

Antenna control commands:

COMMAND	ARGUMENT	DESCRIPTION
N	<int 8>	scan single antenna (1 to 32)
I	<int 8>	set low end of antenna subset for multiscan (1 to 32)
L	<int 32>	set high end of antenna subset for multiscan (1 to 32)
Y	None	scan through multiple antennas
y	None	use only single antenna

Old command (no longer used):

h<int8> select bank of antennas (1 to 4 selects corresponding group of 8)

Inventory commands:

COMMAND	ARGUMENT	DESCRIPTION
V	None	Turn ON inventory mode
v	None	Turn OFF inventory mode
i	None	Display list of inventory frequencies and corresponding tag numbers. If no tags have been entered into the reader memory, then the list of tags will be blank.
g	<int 8>	Automatically add tag to inventory list at position <n>. For example if there is a list of 25 tags in the reader memory and you want to assign tag number 18 in memory to a new tag frequency, then you would place a tag on the antenna and send the command "g18", and the reader would automatically detect the new tag, measure its frequency, and add this frequency to its memory as tag number 18. If tag #18 did not exist in memory, this would create a new tag #18. If a tag #18 already existed in memory, this would essentially overwrite the entry for tag #18.
G	<int 8>	Delete tag entry #n. By deleting an entry from the inventory list, the tag reader will no longer scan for that tag frequency.
q	<int 8>	when scanning (sweeping) is turned off in inventory mode, this sets the current tag frequency to tag n. Tag n thus becomes the currently selected tag.
h	<int 32>	This assigns the given frequency value to the currently selected tag. This commands provides a way to manually enter in the tag frequencies instead of using the g command.
w		turn OFF frequency sweeping. This will cause the reader to stop scanning multiple frequencies. The reader will scan just a single frequency that corresponds to specific tag. If the reader is set to <i>manual mode</i> , then the frequency can be set using the "f" command. If the tag reader is set to <i>inventory mode</i> , then the "q" command can be used to select the single tag to be scanned.

Software RESET:

The reader can be reset via software control by sending the reader the command character “+” (ASC).

Default State: When the reader is RESET upon power up or when an explicit RESET command is received, the reader will enter the default state. In this state the following settings are pre-programmed at the factory:

PARAMETER	DEFAULT STATE
a	3400000
b	14000000
c	10000
f	8000000
K	10
k	20
W	
w	

Calibration commands:

COMMAND	ARGUMENT	DESCRIPTION
R	<int 32>	Set 32-bit frequency ID
r	<int 32>	Display the reader ID
s	<int 32>	display the value of all reader state variables
S	<int 32>	Save the current state of the reader. This state can be later recalled using the “v” command.
??	<int 8>	recall the previously saved state
p		calculates a threshold equal to the lowest value detected over the current frequency span

p calibrate - finds threshold for a single antenna
P calibrate all - finds thresholds for all antennas
B baseline_calibrate

COMMAND	ARGUMENT	DESCRIPTION
a	<int 32>	Set the start frequency for sweeping
b	<int 32>	Set the stop frequency for sweeping
c	<int 32>	Set the frequency step size
f	<int 32>	Set the frequency for non-sweeping operation
k	<int 8>	sets the delay (in units of 10 us) that the reader will wait before sampling the antenna signal. This delay is used to allow any transient signals to decay.
W		turn ON sweeping
w		turn OFF sweeping

Baseline Correction :

Since the baseline frequency response of the reader antenna is generally not monotonic and may contain various features, an additional interpolation function is included in the LC-100 in order to help detect resonant peaks.

If baseline correction is turned ON, the LC-100 reader will sample several different frequency points in the neighborhood of the expected tag resonance peak. The reader will then interpolate between these points in order to calculate an effective baseline. The LC-100 then compares the received signal at the resonant frequency with the effective baseline. In this mode, since the reader is looking at deviations from the baseline, the output data from the reader will be nearly zero when no tag is present.

Another way to describe the baseline correction function is that the LC-100 essentially calculates the slope of the baseline in the neighborhood of a resonance frequency and is thus better able to detect inflection points in this curve.

The command j<int 32> assigns a frequency width to the currently selected tag. This is the frequency width that is used to do the interpolation.

The commands u and U and used to turn ON and OFF the baseline correction.

Additional Commands for MB-100 Reader:

Unlike the LC-100, the MB-100 uses a “pulse-and-ringdown” method of detection. This method transmits an RF pulse and then listens for the decaying oscillations of “ringdown” of the tag. In order to allow system transients to decay, the user can specify a time delay after the RF pulse before listening for the tag oscillations. The tag signal also decays exponentially with time; however, since the Q-factor of the tag is much larger than the Q-factor of other system components, the tag signal will dominate after the transients have decayed.

The baseline of the frequency scan in the MB-100 is quite different than the frequency scan taken from the LC-100. In order to extract the data from the baseline signal, the MB-100 uses time averaging instead of interpolation. The MB-100 samples the same frequency point several times and then averages the result. For the MB-100, the command characters u and U are used to turn on and turn off averaging. J <int> sets averaging factor. If the factor is 1, then this effectively turns OFF averaging.

COMMAND	ARGUMENT	DESCRIPTION
u	none	turn OFF averaging
U	none	turn ON averaging
J	<int 8>	Set averaging factor
k	<int 8>	Set the duration of excitation pulse. This value gets multiplied by 20 us. This is nominally set to 10.
K	<int 8>	Sets the time delay that the reader will wait after the excitation pulse before sampling the received signal. This value is multiplied by 10us.