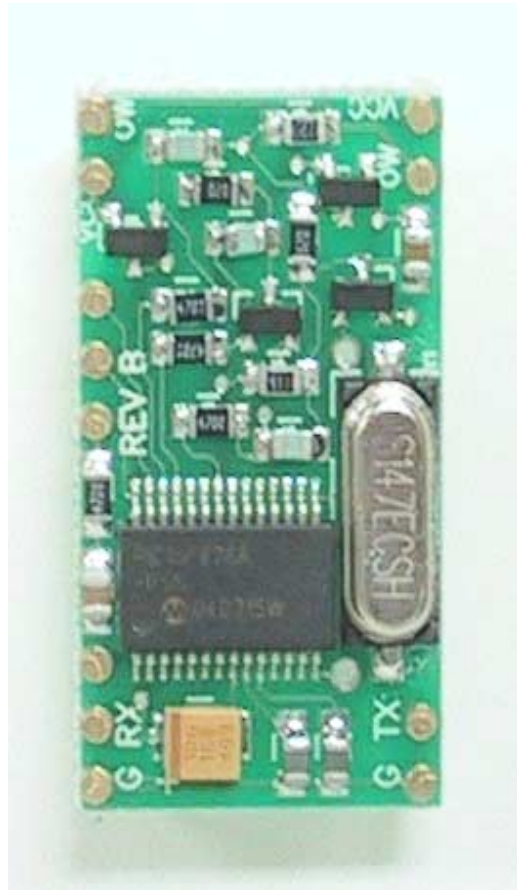# The LinkOEM™ Module
Users Guide

**An Advanced, Intelligent
PCB Mounted Interface
for the iButton™ and 1-Wire™ Bus**

Revision 1.2
11-March-2008

Introduction:

The LinkOEM module is an advanced, intelligent circuit board mounted interface for use with Dallas Semiconductor 1-Wire™ and iButton™ components. It uses superior digital and analog methods to accomplish more reliable operation on a wide variety of network topologies. It also offers many functions that simplify network communications, and some diagnostic tools as well.

The LinkOEM has been designed to operate reliably on long and short 1-Wire busses. This is accomplished by a special analog interface design that uses matched impedances and slew rate controls, as well as smart cable pre-charge. In addition, the firmware (programming) is adaptive and makes adjustments for a variety of network parameters automatically.

The LinkOEM was designed in cooperation with Dallas Semiconductor Corp., Dallas, Texas, who is the manufacturer of the 1-Wire and iButton devices and various accessories. Some terms used in this document may be trademarks of Dallas Semiconductor Corporation, and are used with their permission.
NOTE: LinkOEM will function with <u>TTL signals ONLY</u>

DS9097U Emulation:

The LinkOEM is programmed to closely emulate a Dallas DS9097U serial port interface so that existing software can use it without modification. This allows the LinkOEM to be used in place of the Dallas DS9097U in most cases where increased performance or reliability is required. Some DS9097U functions are <u>not</u> emulated by the LinkOEM, as described below.

Calibration:

Unlike the DS9097U, the LinkOEM does not require calibration from the serial port because it has a crystal-controlled time base. This means that drift in the interface data rate and waveform timing is not an issue. (A calibration byte is expected by the LinkOEM for DS9097U software compatibility, although it is ignored by the LinkOEM.)

Overdrive Speed:

The LinkOEM does not support Overdrive speed bus communication. Because the analog components in the bus interface are carefully tuned for optimum long- and short-line performance at standard speed, the higher speed mode cannot also be supported. However, for the vast majority of applications, this is not an issue.

Flex Timing Modes:

The LinkOEM uses 1-Wire waveform timing that is carefully and dynamically controlled by the intelligent control algorithms. Flex mode timing changes that could be done in the

DS9097U are unnecessary and are not supported in the LinkOEM. However, the LinkOEM will emulate the Flex Mode registers, and so will appear to behave like the DS9097U for software compatibility.

EPROM Programming:

The LinkOEM does not support +12V pulses for programming EPROM 1-Wire or iButton devices. Programming pulses for 5V devices (EEPROM) are supported.

Device Version:

The LinkOEM reports device version 7 when queried using the normal DS9097U method. This allows the software to distinguish The LinkOEM from a standard Dallas DS9097U interface, which (at the time of this writing) returns a 3.

ASCII Control Functions:

In addition to the DS9097U emulation, the LinkOEM also provides many 1-Wire bus functions in response to ASCII commands. This allows the LinkOEM to be used with any terminal program or serial port communications API to perform iButton or 1-Wire bus functions without software drivers. The LinkOEM functions that can be performed have been coded for normal ASCII keys so that all the basic 1-Wire functions can be performed manually on the keyboard of a terminal program, or using programming languages that are limited to ASCII serial port I/O. As a rule, these special commands consist of every command code that is not used in the DS9097U emulation.

The LinkOEM ASCII functions are letters and symbols as follows:

Key **h** – Displays a list of LinkOEM ASCII commands that are available. (These are in addition to the standard DS2480/DS9097U binary command codes that are available.)

Key **r** – Performs a 1-Wire bus reset and returns the status of the bus, either a "P" representing the presence of one or more devices on the bus, an "N" representing no devices on the bus, or an "S" representing a shorted bus.

Key **b** – Places the LinkOEM into byte mode. The next two characters entered will be taken as a hexadecimal byte value, which is then issued onto the bus. The response byte is then displayed in hexadecimal. Subsequent pairs of hexadecimal characters will also generate bytes, allowing for streaming of bytes without intervening commands. Hitting ENTER (Carriage Return) will end the Byte mode.

Key **p** – Places the LinkOEM into byte mode. The next two characters entered will be taken as a hexadecimal byte value, which is then issued onto the bus. The response byte is then displayed in hexadecimal. Subsequent pairs of hexadecimal characters will also generate bytes, allowing for streaming of bytes without intervening commands. Hitting

ENTER (Carriage Return) will end the Byte mode. *This command differs from the "b" command in that power (strong pull-up) is applied to the bus after the last bit of the first byte is issued.* (Subsequent bytes will be performed but will <u>not</u> be followed by strong pull-up.)

Key **j** – Performs the same type of operation as the "**b**" key above, but with only single bits. Single ASCII digits of 0 or 1 value only are allowed, and single ASCII digits are returned. Hitting ENTER (Carriage Return) will end the Bit mode.

Key **~ (tilde)** – Performs the same type of operation as the "**b**" key above, but with only single bits. Single ASCII digits of 0 or 1 value only are allowed, and single ASCII digits are returned. Hitting ENTER (Carriage Return) will end the Bit mode. *This command differs from the "j" command in that power (strong pull-up) is applied to the bus after the first bit is issued.* (Subsequent bits will be performed but will <u>not</u> be followed by strong pull-up.)

Key **f**   - Performs a 1-Wire bus "first" operation. This operation searches the bus and finds the first 1-Wire or iButton device, displaying the device serial number. A single character, either a "+" or a "-", is returned to indicate if there are more ("+") or no more ("-") parts remaining to be found.

Key **n** – Performs a 1-Wire bus "next" operation. This operation searches the bus and returns the next 1-Wire or iButton device, displaying the device serial number. A single character, either a "+" or a "-", is returned to indicate if there are more ("+") or no more ("-") parts remaining to be found. (If used again after a "-" response is received, this function will find the first part again.)

Key **t** – When followed by a two-character hexadecimal value, will change the search type to this function command value. Using "tF0" will make the search normal. Using "tEC" will make the search conditional and will discover only devices for which the search conditions are satisfied. (See the data sheets for each individual Dallas iButton or 1-Wire device for specific search type command codes.)

Key **l (lower case L)** – This will test the level of the 1-Wire bus and report a "0" or "1" followed by a carriage return.

Key **x** – This will take the 1-Wire bus to a low level. Issue a reset ("r") command, or any bit or byte command, to return the 1-Wire bus to functionality. This function is used to cause a bus-wide reset by robbing power from all the bus devices for a few seconds.

Key **z** – Take the Auxiliary line to the LOW level and low impedance. (See *Auxiliary I/O* below.)

Key **d** – Take the Auxiliary line to the HIGH (default) level and low impedance. (See *Auxiliary I/O* below.)

Key **&** - Take the Auxiliary line to high impedance and report the current input level. (See *Auxiliary I/O* below.)

Key **$** - Start arrival/departure scanning (See *Scanning* below.)

Key **^** - Switches the device to the 57,600 baud serial port data rate. The host terminal will be required to switch to 57,600 baud before it can communicate with The LinkOEM further. When a "break" condition is detected, the device resets and returns to the 9600 baud data rate, so sending the "^" followed by more 9600 baud data will often find the device resetting and the speed returning to 9600 baud. *See note (1) below.*

Key : (Colon) - Switches the device to the 115,200 baud serial port data rate. The host terminal will be required to switch to 115,200 baud before it can communicate with The Link Module. When a "break" condition is detected, the device resets and return to the 9600 baud data rate, so sending the "^" followed by more 9600 baud data will often find the device resetting and the speed returning to 9600 baud. **See note (1) below.**

Key ` **(single quote under ~)** - Switches the device to the 38,400 baud serial port data rate. The host terminal will be required to switch to 38,400 baud before it can communicate with The LinkOEM further. When a "break" condition is detected, the device resets and returns to the 9600 baud data rate, so sending the "^" followed by more 9600 baud data will often find the device resetting and the speed returning to 9600 baud. *See note (1) below.*

Key **, (comma)** - Switches the device to the 19,200 baud serial port data rate. The host terminal will be required to switch to 19,200 baud before it can communicate with The LinkOEM further. When a "break" condition is detected, the device resets and returns to the 9600 baud data rate, so sending the "^" followed by more 9600 baud data will often find the device resetting and the speed returning to 9600 baud. *See note (1) below.*

Key (**spacebar**) – Causes The LinkOEM to display its ID string and version number.

Key \ (**backslash**) – Causes The LinkOEM to enter the 1-wire sniffer mode and switch to the 57,600 baud serial port rate. The 1-Wire sniffer function listens to the 1-Wire bus and decodes data on the bus. The LinkOEM ceases serving as the bus master in this mode. When data is detected on the bus, it is converted into hexadecimal bytes and displayed. Each time a 1-Wire bus reset is detected, a carriage return and line feed (CR/LF) are sent. This mode is used to debug 1-Wire master programs by capturing the actual data bytes that are observed on the bus. Overdrive speed is not supported by the sniffer mode.

The Dallas DS1410 series of parallel port 1-Wire interfaces generate narrow pulses (actually out-of-spec) that may not make it through the filtering that is an integral part of the LinkOEM analog front-end, and so this bus master may not work with the sniffer function. DS9097U adaptors, or other Link models, will work well as "sniff-able" bus masters.

In sniffer mode, only whole bytes are reported, so any partial bytes that occur prior to a reset will not be reported.

The switch to 57,600 baud is necessary to keep up with standard speed 1-Wire bus data.

Sending a "break" condition will cause the device to be reset to default settings, and to the default 9600 baud serial port data rate.

Key **|** (**vertical bar**) – This will cause The LinkOEM to enter a pass-thru mode. In this mode, all activity on the serial port output line is passed through (inverted) to the 1-Wire bus, and all activity on the 1-Wire bus is passed-through (inverted) to the serial port input line. This mode can be used to bypass The LinkOEM and allow the serial port direct access to the 1-Wire bus. Because the device is no longer able to interpret serial data in this mode, the only way to get out of the pass thru mode is by a power-on-reset of The LinkOEM.

Note 1: The 1-Wire bus with relaxed timing suitable for long lines can only process bits at a rate of about 14,000 per second. Streaming bytes using the (b) command will fail if the baud rate is set to more than 19,200 because the host will overrun the 1-Wire bus. When the baud rate is set to any value greater than 19,200 the host commands must be paced to assure that 1-Wire bus overrun does not occur.

Key **"** (**double quote**) – This will cause the Auxiliary output to enter the "Iso" mode and to become an image of the 1-Wire bus transmitter drive waveform. This signal can be useful when trying to accomplish an isolated 1-Wire connection or whenever a two-wire connection is preferred. The original 1-Wire bus remains unaffected. Setting the Auxiliary output level using the "z" or "d" keys will turn this feature off, as will any reset of the device. (See Appendix A for more information.)

Key "**.**" (**Period**) – This will turn OFF the dynamic pull-up (DPU) driver in the 1-Wire bus interface. The DPU helps extend the useable length of the 1-Wire bus by increasing the charge current at the appropriate times in the 1-Wire waveform. In the rare event that the action of the DPU causes a problem on shorter networks, this command allows it to be turned off. The LinkOEM responds with a carriage return/line feed. The DPU is turned back ON by any reset of The LinkOEM (break or power cycle).

Scanning:

It is often useful to scan the 1-Wire bus and report the *arrival* of a new 1-Wire device or the *departure* of a device from the bus. A bus scanning function is included in The LinkOEM to serve this purpose. When turned ON using the '$' character, the scanning system continually performs First and Next device discovery operations and builds a table of up to ten (10) device serial numbers. As a new device appears on the 1-Wire bus, and after the same device serial number (with correct CRC8 and a non-zero family code) has been observed on two subsequent full discovery passes, an Arrival is reported as a string with a "!" (exclamation-point) character, a comma, and then the arriving device serial number. When a device has been present on the bus and then is not found in ten (10) successive complete discovery cycles, it is reported as a Departure with a "?" (question mark) followed by a comma and then the serial number of the device that departed from the bus. (This de-bounces the departure.) Scanning is terminated by a Reset, First, Next or any number of other operations.

The scanning system will not work properly if more than 10 iButton or 1-Wire devices are present on the bus. This is due to the limited memory available in the LinkOEM.

Auxiliary I/O:

The LinkOEM provides an Auxiliary I/O line (Pin 10). This line is, by default, driven to the high impedance state and left un-powered. When set to the 5V level by the "**d**" command, this line can be used to provide power for DS2409 and DS2406/7 type 1-Wire switches. As a rule, load on the Aux line should be limited to less than 20 ma.

The Auxiliary pin (Pin 10) can be an output supplying a low level (0 VDC) or a high level (5 VDC), or it can be an input sensing a 0-5VDC logic level. This extra I/O defaults to input (Hi-Z) mode. Commands used by the host can cause the Auxiliary I/O pin to change its behavior as needed.

Questions about The LinkOEM should be directed to info@iButtonLink.com.

Appendix A – Isolation mode

When in the "Iso" (Isolation) mode, The LinkOEM outputs the 1-Wire driving waveform on the Aux pin. This can be used to extend the 1-Wire bus using other signaling protocols, or to isolate the bus using optical or galvanic isolation devices. The following diagram shows how the Isolation mode could be used to extend the 1-Wire port on The LinkOEM.
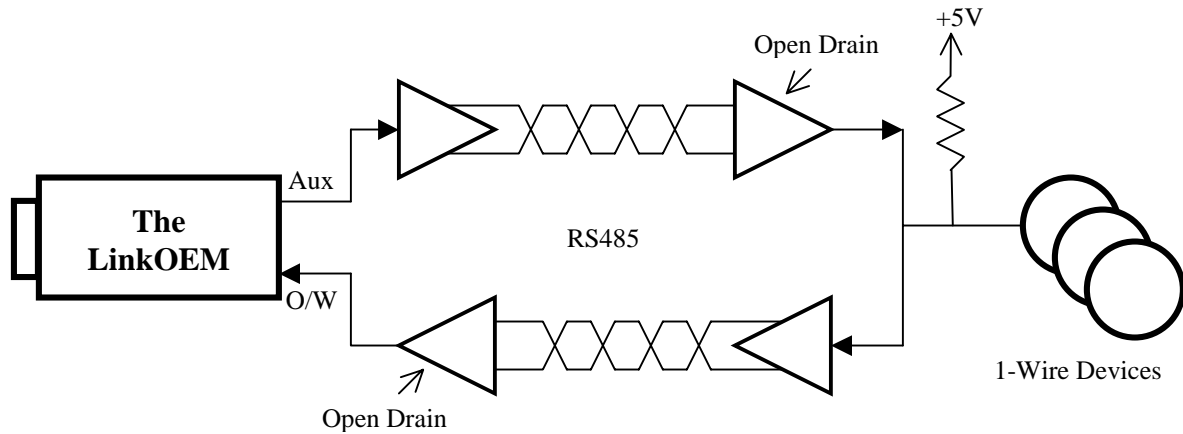
The LinkOEM also has a mode in which the timing of the 1-Wire waveforms is slowed to accommodate the longer turn-around times of extended host connections like that shown above. In the normal mode, network lengths of up to 3000 feet can be used (depending on the medium). In the extended mode, network lengths of between 2000 and 6000 feet

## Appendix B – 1-Wire Communications Examples

The sequence for reading a DS18B20 temp sensor via the LinkOEM ™ Module is straightforward:

1. Issue a 1-wire reset (r).

2. Enter byte mode (b) and address the ROM by sending 0x55 followed by the ROM address in reverse byte order (that is, if the discovered id is E60000003DA0E128 you would address it as 28E1A03D000000E6).

3. Send the convert command 44.

4. Exit byte mode (CR).

5. Wait at least 900ms for the conversion to complete.

6. Issue a 1-wire reset (r).

7. Enter byte mode (b) and address the ROM as before.

8. Send the read command BE.

9. Send two read commands as FFFF. The echoed data will contain the temperature reading in Intel (little-endian) order as a 16-bit signed int.

10. Exit byte mode (CR).
The returned value will be in 1/16 deg C increments. So a return value of 5701 represents 0x0157, or 343 in decimal. Dividing by 16 gives us 21.4 degrees C, or 70.6 degrees F. Mind the sign bit, or values below freezing will appear to be unusually warm by several thousand degrees.

Debugging hint:
The power up default of the device is 85 degrees C (185 degrees F). Look carefully if you receive this value. This indicates that a convert has never been executed by this device. It is possible to address a device and NOT have enough power available for it to execute a convert.

Appendix C ... Pin outs
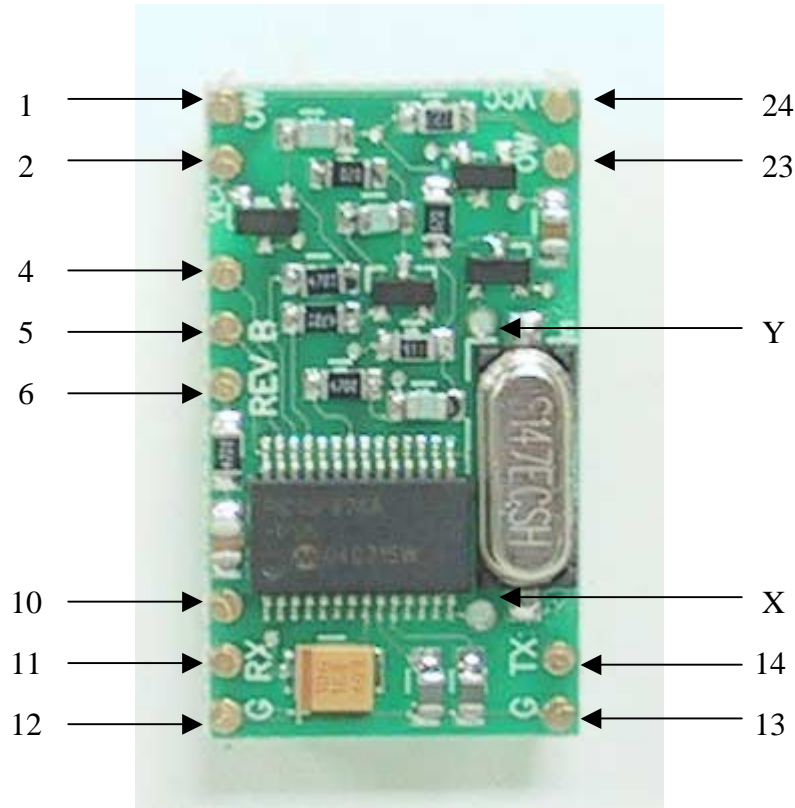
1 – Ow Bus (Repeated on 23)
2 – Vcc (+5V ... Repeated on Pin 24)
4 – RB7/PGD (Pic Pin 23) ... Used for programming
5 – RB6/PGC (Pic Pin 24) ... Used for programming
6 – Master Clear (PIC Pin 1) ... Used for programming and reset
10 – Aux
11 – Serial Receive Data
12 – Vss (Ground)
13 – Vss (Ground)
14 – Serial Transmit Data
X – I2C Clock (Pic Pin 14 ... RC3/SCK/SCL)
Y – I2C Data (Pic Pin 15 ... RC4/SDI/SDA)
23 – OW Data (Repeated on Pin 1)
24 – Vcc (+5V ... Repeated on Pin 2)

Processor is Pic 16F876a clocked at 14.7456 Mhz. This yields serial baud rates
up to 115200 with 0.0% error. Form factor is 24 Pin DIP 0.600 spacing.