Linx
TECHNOLOGIES

QS Series
USB Module
Data Guide

Wireless made simple®

⚠ Warning: Some customers may want Linx radio frequency ("RF") products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns ("Life and Property Safety Situations").

NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS. No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product's regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/ decoder to validate the data. Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

All RF products are susceptible to RF interference that can prevent communication. RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

Do not use any Linx product over the limits in this data guide. Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

Do not make any physical or electrical modifications to any Linx product. This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

Table of Contents

QS Series USB Module

Data Guide

Description

The Linx QS Series USB module allows the rapid addition of USB to virtually any device. Housed in a compact SMD package, the QS module provides a complete solution for converting between USB and CMOS / TTL logic level serial sources. The module can be directly connected to virtually any serial device including microprocessors, RS-232 / RS-485 level converters or Linx wireless RF modules. The QS module is completely self contained so it requires no external components except a USB jack and includes all necessary firmware and drivers, freeing the designer from complicated programming. Power can be supplied externally or from the USB bus. Both USB 1.1 and USB 2.0 are supported at data rates up to 3Mbps.
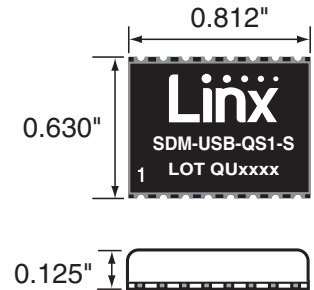
0.812"

0.630"

Linx
SDM-USB-QS1-S
LOT QUxxxx

1

0.125"

Figure 1: Package Dimensions

Features

- Single chip USB-to-asynchronous serial data conversion
- Low cost
- 3Mbps baud rate
- Supports low-speed USB
- Full handshaking support for RS-232 and RS-485
- Bus or self-powered

- Compact surface-mount package
- VID, PID, serial number and descriptors programmed via USB
- No external components needed except a USB jack
- Drivers and firmware included
- Supports Windows 98 / 2000 / ME / XP / Vista/Windows 7
- USB 1.1 and 2.0 compatible

Applications

- Interface / upgrade legacy peripherals
- Interface microcontrollers & USB
- USB to RS-232 / RS-485 converters
- Interfacing RF modules to USB

- USB smart card readers
- USB modems
- Robotics
- USB instrumentation
- USB game controllers
- USB-to-serial converter cables

Ordering Information

Ordering Information	
Part Number	**Description**
SDM-USB-QS-S	QS Series USB Module
MDEV-USB-QS	QS Series Master Development Kit

Figure 2: Ordering Information

Absolute Maximum Ratings

Absolute Maximum Ratings				
Supply Voltage V_{CC}	−0.5	to	+6.0	VDC
Any Input or Output Pin	−0.5	to	V_{CC} + 0.5	VDC
Max. Current Sourced by Output Pins		24		mA
Operating Temperature	0	to	+70	°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

Electrical Specifications

QS Series USB Module Specifications						
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Notes**
Power Supply						
Operating Voltage	V_{CC}	4.35	5.0	5.25	VDC	
Supply Current	I_{CC}		26.0	28.0	mA	
UART SECTION						
Data Rate		0.0003		3.0	Mbps	
Data Output:						
Logic Low	V_{OL}	0.3	0.4	0.6	VDC	
Logic High	V_{OH}	3.2	4.1	4.9	VDC	
EEPROM Size				1,024	Bits	
USB Section						
Data Output:						
Logic Low	UV_{OL}	0.0		0.3	VDC	
Logic High	UV_{OH}	2.8		3.6	VDC	
Single-Ended RX Threshold	UV_{SE}	0.8		2.0	VDC	
Differential Common Mode	UC_{OM}	0.8		2.5	VDC	
Differential Input Sensitivity	UV_{DIF}	0.2			VDC	
Driver Output Impedance	UD_{RVZ}	29		44	Ω	
Environmental						
Operating Temperature Range		0.0		+70	°C	

Figure 4: 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.
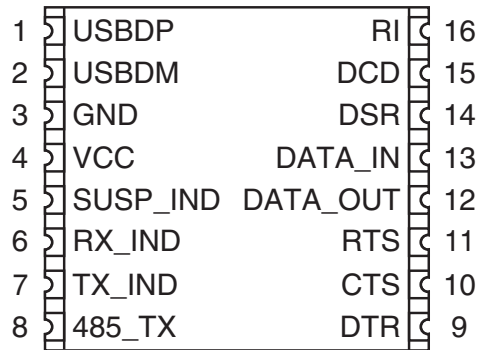
Pin Assignments

```
1  USBDP          RI   16
2  USBDM         DCD   15
3  GND           DSR   14
4  VCC       DATA_IN   13
5  SUSP_IND  DATA_OUT  12
6  RX_IND        RTS   11
7  TX_IND        CTS   10
8  485_TX        DTR    9
```

Figure 5: SDM-USB-QS-S Pinout (Top View)

Pin Descriptions

Pin Descriptions		
Pin Number	Name	Description
1	USBDP	USB data signal plus
2	USBDM	USB data signal minus
3	GND	Ground supply
4	V_{CC}	Positive power supply
5	SUSP_IND	Goes low during USB Suspend Mode. This pin can be used to power down external logic when the host puts the USB bus into suspend mode.
6	RX_IND	This line will pulse low when receiving data from the USB bus. This allows for the connection of a LED indicator.
7	TX_IND	This line will pulse low when transmitting data on the USB bus. This allows for the connection of a LED indicator.
8	485_TX	Transmit enable line for RS-485 applications.
9	DTR	Data Terminal Ready control / handshake output
10	CTS	Clear to Send control / handshake input
11	RTS	Request To Send / handshake output
12	DATA_OUT	Transmit asynchronous data output
13	DATA_IN	Receive asynchronous data input
14	DSR	Data Set Ready control / handshake input
15	DCD	Data Carrier Detect control / input
16	RI	Ring Indicator control input

Figure 6: Pin Descriptions

Module Description

The Linx SDM-USB-QS module converts USB signals from a host, such as a PC or hub, into TTL logic level signals. This enables the module to be connected directly to microcontrollers (or Linx RF modules for wireless applications) or to RS-232 or RS-485 level converters for communication with legacy devices. The module handles all complicated enumeration and bus communication processes, freeing the designer to focus on handling the data. All necessary firmware is included in the module and the device descriptors can easily be changed to customize the module.

The host application software can access the USB device by simple, custom functions or by standard Windows Win32 API calls. In addition, Virtual COM Port drivers are available that make the USB module appear to the PC as a COM port, without the need for additional system resources, such as an IRQ or address. This allows the designer to program the application software to use standard serial or parallel ports and then simply select the port that represents the USB module. The drivers automatically direct the data to the USB bus and the device.

Theory of Operation
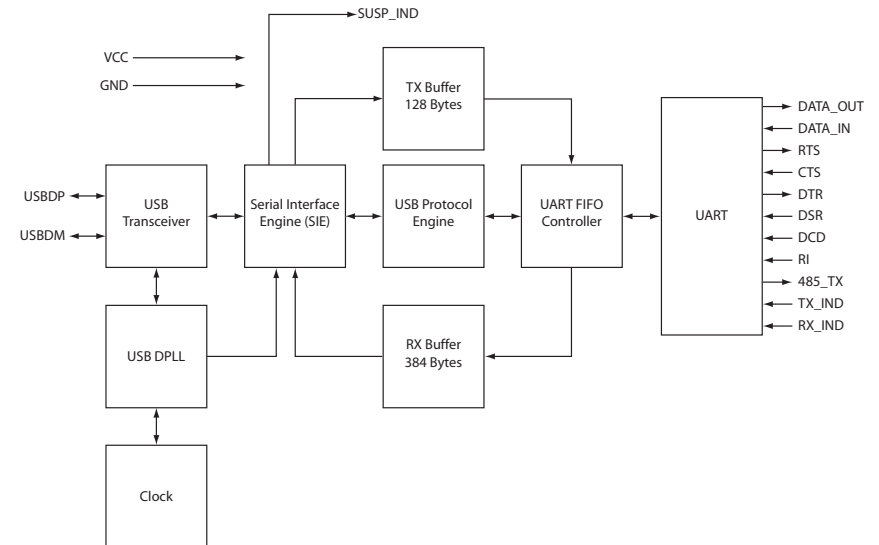
Figure 7 shows a block diagram of the QS module.

Figure 7: SDM-USB-QS-S Block Diagram

The USB transceiver block provides the physical interface for the USB signalling.

The USB DPLL locks onto the NRZ data and provides separate recovered clock and data signals to the Serial Interface Engine (SIE).

The SIE performs the parallel-to-serial and serial-to-parallel conversion, bitstuffing / un-stuffing, and CRC calculations on the USB data.

The USB Protocol Engine manages the data from the USB control endpoint, the USB protocol requests from the USB host controller, and the commands for controlling the functional parameters of the UART.

Data from the USB data out endpoint is stored in the TX buffer and removed from the buffer to the UART transmit register under control of the UART FIFO controller.

Data from the UART receive register is stored in the RX buffer prior to being removed by the SIE on a USB request for data from the device data in endpoint.

The UART FIFO controller handles the transfer of data between the RX and TX buffers and the UART transmit and receive registers.

The UART performs asynchronous 7 / 8 bit parallel-to-serial and serial-to-parallel conversion of the data on the RS-232 interface. Control signals supported by the UART include RTS, CTS, DSR, DTR, DCD, and RI. The UART provides a transmitter-enable control signal (485_TX) to assist with interfacing to RS-485 transceivers. The UART supports RTS / CTS, DSR / DTR and X-On / X-Off handshaking options. Handshaking, where required, is handled in hardware to ensure fast response times. The UART also supports the RS-232 BREAK setting and detection conditions.

Installing the Drivers

The drivers for the USB module are included with the module's development system or may be downloaded from the Linx website at www.linxtechnologies.com. These drivers should be downloaded onto the hard drive of a PC or onto a disk. When the module is attached to the PC for the first time, Windows automatically detects the device and searches for the best driver. Windows prompts for the location of the drivers, so browse to the folder or the disk, click Next, and Windows does the rest. Windows XP may return an error window as shown in Figure 8.
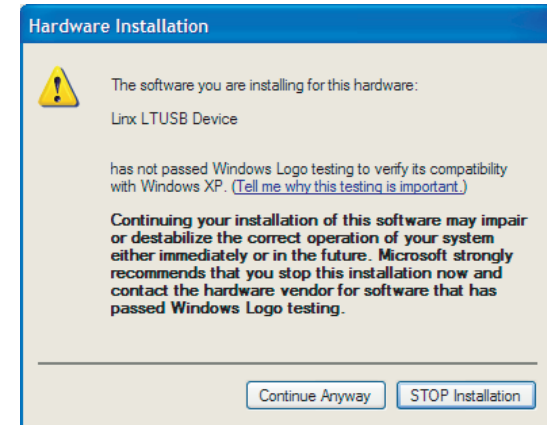

Figure 8: Windows XP Driver Error Window

This window is simply a warning that the driver has not gone through Microsoft's certification process and could potentially pose a problem for the system. The drivers provided for the QS module are Microsoft Certified and should not pose any problems unless modified by the user. Click the Continue Anyway button to finish the installation process.

Changing the Device Descriptions

The QS can be customized to display the product's name, manufacturer name, and to use different Product Identifiers (PID) and Vendor Identifiers (VID). This allows an end user to see the final product's name in their Windows Device Manager and when the hardware is first loaded. The PID and VID are set by the USB Implementers Forum and should not be changed unless the final product has gone through the certification process and received its own unique IDs.

The Manufacturer, Description, and Serial Number strings can all be modified using the QS EEPROM Programmer software, which can be downloaded from the Linx web site. This easy-to-use software reprograms the module via the USB bus and can be done during production testing.

Once the module is reprogrammed, some modifications to the driver files may be necessary. If a VID and PID other than the default Linx numbers are used, these numbers need to be added to the files. This requires modifying several lines in the .inf files and is described in detail in the QS Series Programmer's Guide. Modifying the name displayed by the Windows Device Manager requires changing only one line, also described in the Programmer's Guide.

Software Considerations

The PC needs a set of drivers that tell it how to communicate with the QS module. The CDM drivers for the QS Series module install two different drivers at the same time. The first driver makes the QS appear as a COM port on the host PC. This allows the application to use standard writes and reads to a serial port, and the drivers redirect data to the USB module.

The second driver supports a series of functions that allow direct control of the QS module. These functions are described in Application Note AN-00200: SDM-USB-QS Programmer's Guide, where examples are given in both Visual Basic and C. The Programmer's Guide can be downloaded from the Application Notes page in the Support section of the Linx website. Sample software is available on the Software page in the Support section.

In addition to the Programmer's Guide, the QS Series Master Development System (MDEV-USB-QS) includes example software and sample system source code. This source code provides the driver function declarations, examples of how to use the functions in a program, and other code that may be of use.

Serial Number Considerations

The VID and PID are used by Windows to determine what devices are attached to the bus and which drivers to load in order to communicate with each device. A unique serial number is used to distinguish between different devices of the same type so that the operating system can be sure that it is communicating with the correct one. Windows views every different combination of VID, PID and serial number as a new device and starts the "Found New Hardware" wizard for each one. This is an issue in a mass production environment, so the QS modules are shipped with the "Enable Serial Number" option disabled in the EEPROM. This prevents the serial number from being used during ennumeration.

With the serial number disabled, Windows tracks each device by connection and assign a USB port to a particular device. If the device is moved to another port, it needs to be reinstalled. The problem that arises is that the device is installed on the same PC multiple times, once for each USB port into which it has been plugged.

It is recommended to set the "Enable Serial Number" option and to use a unique serial number as a part of the product's final testing procedure. The QS EEPROM Programmer can be downloaded from the Linx website and the EEPROM programming functions can be found in Application Note AN-00200. These can be used as a part of an automated test program at the end of the production line to program custom descriptors and a unique serial number into the product.

> Note: Avoid using the same serial number for multiple devices, as it can cause a conflict in the operating system. Windows XP has a particular problem with this and may crash if it sees two of the same type of device with the same serial number on the same bus.

Power Supply Guidelines

The USB module can be powered in two ways: from the USB bus or from an external source. If necessary, a voltage regulator can be used to supply a clean 5V as the external source, or the V_{CC} pin can be connected to the bus power pin of the USB connector. Using the bus to power the module is an advantage because the module then uses power from the host rather than from the peripheral. This is especially helpful if the peripheral is battery-powered. Figure 9 shows the schematic powering from the bus.
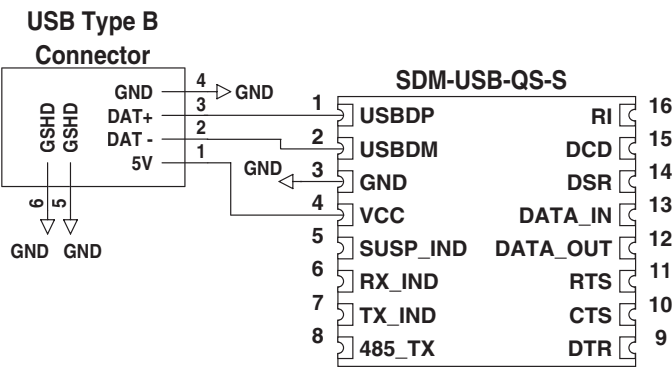
Figure 9: USB Bus-Powered Schematic

The USB specification has strict allowances for using power from the bus. A device is allowed to use 100mA before enumeration, 500mA during normal operation, and 500mA in suspend mode. A descriptor stored in the EEPROM tells the host how much current the device will pull from the bus so that the host can allocate the appropriate power. The modules come programmed for 100mA, but if the final product draws more than this, then the device descriptors need to be changed.

Pad Layout

The following pad layout diagram is designed to facilitate both hand and automated assembly.
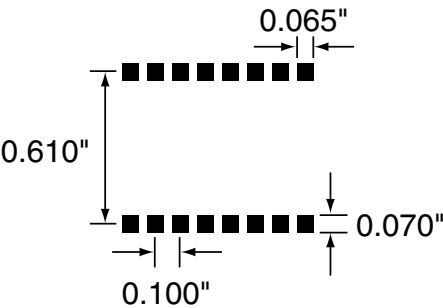

Figure 10: Recommended PCB Layout

Helpful Application Notes from Linx

It is not the intention of this manual to address in depth many of the issues that should be considered to ensure that the modules function correctly and deliver the maximum possible performance. We recommend reading the application notes listed in Figure 11 which address in depth key areas of RF design and application of Linx products. These applications notes are available online at www.linxtechnologies.com or by contacting Linx.

Helpful Application Note Titles	
Note Number	Note Title
AN-00200	SDM-USB-QS-S Programmer's Guide
AN-00201	Installing the SDM-USB-QS-S Drivers

Figure 11: Helpful Application Note Titles

Typical Applications

There are many potential uses for the QS Series modules, three of which will be described here. Figure 12 shows the QS and a MAX213 RS-232 level converter IC from Maxim. This creates a USB-to-RS-232 converter that supports all of the standard handshaking lines. Similarly, RS-485 or RS-422 level converter chips could be used for designs requiring those standards.
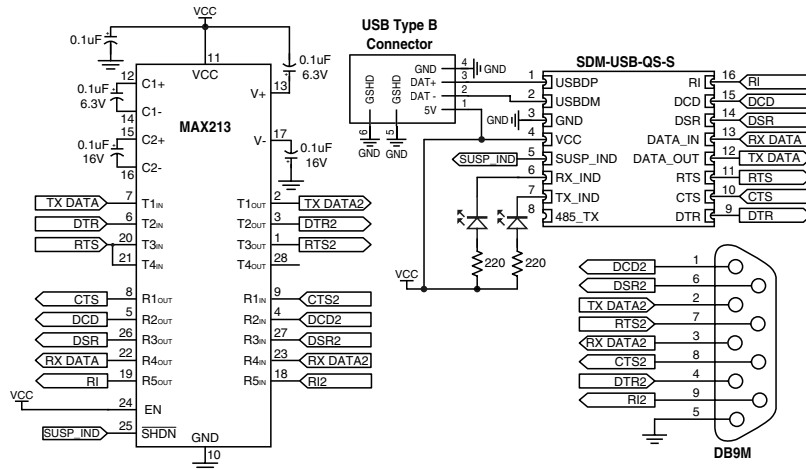

Figure 12: RS-232 to USB Converter

The QS Series modules can be used with Linx RF modules to create a wireless link between two PCs. Figure 13 shows a design using the ES Series RF modules. An option not shown in the schematic below is that one of the output lines of the QS module (RTS or DTR) could be connected to the PDN lines of the RF modules, enabling the host to turn the RF modules on and off.
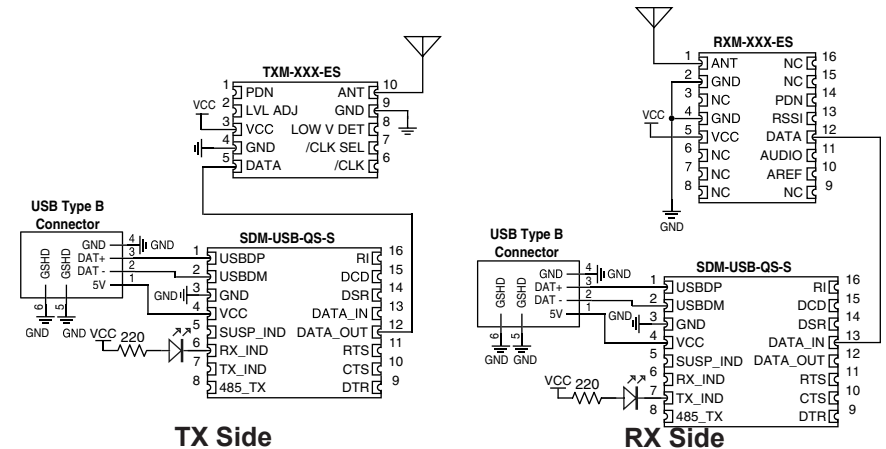

TX Side   RX Side

Figure 13: Wireless Modem Using ES Series RF Modules

Figure 14 below shows the QS module connected to a microprocessor. This is the design used in the QS Master Development Kit and the documentation for the kit describes the connections and software.
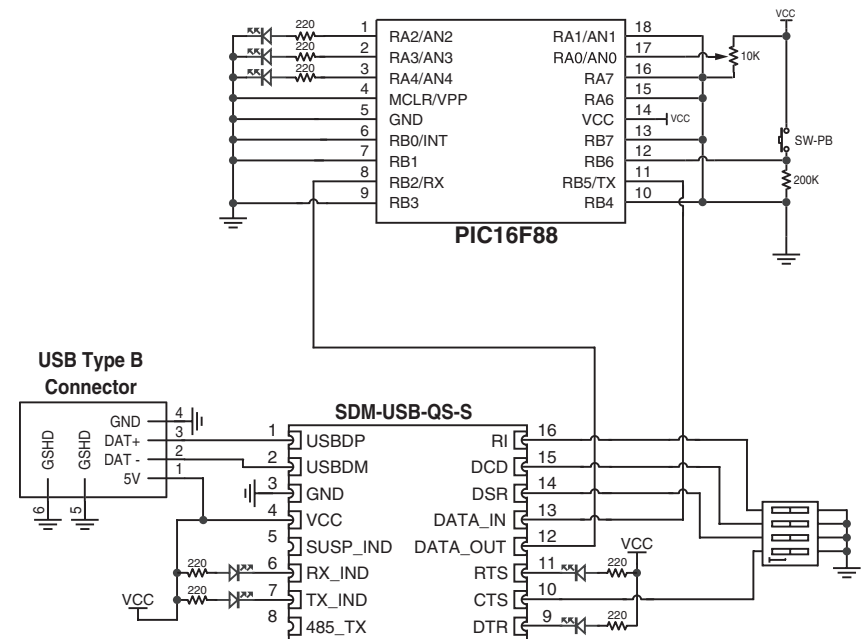

Figure 14: Interface with a Microprocessor

Production Guidelines

The module is housed in a hybrid SMD package that supports hand and automated assembly techniques. Since the modules contain discrete components internally, the assembly procedures are critical to ensuring the reliable function of the modules. The following procedures should be reviewed with and practiced by all assembly personnel.

Hand Assembly

Pads located on the bottom of the module are the primary mounting surface (Figure 15). Since these pads are inaccessible during mounting, castellations that run up the side of the module have been provided to facilitate solder wicking to the module's underside. This allows for very
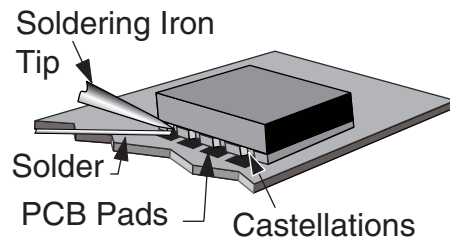

Figure 15: Soldering Technique

quick hand soldering for prototyping and small volume production. If the recommended pad guidelines have been followed, the pads will protrude slightly past the edge of the module. Use a fine soldering tip to heat the board pad and the castellation, then introduce solder to the pad at the module's edge. The solder will wick underneath the module, providing reliable attachment. Tack one module corner first and then work around the device, taking care not to exceed the times in Figure 16.

Warning: Pay attention to the absolute maximum solder times.

Absolute Maximum Solder Times
Hand Solder Temperature: +427ºC for 10 seconds for lead-free alloys
Reflow Oven: +255ºC max (see Figure 40)

Figure 16: Absolute Maximum Solder Times

Automated Assembly

For high-volume assembly, the modules are generally auto-placed. The modules have been designed to maintain compatibility with reflow processing techniques; however, due to their hybrid nature, certain aspects of the assembly process are far more critical than for other component types. Following are brief discussions of the three primary areas where caution must be observed.

Reflow Temperature Profile

The single most critical stage in the automated assembly process is the reflow stage. The reflow profile in Figure 17 should not be exceeded because excessive temperatures or transport times during reflow will irreparably damage the modules. Assembly personnel need to pay careful attention to the oven's profile to ensure that it meets the requirements necessary to successfully reflow all components while still remaining within the limits mandated by the modules. The figure below shows the recommended reflow oven profile for the modules.
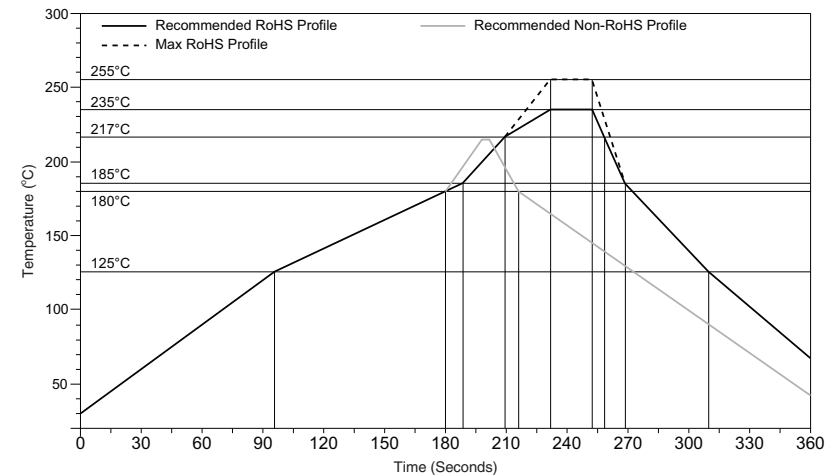

Figure 17: Maximum Reflow Temperature Profile

Shock During Reflow Transport

Since some internal module components may reflow along with the components placed on the board being assembled, it is imperative that the modules not be subjected to shock or vibration during the time solder is liquid. Should a shock be applied, some internal components could be lifted from their pads, causing the module to not function properly.

Washability

The modules are wash-resistant, but are not hermetically sealed. Linx recommends wash-free manufacturing; however, the modules can be subjected to a wash cycle provided that a drying time is allowed prior to applying electrical power to the modules. The drying time should be sufficient to allow any moisture that may have migrated into the module to evaporate, thus eliminating the potential for shorting damage during power-up or testing. If the wash contains contaminants, the performance may be adversely affected, even after drying.

Linx Technologies
159 Ort Lane
Merlin, OR, US 97532

Phone: +1 541 471 6256
Fax: +1 541 471 6251

www.linxtechnologies.com

Disclaimer

Linx Technologies is continually striving to improve the quality and function of its products. For this reason, we reserve the right to make changes to our products without notice. The information contained in this Data Guide is believed to be accurate as of the time of publication. Specifications are based on representative lot samples. Values may vary from lot-to-lot and are not guaranteed. "Typical" parameters can and do vary over lots and application. Linx Technologies makes no guarantee, warranty, or representation regarding the suitability of any product for use in any specific application. It is the customer's responsibility to verify the suitability of the part for the intended application. NO LINX PRODUCT IS INTENDED FOR USE IN ANY APPLICATION WHERE THE SAFETY OF LIFE OR PROPERTY IS AT RISK.

Linx Technologies DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL LINX TECHNOLOGIES BE LIABLE FOR ANY OF CUSTOMER'S INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING IN ANY WAY FROM ANY DEFECTIVE OR NON-CONFORMING PRODUCTS OR FOR ANY OTHER BREACH OF CONTRACT BY LINX TECHNOLOGIES. The limitations on Linx Technologies' liability are applicable to any and all claims or theories of recovery asserted by Customer, including, without limitation, breach of contract, breach of warranty, strict liability, or negligence. Customer assumes all liability (including, without limitation, liability for injury to person or property, economic loss, or business interruption) for all claims, including claims from third parties, arising from the use of the Products. The Customer will indemnify, defend, protect, and hold harmless Linx Technologies and its officers, employees, subsidiaries, affiliates, distributors, and representatives from and against all claims, damages, actions, suits, proceedings, demands, assessments, adjustments, costs, and expenses incurred by Linx Technologies as a result of or arising from any Products sold by Linx Technologies to Customer. Under no conditions will Linx Technologies be responsible for losses arising from the use or failure of the device in any application, other than the repair, replacement, or refund limited to the original product purchase price. Devices described in this publication may contain proprietary, patented, or copyrighted techniques, components, or materials. Under no circumstances shall any user be conveyed any license or right to the use or ownership of such items.