



**F4 Series**  
**GPS Receiver Module**  
**Data Guide**

**Wireless made simple<sup>®</sup>**



**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.

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**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.

## Ordering Information

Ordering Information	
Part Number	Description
RXM-GPS-F4-x	F4 Series GPS Receiver Module
MDEV-GPS-F4	F4 Series GPS Receiver Master Development System

x = "T" for Tape and Reel, "B" for Bulk  
 Reels are 1,000 pieces  
 Quantities less than 1,000 pieces are supplied in bulk

Figure 2: Ordering Information

## Electrical Specifications

F4 Series GPS Receiver Specifications						
Parameter	Symbol	Min.	Typ.	Max.	Units	Notes
Power Supply						
Operating Voltage	$V_{CC}$	1.71	1.8	1.89	VDC	
Supply Current	$I_{CC}$					
Peak				130	mA	1
Acquisition			46		mA	1
Tracking			27.5		mA	1
Hibernate			20		$\mu$ A	1
Ready-to-Start			9		$\mu$ A	2
Output Low Voltage	$V_{OL}$			0.4	VDC	
Output High Voltage	$V_{OH}$	0.75*VCC		VCC	VDC	
Output Low Current	$I_{OL}$		2.0		mA	
Output High Current	$I_{OH}$		2.0		mA	
Input Low Voltage	$V_{IL}$	-0.4		0.45	VDC	
Input High Voltage	$V_{IH}$	0.7*VCC		3.6	VDC	
Input Capacitance	$C_{IN}$		5		pF	
Load Capacitance	$C_{LOAD}$			8	pF	
LNA Section						
Input Power	$P_{IN}$			18	dB	
Antenna Port						
RF Impedance	$R_{IN}$		50		$\Omega$	
Environmental						
Operating Temperature		-30		85	$^{\circ}$ C	
Storage Temperature		-40		85	$^{\circ}$ C	

## Pin Assignments

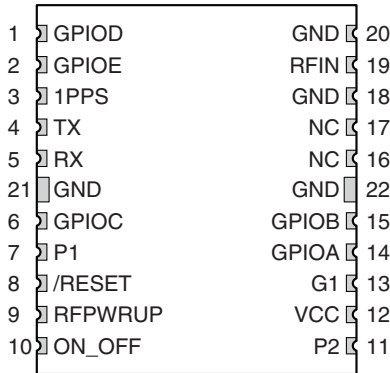


Figure 5: F4 Series GPS Receiver Pin Assignments (Top View)

## Pin Descriptions

Pin Descriptions			
Pin Number	Name	I/O	Description
1	GPIOD	I/O	General Purpose I/O. 3.6V tolerant.
2	GPIOE	I/O	General Purpose I/O. 3.6V tolerant.
3	1PPS	O	1 Pulse Per Second. 1.8V level.
4	TX	O	Serial output (default NMEA)
5	RX	I	Serial input (default NMEA). 3.6V tolerant.
6	GPIOC	I/O	General Purpose I/O. 3.6V tolerant.
7, 11	P1, P2	I	Pull to 1.8V VCC through 2.2k resistors.
8	/RESET	I	Reset Input. Active low with an internal pull-up. Internal reset is preferred; external reset will clear all RAM. 3.6V tolerant.
9	RFPWRUP	O	Power State Indicator
10	ON_OFF	I	Power Control Pin. Internal 10k pull-down resistor. 3.6V tolerant.
12	VCC	P	Supply Voltage
13	G1	I	Pull to GND through a 100k resistor.
14	GPIOA	I/O	General Purpose I/O. 3.6V tolerant.
15	GPIOB	I/O	General Purpose I/O. 3.6V tolerant.
16, 17	NC	-	No electrical connection.
18, 20, 21, 22	GND	P	Ground
19	RFIN	I	GPS RF signal input

Figure 6: F4 Series GPS Receiver Pin Descriptions

## Time To First Fix (TTFF)

TTFF is often broken down into three parts:

**Cold:** A cold start is when the receiver has no accurate knowledge of its position or time. This happens when the receiver's internal Real Time Clock (RTC) has not been running or it has no valid ephemeris or almanac data. In a cold start, the receiver takes 35 to 40 seconds to acquire its position.

**Warm or Normal:** A typical warm start is when the receiver has valid almanac and time data and has not significantly moved since its last valid position calculation. This happens when the receiver has been shut down for more than 2 hours, but still has its last position, time, and almanac saved in memory, and its RTC has been running. The receiver can predict the location of the current visible satellites and its location; however, it needs to wait for an ephemeris broadcast (every 30 seconds) before it can accurately calculate its position.

**Hot or Standby:** A hot start is when the receiver has valid ephemeris, time, and almanac data. This happens when the receiver has been shut down for less than 2 hours and has the necessary data stored in memory with the RTC running. In a hot start, the receiver takes 1 second to acquire its position. The time to calculate a fix in this state is sometimes referred to as Time to Subsequent Fix or TTTF.

## Antenna Considerations

The F4 Series module is designed to utilize a wide variety of external antennas, but care must be taken in antenna selection to ensure optimum performance. For example, a handheld device may be used in many varying orientations so an antenna element with a wide and uniform pattern may yield better overall performance than an antenna element with high gain and a correspondingly narrower beam. Conversely, an antenna mounted in a fixed and predictable manner may benefit from pattern and gain characteristics suited to that application. Evaluating multiple antenna solutions in real-world situations is a good way to rapidly assess which will best meet the needs of your application.

For GPS, the antenna should have good right hand circular polarization characteristics (RHCP) to match the polarization of the GPS signals. Ceramic patches are the most commonly used style of antenna, but there are many different shapes, sizes and styles of antennas available. Regardless of the construction, they will generally be either passive or active types. Passive antennas are simply an antenna tuned to the correct frequency. Active antennas add a Low Noise Amplifier (LNA) after the antenna and before the module to amplify the weak GPS satellite signals.

For active antennas, a 300 ohm ferrite bead can be used to connect the the RFIN line to an external supply for the antenna. This bead prevents the RF from getting into the power supply, but allows the DC voltage onto the RF trace to feed into the antenna. A series capacitor inside the module prevents this DC voltage from affecting the bias on the module's internal LNA.

Maintaining a 50 ohm path between the module and antenna is critical. Errors in layout can significantly impact the module's performance. Please review the layout guidelines elsewhere in this guide carefully to become more familiar with these considerations.

## Power Control

The F4 Series GPS Receiver module offers four power control modes: Full Power, Adaptive Trickle Power, Push-to-Fix and Hibernate. In Full Power mode the module is fully active and continuously tracking. Measurements are of the highest quality and are continuously output by the module. This is the highest current consumption state.

In Adaptive Trickle Power mode, the receiver powers on at full power to

## Module Power-up Sequence

The module requires a specific sequence to power up and begin normal operation. When power is first applied the module enters a “ready-to-start” state while the Real Time Clock (RTC) starts up and settles. It awaits a pulse on the ON\_OFF line to enter Full Power Mode.

The RTC start time is variable, so the host needs to either monitor the RFPWRUP line for a high pulse or wait for at least one second before pulsing the ON\_OFF line. An example flowchart is shown in Figure 8.

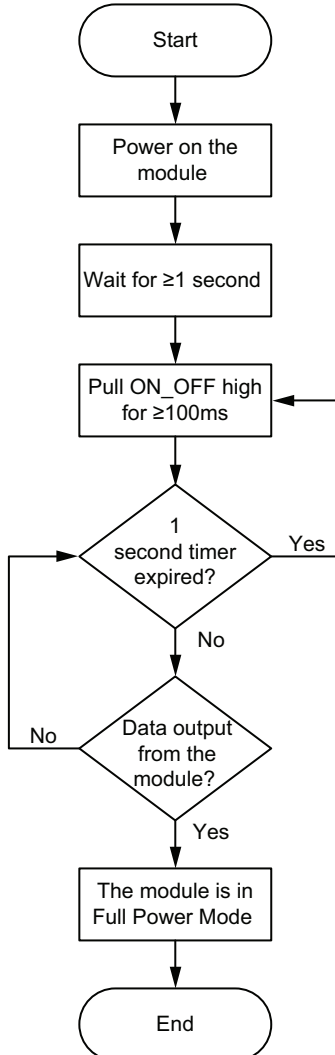


Figure 8: F4 Series GPS Receiver Power Power-up Sequence



## Slow Start Time

The most critical factors in start time are current ephemeris data, signal strength and sky view. The ephemeris data describes the path of each satellite as they orbit the earth. This is used to calculate the position of a satellite at a particular time. This data is only usable for a short period of time, so if it has been more than a few hours since the last fix or if the location has significantly changed (a few hundred miles), then the receiver may need to wait for a new ephemeris transmission before a position can be calculated. The GPS satellites transmit the ephemeris data every 30 seconds. Transmissions with a low signal strength may not be received correctly or be corrupted by ambient noise. The view of the sky is important because the more satellites the receiver can see, the faster the fix and the more accurate the position will be when the fix is obtained.

If the receiver is in a very poor location, such as inside a building, urban canyon, or dense foliage, then the time to first fix can be slowed. In very poor locations with poor signal strength and a limited view of the sky with outdated ephemeris data, this could be on the order of several minutes. In the worst cases, the receiver may need to receive almanac data, which describes the health and course data for every satellite in the constellation. This data is transmitted every 15 minutes. If a lock is taking a long time, try to find a location with a better view of the sky and fewer obstructions. Once locked, it is easier for the receiver to maintain the position fix.

## Protocols

Linx GPS modules use the SiRFstar IV chipset. This chipset allows two protocols to be used, NMEA-0183 and SiRF Binary. Switching between the two is handled using a single serial command. The NMEA protocol uses ASCII characters for the input and output messages and provides the most common features of GPS development in a small command set. The SiRF Binary protocol uses BYTE data types and allows more detailed control over the GPS receiver and its functionality using a much larger command set. Although both protocols have selectable baud rates, it's recommended that SiRF Binary use 115,200bps. For a detailed description of the SiRF Binary protocol, see the SiRF Binary Protocol Reference Manual, available from SiRF Technology, Inc.

**Note:** Although SiRF Binary protocol may be used with the module, Linx only offers tech support for the NMEA protocol.

## NMEA Output Messages

The following sections outline the data structures of the NMEA messages that are supported by the module. By default, the NMEA commands are output at 9,600bps, 8 data bits, no parity 1 start bit and 2 stop bits.

### GGA – Global Positioning System Fixed Data

Figure 10 contains the values for the following example:

*\$GPGGA,053740.000,2503.6319,N,12136.0099,E,1,08,1.1,63.8,M,15.2,M,,0000\*64*

Global Positioning System Fixed Data Example			
Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	053740.000		hhmmss.sss
Latitude	2503.6319		ddmm.mmmm
N/S Indicator	N		N=north or S=south
Longitude	12136.0099		dddmm.mmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Figure 11
Satellites Used	08		Range 0 to 12.
HDOP	1.1		Horizontal Dilution of Precision
MSL Altitude	63.8	meters	
Units	M	meters	
Geoid Separation	15.2	meters	
Units	M	meters	
Age of Diff. Corr.		second	Null fields when DGPS is not used
Diff. Ref. Station	0000		
Checksum	*64		
<CR> <LF>			End of message termination

Figure 10: Global Positioning System Fixed Data Example

Position Indicator Values	
Value	Description
0	Fix not available or invalid
1	GPS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
3-5	Not supported
6	Dead Reckoning Mode, fix valid

Figure 11: Position Indicator Values

## Mode 1 Values

Value	Description
M	Manual – forced to operate in 2D or 3D mode
A	Automatic – allowed to automatically switch 2D/3D

Figure 14: Mode 1 Values

## GSV – GPS Satellites in View

Figure 15 contains the values for the following example:

`$GPGSV,3,1,12,28,81,285,42,24,67,302,46,31,54,354,,20,51,077,46*73`

`$GPGSV,3,2,12,17,41,328,45,07,32,315,45,04,31,250,40,11,25,046,41*75`

`$GPGSV,3,3,12,08,22,214,38,27,08,190,16,19,05,092,33,23,04,127,*7B`

### GPS Satellites in View Example

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Total number of messages <sup>1</sup>	3		Range 1 to 3
Message number <sup>1</sup>	1		Range 1 to 3
Satellites in view	12		
Satellite ID	28		Channel 1 (Range 01 to 196)
Elevation	81	degrees	Channel 1 (Range 00 to 90)
Azimuth	285	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	42	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
Satellite ID	20		Channel 4 (Range 01 to 32)
Elevation	51	degrees	Channel 4 (Range 00 to 90)
Azimuth	077	degrees	Channel 4 (Range 00 to 359)
SNR (C/No)	46	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking).
Checksum	*73		
<CR> <LF>			End of message termination

1. Depending on the number of satellites tracked, multiple messages of GSV data may be required.

Figure 15: GPS Satellites in View Example

## VTG – Course Over Ground and Ground Speed

Figure 17 contains the values for the following example:

\$GPVTG,79.65,T,,M,2.69,N,5.0,K,A\*38

Course Over Ground and Ground Speed Example			
Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course over ground	79.65	degrees	Measured heading
Reference	T		TRUE
Course over ground		degrees	Measured heading (N/A, null field)
Reference	M		Magnetic
Speed over ground	2.69	knots	Measured speed
Units	N		Knots
Speed over ground	5.0	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		A=autonomous, D=DGPS, N= Data not valid
Checksum	*38		
<CR> <LF>			End of message termination

Figure 17: Course Over Ground and Ground Speed Example

Query	214	Get configuration and last state of all GPIOs
Query	215	Get configuration and current state of all GPIOs

Figure 19: Message ID Values

## 100 – SetSerialPort

This command message is used to set the protocol (SiRF binary or NMEA) and/or the communication parameters (baud rate). Generally, this command is used to switch the module back to SiRF binary protocol mode where a more extensive command message set is available. When a valid message is received, the parameters are stored in battery-backed SRAM and the receiver restarts using the saved parameters.

Figure 20 contains the values for the following example:

Switch to SiRF binary protocol at 9600,8,N,1

*\$PSRF100,0,9600,8,1,0\*0C*

SetSerialPort Example		
Name	Example	Description
Message ID	\$PSRF100	PSRF100 protocol header
Protocol	0	0=SiRF binary, 1=NMEA
Baud	9600	4800, 9600, 19200, 38400, 57600, 115200
DataBits	8	8 <sup>1</sup>
StopBits	1	0, 1 <sup>1</sup>
Parity	0	0=None, 1=Odd, 2=Even <sup>1</sup>
Checksum	*0C	
<CR> <LF>		End of message termination

1. SiRF protocol is only valid for 8 data bits, 1 stop bit and no parity.
2. Default settings are NMEA protocol using 9,600 baud, 8 data bits, 2 stop bits and no parity.

Figure 20: SetSerialPort Example

For details on the SiRF binary protocol, please refer to SiRF's Binary Protocol Reference Manual.

### 103 – Update Rate Control

This command is used to control the output of standard NMEA messages GGA, GLL, GSA, GSV, RMC and VTG. Using this command message, standard NMEA messages may be polled once, or setup for periodic output. Checksums may also be enabled or disabled depending on the needs of the receiving program. NMEA message settings are saved in battery-backed memory for each entry when the message is accepted.

Figure 23 contains the values for the following example:

1. Query the GGA message with checksum enabled  
*\$PSRF103,00,01,00,01\*25*
2. Enable VTG message for a 1Hz constant output with checksum enabled  
*\$PSRF103,05,00,01,01\*20*
3. Disable VTG message  
*\$PSRF103,05,00,00,01\*21*
4. Enable 5Hz mode  
*\$PSRF103,0,6,0,0\*23*
5. Disable 5Hz mode  
*\$PSRF103,0,7,0,0\*22*

**Note:** When using 5Hz mode, it is recommended to disable any unused NMEA message types (see example 3) and set the serial port to maximum baud rate (see Figure 20). The rate divider takes effect only after a fix is established.

## 104 – LLANavigationInitialization

This command is used to initialize the receiver with the current position (in latitude, longitude and altitude coordinates), clock offset, and time, enabling a faster fix. Increased receiver sensitivity and the removal of Selective Availability (SA) have made this unnecessary. The command is retained for its ability to reset the module, but the initialization fields are no longer supported.

Figure 25 contains the values for the following example:

`$PSRF104,37.3875111,-121.97232,0,96000,237759,1946,12,1*07`

LLANavigationInitialization Example			
Name	Example	Units	Description
Message ID	\$PSRF104		PSRF104 protocol header
Latitude	37.3875111	degrees	Latitude position (Range 90 to -90)
Longitude	-121.97232	degrees	Longitude position (Range 180 to -180)
Altitude	0	meters	Altitude position
ClkOffset	96000	Hz	Clock Offset of the Evaluation Receiver1
TimeOfWeek	237759	seconds	GPS Time Of Week
WeekNo	1946		Extended GPS Week Number (1024 added)
ChannelCount	12		Range 1 to 12
ResetCfg	1		See Figure 26
Checksum	*07		
<CR> <LF>			End of message termination

- Use 0 for the last saved value if available. If this is unavailable, a default value of 96000 is used.

Figure 25: NavigationInitialization Example

ResetCfg Values	
Hex	Description
0x01	Hot Start – All data valid
0x02	Warm Start – Ephemeris cleared
0x04	Cold Start – Clears all data in memory
0x08	Clear Memory – Clears all data in memory and resets the receiver back to factory defaults

Figure 26: ResetCfg Values

## 200 – PowerManagement

This command sets the power mode to Full Power, Adaptive Trickle Power, or Push-to-Fix mode. Figure 29 contains the values for the following example to set the receiver to Adaptive Trickle Power mode:

*\$PLSC,200,2,200,3000,300000,30000\*0D*

Power Management Command Example <sup>1</sup>			
Name	Example	Units	Description
MID	\$PLSC,200		Message ID
Mode	2		See Figure 30
OnTime	200 (200 – 900)	ms	Must be a multiple of 100 (if not, it is rounded up to the nearest multiple of 100). Set this to 0 when Mode = 3.
LP Interval	3000 (1000 – 10000)	ms	Must be an integer value $\geq 1000$ and $\leq 10000$ . Set this to 0 when Mode = 3.
MaxAcqTime	300000 ( $\geq 1000$ )	ms	When Adaptive Trickle Power is enabled, this is the maximum allowable time from the start of a power cycle to the time a valid position fix is obtained. If no fix is obtained in this time, the receiver is deactivated for up to MaxOffTime, and a hot start is commanded when the receiver reactivates. The integer must be in multiples of 1000ms. There is no upper limit.
MaxOffTime	30000 (1000 – 1800000)	ms	The longest period (in mS) for which the receiver deactivates due to the MaxAcqTime timeout. The actual deactivated period may be less if the user-specified duty cycle (OnTime / LpInterval) can be maintained.
PushToFixPeriod	(10 – 7200)	sec	The receiver automatically awakens every Push-to-Fix period to obtain a position fix, collect ephemeris (if needed), and calibrate the real-time clock (RTC) (if needed).
Checksum	*0D		
<CR> <LF>			End of message termination

1. Default setting is full power; trickle power disabled.

Figure 29: Power Management Command Example

Mode Values	
Value	Description
0	Ask the receiver to send the current power mode
1	Set the receiver to Full Power mode
2	Set the receiver to Adaptive Trickle Power mode
3	Set the receiver to Push-to-Fix mode

Figure 30: Power Management Mode Values



## 201 – Poll Software Version

Figure 32 contains the values for the following example to poll the SiRF and Linx software versions:

`$PLSC,201*13`

Poll Software Version Command Example			
Name	Example	Units	Description
MID	\$PLSC,201		Message ID
Checksum	*0D		
<CR> <LF>			End of message termination

Figure 32: Poll Software Version Example

Figure 33 contains the response for this command:

`$PLSR,201,1,GSD4e_4.1.2,B20121219.9600BPS.CUSTOMIO.LINX*58`

Poll Software Version Response Example			
Name	Example	Units	Description
MID	\$PLSC,201		Message ID
Valid	1		0: command invalid, 1:command valid
SiRF	String		SiRF software version
Linx	String		Linx software version
Checksum	*01		
<CR> <LF>			End of message termination

Figure 33: Power Management Response Example

## 211 – SetIO

Figure 36 contains the values for the following example to get GPIOA as an input:

*\$PLSC,211,A,0,0\*7F*

SetIO Example			
Name	Example	Units	Description
MID	\$PLSC,211		Message ID
GPIO Number	A		Number of the GPIO line to set. Only one line can be set at a time.
Direction	0		Direction: 0 = Input; 1 = Output
State	0		Set to 1 if the direction is an output; the value does not matter if the direction is an input.
Checksum	*7F		
<CR> <LF>			End of message termination

Figure 36: SetIO Example

The receiver outputs a response to this command. Figure 37 contains the response for the above command.

SetIO Response Example			
Name	Example	Units	Description
MID	\$PLSR,211		Message ID
Valid	1		0: command invalid, 1: command valid
Checksum	*7F		
<CR> <LF>			End of message termination

Figure 37: SetIO Response Example

For some further examples of this command:

Set GPIOA as an input

Input command: *\$PLSC,211,A,0,0\*7F*

Output response: *\$PLSR,211,1\*1E*

Set GPIOA as an output, initial state low

Input command: *\$PLSC,211,A,1,0\*7F*

Output response: *\$PLSR,211,1\*1E*

NOTE

1. If the message ID is not recognized, the response will be "\$PLSR,999,0,ERROR\*60"
2. If the value is not allowed, the response will be "\$PLSR,MID,0,ERROR\*CS"
3. All GPIOs default to inputs on power-up and reset

## 213 – WriteOutput

Figure 40 contains the values for the following example to write the state of GPIOA to low:

*\$PLSC,213,A,0\*61*

WriteOutput Example			
Name	Example	Units	Description
MID	<i>\$PLSC,213</i>		Message ID
GPIO Number	A		Number of the GPIO line to write. Only one line can be set at a time.
State	0		State; 0 = Low; 1 = High
Checksum	*61		
<CR> <LF>			End of message termination

Figure 40: WriteOutput Example

The receiver outputs a response to this command. Figure 41 contains the response for the above command.

WriteOutput Response Example			
Name	Example	Units	Description
MID	<i>\$PLSR,213</i>		Message ID
Valid	A		0: command invalid, 1: command valid
Checksum	*1C		
<CR> <LF>			End of message termination

Figure 41: WriteOutput Response Example

For some further examples of this command:

Set GPIOA to low

Input command: *\$PLSC,213,A,0\*61*

Output response: *\$PLSR,213,1\*1C*

Set GPIOA to high

Input command: *\$PLSC,213,A,1\*60*

Output response: *\$PLSR,213,1\*1C*

GPIOA is not an output

Input command: *\$PLSC,213,A,1\*60*

Output response: *\$PLSR,213,0\*1D*

## 215 – Query: Get Configuration and GPIO Current State

Figure 44 below contains the values for the following example to read the configuration and state of all of the GPIO lines:

*\$PLSC,215\*16*

Query Example			
Name	Example	Units	Description
MID	\$PLSC,215		Message ID
Checksum	*16		
<CR> <LF>			End of message termination

Figure 44: Query Example

The receiver outputs a response to this command. Figure 45 contains the response for the above command.

WriteOutput Example			
Name	Example	Units	Description
MID	\$PLSR,215		Message ID
Count	5		Total number of GPIOs
GPIO Number	A		GPIO Number
Configuration	0		Direction; 0 = Input; 1 = Output
Current State	0		0 = Low; 1 = High
GPIO Number	B		GPIO Number
Configuration	0		Direction; 0 = Input; 1 = Output
Current State	0		0 = Low; 1 = High
GPIO Number	C		GPIO Number
Configuration	0		Direction; 0 = Input; 1 = Output
Current State	0		0 = Low; 1 = High
GPIO Number	D		GPIO Number
Configuration	0		Direction; 0 = Input; 1 = Output
Current State	1		0 = Low; 1 = High
GPIO Number	E		GPIO Number
Configuration	0		Direction; 0 = Input; 1 = Output
Current State	0		0 = Low; 1 = High
Checksum	*72		
<CR> <LF>			End of message termination

Figure 45: Query Response Example

## Typical Applications

Figure 46 shows the F4 Series GPS receiver in a typical application using a passive antenna.

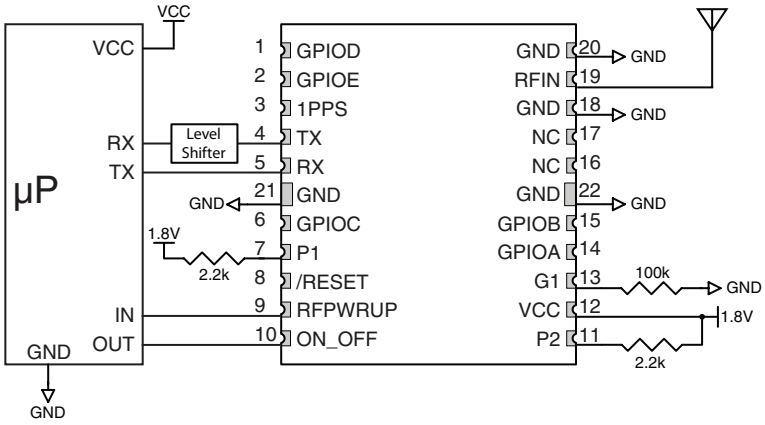


Figure 46: Circuit Using the F4 Series Module with a Passive Antenna

A microcontroller UART is connected to the receiver's UART for passing data and commands. A 3.3V coin cell battery is connected to the VBACKUP line to provide power to the module's memory when main power is turned off.

Figure 47 shows the module using an active antenna.

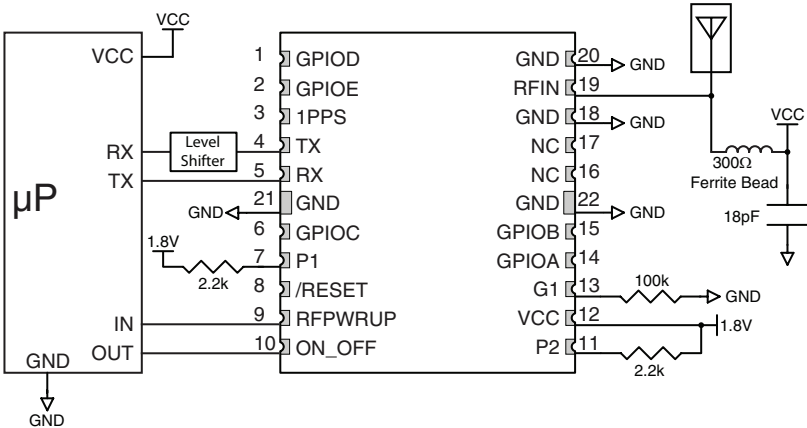


Figure 47: Circuit Using the F4 Series Module with an Active Antenna

A 300Ω ferrite bead is used to put power from VOUT onto the antenna line to power the active antenna.

## Board Layout Guidelines

The module's design makes integration straightforward; however, it is still critical to exercise care in PCB layout. Failure to observe good layout techniques can result in a significant degradation of the module's performance. A primary layout goal is to maintain a characteristic 50-ohm impedance throughout the path from the antenna to the module. Grounding, filtering, decoupling, routing and PCB stack-up are also important considerations for any RF design. The following section provides some basic design guidelines which may be helpful.

During prototyping, the module should be soldered to a properly laid-out circuit board. The use of prototyping or "perf" boards will result in poor performance and is strongly discouraged.

The module should, as much as reasonably possible, be isolated from other components on your PCB, especially high-frequency circuitry such as crystal oscillators, switching power supplies, and high-speed bus lines.

When possible, separate RF and digital circuits into different PCB regions. Make sure internal wiring is routed away from the module and antenna, and is secured to prevent displacement.

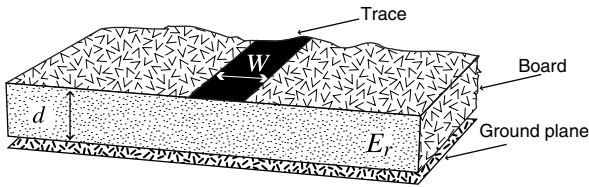
Do not route PCB traces directly under the module. There should not be any copper or traces under the module on the same layer as the module, just bare PCB. The underside of the module has traces and vias that could short or couple to traces on the product's circuit board.

The Pad Layout section shows a typical PCB footprint for the module. A ground plane (as large and uninterrupted as possible) should be placed on a lower layer of your PC board opposite the module. This plane is essential for creating a low impedance return for ground and consistent stripline performance.

Use care in routing the RF trace between the module and the antenna or connector. Keep the trace as short as possible. Do not pass under the module or any other component. Do not route the antenna trace on multiple PCB layers as vias will add inductance. Vias are acceptable for tying together ground layers and component grounds and should be used in multiples.

## Microstrip Details

A transmission line is a medium whereby RF energy is transferred from one place to another with minimal loss. This is a critical factor, especially in high-frequency products like Linx RF modules, because the trace leading to the module's antenna can effectively contribute to the length of the antenna, changing its resonant bandwidth. In order to minimize loss and detuning, some form of transmission line between the antenna and the module should be used, unless the antenna can be placed very close ( $<1/8$ in) to the module. One common form of transmission line is a coax cable; another is the microstrip. This term refers to a PCB trace running over a ground plane that is designed to serve as a transmission line between the module and the antenna. The width is based on the desired characteristic impedance of the line, the thickness of the PCB, and the dielectric constant of the board material. For standard 0.062" thick FR-4 board material, the trace width would be 111 mils. The correct trace width can be calculated for other widths and materials using the information below. Handy software for calculating microstrip lines is also available on the Linx website, [www.linxtechnologies.com](http://www.linxtechnologies.com).



$$E_e = \frac{E_r + 1}{2} + \frac{E_r - 1}{2} \cdot \frac{1}{\sqrt{1 + 12d/W}}$$

$$Z_0 = \begin{cases} \frac{60}{\sqrt{E_e}} \cdot \ln\left(\frac{8d}{W} + \frac{W}{4d}\right) & \text{For } \frac{W}{d} \leq 1 \\ \frac{120\pi}{\sqrt{E_e} \cdot \left(\frac{W}{d} + 1.393 + 0.667 \cdot \ln\left(\frac{W}{d} + 1.444\right)\right)} & \text{For } \frac{W}{d} \geq 1 \end{cases}$$

$E_r$  = Dielectric constant of PCB material

Figure 51: Microstrip Formulas

Example Microstrip Calculations			
Dielectric Constant	Width/Height Ratio (W/d)	Effective Dielectric Constant	Characteristic Impedance ( $\Omega$ )
4.80	1.8	3.59	50.0
4.00	2.0	3.07	51.0
2.55	3.0	2.12	48.0

Figure 52: Example Microstrip Calculations

## Reflow Temperature Profile

The single most critical stage in the automated assembly process is the reflow stage. The reflow profile in Figure 55 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.

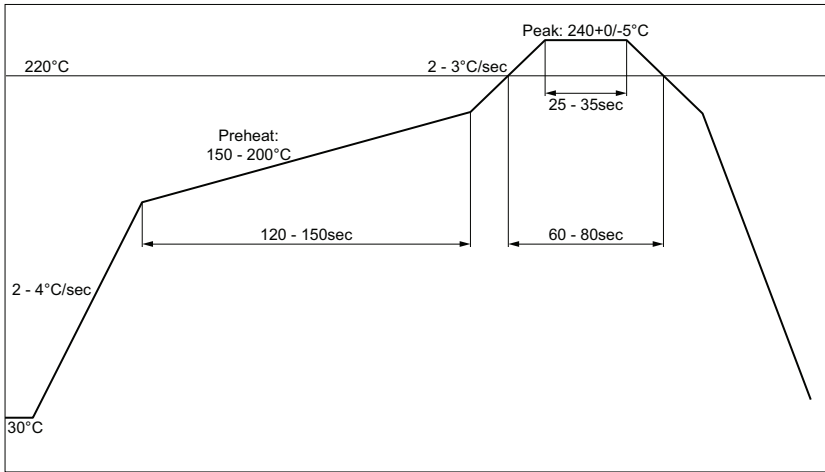


Figure 55: Maximum Reflow Profile

## 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.





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