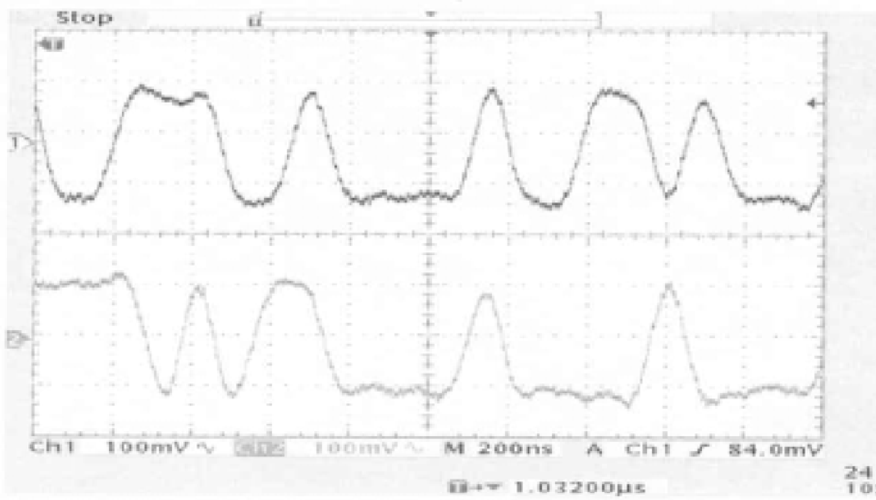
Barker Code to provide the spreading function.

FIGURE 6. RECEIVE I and Q SIGNALS AT THE INPUT OF THE ISL3873 BASEBAND MAC



NOTE: QPSK mode is used for the plots in this figure.

FIGURE 6. RECEIVE I and Q SIGNALS AT THE INPUT OF THE ISL3873 BASEBAND MAC

The baseband processor correlates the PN sequence, adjusting its carrier and symbol timing to lock onto the signal and uncover the packet data.

The receiver section operates on the RAKE receiver principle, which maximizes the Signal to Noise Ratio (SNR) of the signal by combining the energy of multipath signal components. The RAKE receiver is implemented with a Channel Matched Filter (CMF) using a finite-duration impulse response (FIR) filter structure with 16 taps. The CMF is programmed by calculating the channel impulse response (CIR) and mathematically manipulating the tap coefficients. Thus, the CMF compensates for channel distortion characteristics such as multipath and optimizes the signal for minimum inter-symbol interference (ISI). Since the calculation of the impulse response is inaccurate at low Signal to Noise or in the presence of a strong continuous wave (CW) interference, the chip has thresholds (CR36 to CR39) that are set to substitute a default CMF shape under these conditions.

The RAKE receiver contains 16 correlation fingers that are evenly spaced at 1/2 chip intervals. The RAKE receiver aligns correlation peaks on the fingers and sums them to optimize the SNR in the presence of multipath. The ISL3874A also employs a Decision Feedback Equalizer (DFE) at the output of the RAKE receiver that updates the CMF for the next receive bit. The combination of these two functions acting in concert, optimize the SNR of the received signal in the presence of multipath fading while minimizing the ISI of signal at the same time.

Following the channel filters, there are two types of correlators in the ISL3874A baseband processor. The first is a parallel matched filter correlator that searches for the Barker sequence used in the preamble, header, and PSK data modes. These modes are DBPSK modulation used for 1M bits per second data rate while DQPSK is used for 2Mbps. The correlator despreads the samples from the chip rate back to the original symbol rate giving 10.4dB processing gain for 11 chips per symbol. While despreading the desired signal, the correlator spreads out the energy of any non-correlating interfering signal thus providing greater resistance to jamming.

The second form of correlator is the parallel correlator bank used for detection of the Complementary Code Keying (CCK) modulation for either 5.5Mbps or 11Mbps data rates. Data is encoded into orthogonal PN sequences used instead of a fixed Barker Code. Each correlator of the bank searches for a specific Pseudo Random sequence resulting in 2 decoded bits for 5.5Mbps and 6 decoded bits for 11Mbps.
The detected output is then processed through the differential phase decoder to demodulate the last two bits of each symbol.

The packet header contains a Start Frame Delimiter (SFD), other signal related data and a Cyclic Redundancy Check (CRC) for data error detection. The MAC processes the header data to locate the SFD, determine the mode and length of the incoming message and to check the CRC. The MAC then processes the packet data and sends it on through the PCI interface to the host computer. The PCI host interface allows access to the ISL3874A memory and host registers using memory read or write transactions. If corrupt data is detected, the MAC requests a re-transmission of the packet.

The IEEE802.11b WLAN MAC protocol is implemented with the on board firmware. The MAC firmware supports Ad Hoc and infrastructure operation as well as low level protocols such as Request to Send (RTS), Clear to Send (CTS) generation and acknowledgement. Additional features include: fragmentation, de-fragmentation, and automatic beacon monitoring are handled without host intervention.
Active scanning is performed autonomously once initiated by host command, while host interface commands and status handshakes allow concurrent operation from multi-threaded I/O drivers. Additional firmware functions specific to access point applications are also available. The ISL3873A MAC/Baseband Processor chip operates from regulator U5 providing 3.3V.

Transmit Processing

Data from the host computer is sent to the MAC section of the ISL3873 chip via the USB interface. Prior to any communication, the MAC sends a Request to Send (RTS) packet to the other end of the link and in turn, receives a Clear to Send (CTS) packet. The MAC then formats the payload data packet (MPDU) by appending to it a preamble and header. This is then sent to the Baseband Processor (BBP) section of the same chip which clocks it in.

The packet will then be processed along two different paths depending on the modulation used. For 1 and 2 Mbps modes, the transmitter accepts data from the external source, scrambles it, differentially encodes it as either DBPSK or DQPSK respectively (refer to AN9829), and spreads it with the PN sequence. The BPSK and QPSK spreading is performed using a 11 chip Barker sequence and is modulated with I and Q data components.

While employing the Complementary Code Keying (CCK) modes (refer to AN9850), the output of the scrambler is partitioned into nibbles (4 bits) or bytes (8 bits). At 5.5Mbps, it uses two of those bits to select one of four complex spread sequences from a table of CCK sequences and then QPSK modulates that symbol with the remaining two bits. Thus, there are four possible spread sequences to send at four possible carrier phases, but only one is sent.

The sequence is then modulated on the I and Q output. At 11Mbps, one byte is used in a similar method as at 5.5Mbps, where 6 bits are used to select one of 64 spread sequences for a symbol, and the other two are used to QPSK modulate that symbol.

Therefore, there are in total 256 possible combinations of sequence and carrier phases, with only one being sent. Again, the sequence is modulated on the I and Q output. All the above data rates are implemented with an 11MHz chip rate using a 44MHz clock.

The scrambler is used for the preamble, header and data in all modes. The preamble is always transmitted as the DBPSK waveform, while the header can be configured to either be DBPSK, or DQPSK. Data packets can be configured for either DBPSK, DQPSK, or CCK. The preamble is used by the receiver to achieve initial Pseudo Noise (PN) synchronization, while the header includes the necessary data fields for the communications protocol to establish the physical layer link.

The transmitter generates the synchronization preamble and header and knows when to make the DBPSK to DQPSK or CCK switchover, as required.

The modulator output is the balanced differential analog signals (TXI+, TXI-, TXQ+, TXQ-).

The transmit section digitally filters these signals using a Finite Impulse Response (FIR) style filter. This filter shapes the spectrum to meet the radio spectral mask requirements while minimizing the peak to average amplitude on the output. The I and Q signals then enter the transmit 6-bit Digital to Analog Converter (DAC) making their way to the HFA3783 (I/Q IF modulator/demodulator). The shape of the transmit I and Q analog signals at the input of the HFA3783 are shown in Figure 7.

FIGURE 7. TRANSMIT I AND Q SIGNALS AT THE INPUT OF THE HFA3783

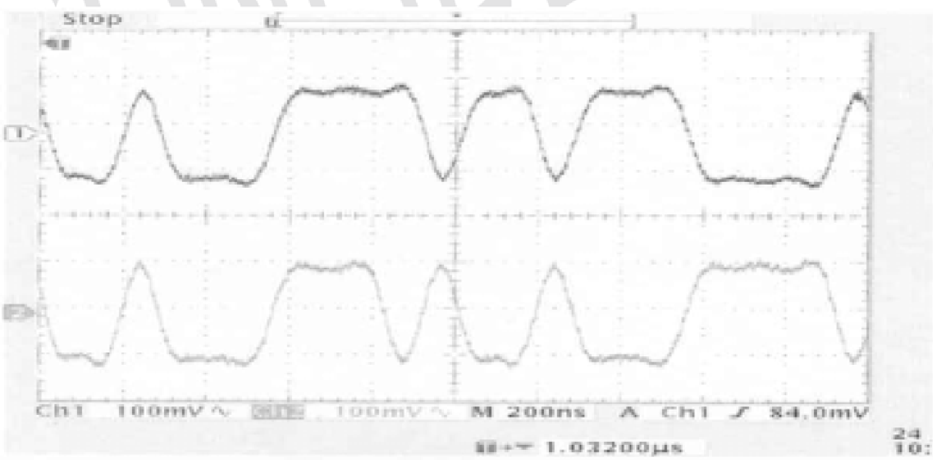


FIGURE 7. TRANSMIT I AND Q SIGNALS AT THE INPUT OF THE HFA3783

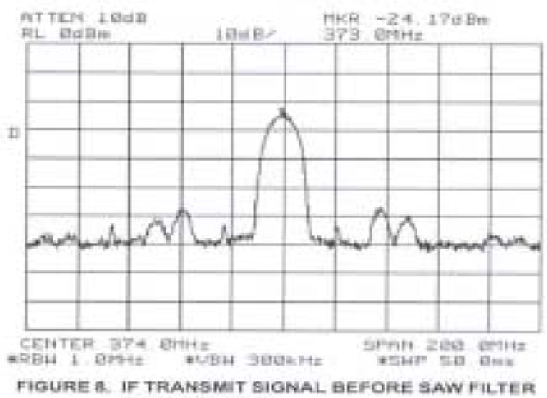
The transmit AGC uses a 7-Bit DAC control to obtain maximum performance in the analog portions of the transceiver. As mentioned previously in the Receiver Processing section, the ISL3873 MAC/BBP chip operates from a regulated 3.3V supply.

The HFA3783 modulator section has a I/Q baseband bandwidth of DC to 13MHz (typ) and IF frequency range of 70MHz to 600MHz. It consists of differential I and Q baseband inputs requiring pre-shaped analog data levels up to 500mVpp. A common mode voltage of around 1.3V is required for proper operation of the four differential input pins. There are no internal pre-shaping filters in the modulator section. Following the differential input stages, a DC coupled up-conversion pair of quadrature doubly balanced mixers are used for I and Q baseband IF processing. These differential mixers are driven by the same internal IF LO quadrature generator used in the receive section. Their phase and gain characteristics, including I/Q matching, are well suited for accurate data transmission.

The final stage is an AGC differential amplifier with 70dB of dynamic range. The output is a differential, open collector signal (IF_TX+, IF_TX-) which requires DC bias from VCC through an inductor. A matching network was designed at the differential output path of the HFA3783 in order to balance it to 20?. This network consists of R40, L9, L10, C51 and C52. The differential signals are fed into a bandpass IF SAW filter, FL1.

This is the same filter used in the receive path of the PRISM 2.5 radio. The IF SAW filter shapes the transmit spectrum and rejects any spurs generated in the transmit section of the HFA3783. The effect of the IF SAW filter on transmit signal spectrum is displayed in the Figures 8 and 9.

FIGURE 8. IF TRANSMIT SIGNAL BEFORE SAW FILTER



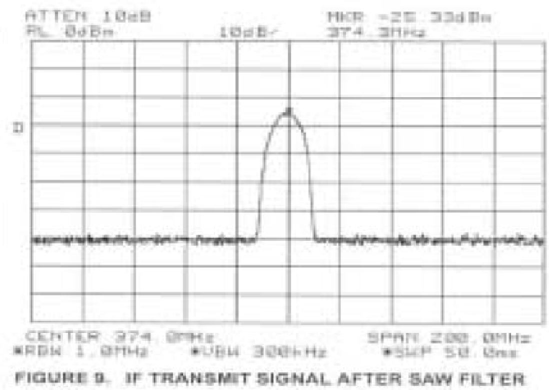


FIGURE 9. IF TRANSMIT SIGNAL AFTER SAW FILTER

The output of the SAW filter then enters the RF/IF Converter(ISL3685). This differential pair of IF signals (Tx_mx_in+, Tx_mx_in-) are dc coupled, high impedance inputs. The differential input path into the ISL3685 is also balanced to 200 Ù by using C47 and C74.

The transmit path of the ISL3685 consists of an up-converter mixer and a high performance preamplifier (approx. 15.6dB of gain at 2.45GHz). This preamplifier aids in easing the requirement for MAX2242 RFPA gain. The up-converter is driven by the same RF VCO and PLL used in the receive path of PRISM 2.5. No external filtering is required between the RF up-converter and the TX preamplifier, due to the internal bandpass characteristics of mixer and preamp.

The output of the RF/IF converter is a non-differential signal (TXA_OUT). The signal is then fed into two series MURATA bandpass filters, FL4 and FL5. These filters suppress the LO feedthrough, the image frequency as well as low level harmonics and undesired mixing products.

This RF signal is then sent to the MAX2242 single supply SiGe RF Power Amplifier. At this point in the transmit chain, the output spectrum contains no sidelobes as the SAW IF filter has removed them (see Figure 9). The image-reject up-converter and amplifiers operate in their linear region and produce no spectral regrowth. This allows the MAX2242 to be the sole contributor to spectral regrowth, which allows the PA to operate as close as possible to the 1 dB compression point with minimum back-off. This maximizes the power efficiency of the overall design. A typical output frequency spectrum showing -30dBc sidebands is shown in Figure 10. The MAX2242 delivers 18dBm (typ) of output power while meeting ACPR specification of less than -30dBc (1st Side Lobe) and less than -50dBc (2nd Side Lobe) In addition, the device includes a 2.4GHz Power detector, which is accurate over a 20dB dynamic range within ±1dB which supports an accurate Automatic Level Control (ALC) function. Following the RFPA, a low pass filter (FL3) is used to attenuate high frequency harmonics of the desired signal and LO. The insertion loss of FL3 is approximately 1.0dB. The T/R switch also exhibits a loss of 0.5dB so the amount of transmit power available at the test point J1 is approximately +17dBm.

As mentioned in the Receive Processing Section, the BBP section of the ISL3873 chip is in charge of controlling the antenna diversity. Diversity is only provided during receive. Transmitted signals must use the J1 port designed for maximum output power. The BBP continuously checks the channel to receive any incoming data from the reference transmitter. However, if the channel is clear and there is no data to receive, it enables AN1 to transmit any outgoing data. Therefore, by default, the WLAN card is always in receive mode. This is done to avoid collisions of incoming and outgoing data.

The final output spectrum can be seen in Figure 10. The center frequency of this signal is 2412-2484MHz depending on the channel of operation. The sidelobes of the spectrum are adjusted by the ALC/AGC to be 30dB below the main peak of the spectrum per requirements of IEEE 802.11b.

FIGURE 10. TRANSMITTED 2.4GHz SIGNAL SPECTRUM

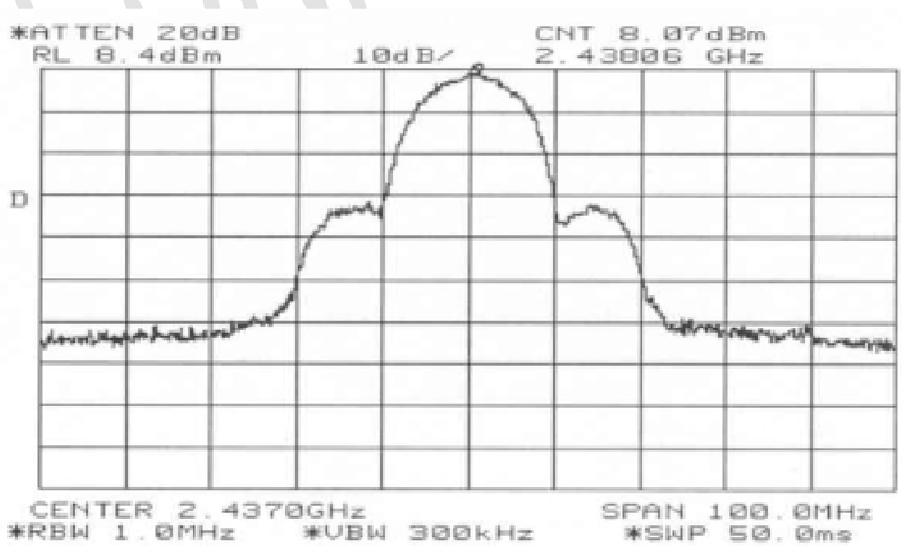


FIGURE 10. TRANSMITTED 2.4GHz SIGNAL SPECTRUM

Synthesizer Section

There are two local oscillators used in the PRISM 2.5 WLAN USB card. The RF LO consists of the RF VCO U14 and the synthesizer which is internal to the RF/IF Converter (ISL3685). The RF output of the RF VCO is buffered using U16 (UPC2745TB buffer amplifier). This amplifier will help reduce pulling effects on the first LO, especially when the RF front end switches between the RX and TX mode of operation.(Not population yet)

The loop filter for the first PLL is made from C118, C123, R69, R65 and C125. Measurement of the phase noise and calculation of integrated RMS phase jitter are included in Appendix A. The RF LO input of the ISL3685 is internally AC coupled and matched to 50• • The behavior of the RF VCO can be monitored at RF LO Output and is shown in Figure 11.

Ideally, the tuning voltage of the VCO, when locked, falls between 0.5V and 2.2V. The tuning voltage of the RF VCO can be observed at RF LO Lock Voltage.

FIGURE 11. RF LOCAL OSCILLATOR OUTPUT

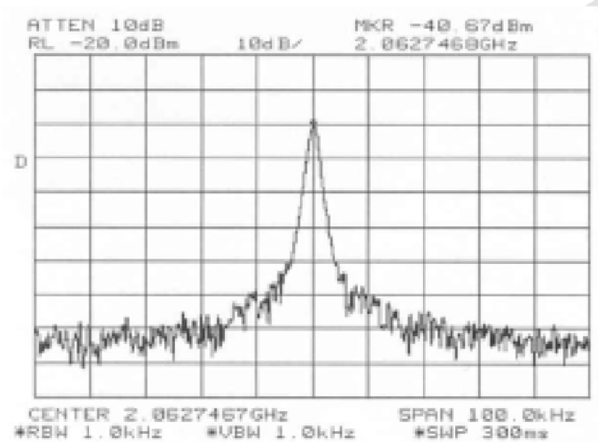


FIGURE 11. RF LOCAL OSCILLATOR OUTPUT

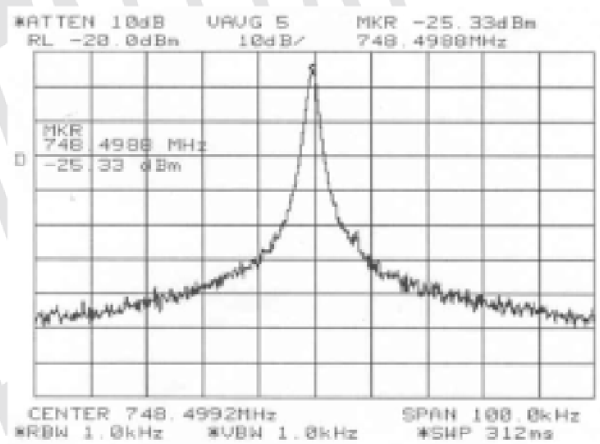


FIGURE 12. IF LOCAL OSCILLATOR OUTPUT

FIGURE 12. IF LOCAL OSCILLATOR OUTPUT

The IF LO consists of the IF VCO, U13 MVE-748 and the synthesizer which is internal to the I/Q Modulator/Demodulator (HFA3783). The IF synthesizer is programmed to the fixed frequency of 748.5MHz. The output of the IF VCO is fed differentially back into the HFA3783 (U9). This differential IF signal is divided by 2 in U9 to yield the IF LO frequency of 374.25MHz. This LO is applied to the IQ Modulator/Demodulator section of the HFA3783. The loop filter for the IF PLL is made from C91, C100, R52, R55 and C107. Phase noise measurement and calculation of integrated RMS phase jitter are included in the Appendix A.

It should be noted that both synthesizers are using the same 44MHz reference frequency crystal oscillator, U6.

Frequency Assignment

Table 2 delineates the IEEE 802.11 channels and their corresponding center frequencies. Although information contained in Table 2 is deemed to be accurate, local regulatory authorities should be consulted before using such equipment.

TABLE 2.

CHANNEL NUMBER	CHANNEL FREQUENCY	GEOGRAPHIC USAGE
1	2412MHz	US, CA, ETSI, MKK, KR
2	2417MHz	US, CA, ETSI, MKK, KR
3	2422MHz	US, CA, ETSI, MKK, KR
4	2427MHz	US, CA, ETSI, MKK, KR
5	2432MHz	US, CA, ETSI, MKK, KR
6	2437MHz	US, CA, ETSI, MKK, KR
7	2442MHz	US, CA, ETSI, MKK, KR
8	2447MHz	US, CA, ETSI, MKK, KR
9	2452MHz	US, CA, ETSI, MKK, KR
10	2457MHz	US, CA, ETSI, MKK, KR, FR, SP
11	2462MHz	US, CA, ETSI, MKK, KR, FR, SP
12	2467MHz	ETSI, FR, MKK, KR
13	2472MHz	ETSI, FR, MKK, KR
14	2484MHz	MKK

KEY: US = United States, CA = Canada,
ETSI = European countries(except France and Spain), FR = France, SP = Spain,
MKK = Japan , KR = Korea

Handling and Processing Moisture Sensitive Surface Mount Devices

Certain plastic encapsulated surface mount devices (SMDs) if not handled properly can incur damage during the solder reflow attachment process to printed circuit boards (PCBs). The damage occurs as a result of internal package cracking (commonly referred to as popcorn cracking) and / or delamination between internal package interfaces.

The root cause of this type of failure mechanism is the rapid heating of the moisture absorbed within the plastic encapsulant. All plastic packages absorb moisture. During typical solder reflow operations when SMDs are mounted onto a PCB, the entire PCB and device population are exposed to a rapid change in ambient temperature. Any absorbed moisture is quickly turned into superheated steam.
This sudden change in vapor pressure can cause the package to swell. If the pressure exerted exceeds the flexural strength of the plastic mold compound, then it is possible to crack the package. Even if the package does not crack, interfacial delamination can occur.

If a particular package style is determined to be moisture sensitive, then the product must be shipped in dry pack. The dry pack bag is a tough, moisture resistant bag. Placed inside a dry pack bag along with predetermined amount of desiccant and a humidity sensitive indicator card. Upon opening a dry pack bag with product, the user needs to check 2 items:

the seal date on the label, and

the moisture indicator from within the bag.

If the bag seal date is over 1 year and / or the humidity indicator card shows >20% RH, the product needs to be rebaked prior to reflow.

If a rework of a PCB with moisture sensitive SMDs is required, special precautions must be observed. Should the rework require complete exposure of the PCB to reflow conditions, then the manufacturer needs to take into account the shortest floor life of any moisture sensitive SMD on the board. If the floor life has been surpassed, then the entire board should be re-baked.

Detailed information on classification and handling instructions can be found in Guidelines for Handling and Processing Moisture Sensitive surface Mount Devices [7].

FCC Information to User

This product does not contain any user serviceable components and is to be used with approved antennas only. Any product changes or modifications will invalidate all applicable regulatory certifications and approvals.

FCC Radiation Exposure Statement

This device generates and radiates radio-frequency energy. In order to comply with FCC radio-frequency radiation exposure guidelines for an uncontrolled environment, this equipment should be installed and operated with the minimum distance of 8 inches between your body and the antenna.

FCC Electronic Emission Notices

This device complies with part 15 of the FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Radio Frequency Interference statement

The wireless LAN PC card is subject to the rules of the Federal Communications Commission (FCC). This card is considered an international radiator as per the FCC guidelines.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

WARNING: Any changes or modifications of equipment not expressly approved by Samsung could void the user's authority to operate the equipment.

FCC Guidelines for Human Exposure

The EIRP was measured for the lower, middle and highest frequencies used by the transmitter. The results in Table 3 are based on a safe distance between antenna and operator of 8 inches. The equipment therefore fulfills the requirements on power density for general population / uncontrolled exposure of 1.0mW/cm² and therefore complies with the requirements of FCC part 15.247 (b) (4) and FCC OET Bulletin 65 incl. supplements A, B and C.

TABLE 3. POWER DENSITY CALCULATION

	CH. 1	**CH. 6**	**CH. 11**
Measured EIRP(mW)	???	???	???
Calculated Power Density (mW/cm²)	???	???	???

Reference Documents

Main reference is **AN9972 Application Note, Intersil Corporation,**
ISL3700U-CD PRISM 2.5 miniUSB Wireless LAN Radio Description.

You can consult Unders for more information :

[1] ISL3873 Data Sheet, Intersil Corporation, FN8015.

[2] ISL3685 Data Sheet, Intersil Corporation, FN4860.

[3] MAX2242 Data Sheet, Intersil Corporation, FN4862.

[4] ISL3783 Data Sheet, Intersil Corporation, FN4633.

[5] ISL3183 Data Sheet, Intersil Corporation, FN4909.

[6] *Integrating RF and Digital Circuits in a PC Card Environment,* Portable Design, May 1996.

[7] TB363 Tech Brief , Intersil Corporation *Guidelines for Handling and Processing Moisture Sensitive surface Mount Devices.*

[8] AN9850 Application Note, Intersil Corporation, *Complementary Code Keying Made Simple.*

[9] FN4983 Data Sheet, Intersil Corporation, *PRISM 2.5, 11Mbps with USB interface.*

[10] TB382 Tech Brief , Intersil Corporation *Measurement of WLAN Receiver Sensitivity.*

[11] AN9829 Application Note, Intersil Corporation *Brief Tutorial on IEEE802.11 Wireless LANs.*

[12] AN9820 Application Note, Intersil Corporation, *A Condensed Review of Spread Spectrum Techniques for ISM Band.*

[13] TB389 Tech Brief , Intersil Corporation *PCB Land Pattern Design and Surface Mount Guidelines for MLFP Packages.*

[14] TB337 Tech Brief , Intersil Corporation *A Brief Tutorial on Spread Spectrum and Packet Radio.*

[15] AN9973 Application Note, Intersil Corporation, *Test Plan for PRISM 2.5 Mini USB Radio Card.*

[16] AN9895 Application Note, Intersil Corporation, *Multipath Measurement in Wireless LANS.*

[17] AN9633 Application Note, Intersil Corporation, *Processing Gain for Direct Sequence Spread Spectrum Communications Systems and PRISM.*

[18] TB380 Tech Brief, Intersil Corporation *Choosing the IF Frequency for the PRISM II 11Mpbs Radio Reference Design.*

Intersil documents can be found on the Premier Web site.

http://www.intersil.com/prism/software