FCC Part 15, Subpart C (Intentional Radiator)

Product Name: ThinkPad T30 Series

(Machine type : 2366/2367)

FCC ID: ANOCORN1TASULIV

January 30, 2002

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Yellow Sheet : No. EM633

MEASUREMENT / TECHNICAL REPORT – Part 15 Subpart C
(Intentional Radiator)

ThinkPad T30 Series
(Machine type : 2366, 2367)

FCC ID : ANOCORN1TASULIV

January 30, 2002

This report concerns: (check one) Original Grant ✓ Class I change Class II change Equipment type: Wireless LAN / Bluetooth device in Computer (computer, printer, modem, etc.)
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Operational Description

1. Objective

This is a Certification Compliance Report for FCC Part 15, Subpart C (Intentional Radiator).

- The applying equipment : ThinkPad T30 Series
- FCC ID : ANOCORN1TASULIV

2. Product Description

The applying equipment is a standard fullsize laptop computer integrating IEEE 802.11b Wireless LAN and Bluetooth functions inside.

The integrated wireless cards are the same as the previous model "ThinkPad A30 Series (FCC ID : ANOVNCBDC80211B)". The all wireless features (antennas and cards) are built in the applying equipment by IBM .

The specification of the applying equipment is as follows :

- The Wireless LAN feature consists of an OEM card (Actiontec Electronics Inc., IEEE802.11b Wireless LAN Mini-PCI card) and IBM original integrated antennas (Inverted F-figure type antenna **x 2**).
- The Bluetooth feature consists of an OEM card (TDK Systems Europe Ltd., Bluetooth standard card) and IBM original integrated antenna (Inverted F-figure type antenna **x 1**).

Table 1 : Specification of PC main body

Model Identification		ThinkPad T30 Series
Machine Type Number		2366, 2367
PC Functions	Max. size	304mm(12.0")(W) : 250mm(9.9")(D) : 36.6mm(1.5")(H)
	Max. weight	5.9lbs
	Hard disk	2.5" Max. 50GB
	Memory	256MB
	Bay Device	DVD-ROM or CD-RW DVD Combo
	Power	AC adapter, Battery (Li-Ion)
	Ports & Slots	Serial, Parallel, CRT, Headphone, Microphone, Line In, USBx2, 4MB IR, SVGA & S-video, Docking Ethernet, Modem, PCMCIA slot (type-2 x 2)
	CPU	Mobile Intel® Pentium® 4 processor -M , Max. 2.0GHz
	LCD	14.1" TFT XGA or SXGA+
	Integrated Wireless feature	IEEE802.11b Wireless LAN, Bluetooth

Table 2 : Specification of IEEE802.11b Wireless-LAN feature

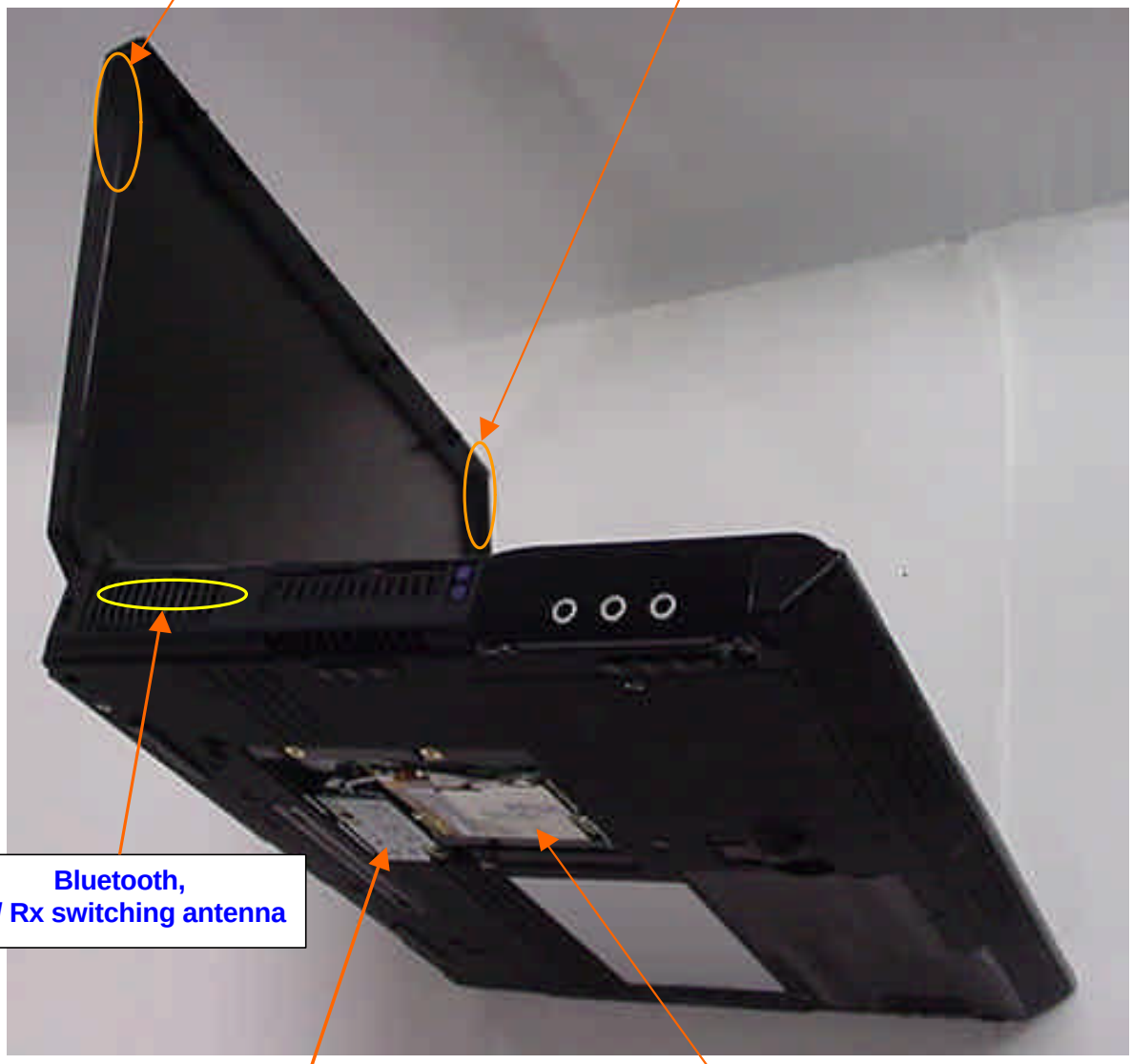
Carrier Frequencies	2412MHz – 2462MHz			
Occupied BW at 20dB below (Band-edge)	2403.67MHz – 2470.57MHz			
Channels	Total 11 channels (default setting ch. # : 1, 6, 11)			
Channel BW at 20dB below	Max. 16.96MHz / ch			
Channal spacing	5 MHz			
Conducted emission Power	15.8 dBm			
Antenna gain	0.53 dBi			
Antenna type	Inverted F-figure type antenna Tx/Rx switching antenna : IBM P/N: 46L4819 Rx antenna : IBM P/N: 46L4818			
Antenna cable type and length	Tx/Rx switching antenna : coax 560mm Rx antenna : coax 800mm			
Bit rate	1 Mbit/sec	2 Mbit/sec	5.5 Mbit/sec	11 Mbit/sec
Chip/symbol rate	11	11	8	8
Bit/symbol rate	1 (DBPSK)	2 (DQPSK)	4 (CCK)	8 (CCK)
Chip/bit rate	11	5.5	2	1

Table 3 : Specification of Bluetooth feature

Carrier Frequencies	2402MHz – 2480MHz
Occupied BW at 20dB below (Band-edge)	2401.606MHz – 2480.352MHz
Channels	Total 79 channels (Inquiry / Paging mode : 32 channels)
Channel BW at 20dB below	Max. 0.782MHz / ch
Channal spacing	1 MHz
Conducted emission Power	3.9 dBm
Antenna gain	1.87 dBi
Antenna type	Inverted F-figure type antenna IBM P/N: 46L4932
Antenna cable type and length	coax 125mm

3. Mounting structure of Wireless features

The left antenna in LCD is used for both RF transmission and receiving with half duplex switching mode. The right antenna is used for RF receiver only.
When the Wireless LAN card is in RF receiving state, one of the antennas is selected automatically to have a good quality of radiocommunication.



4. Related Submittal(s)/Grant(s)/Notes

- The device without wireless features is classified as a digital device under Part 15 Subpart B and subject to DoC.

5. Circuitry description of the Wireless LAN PC card

Reference: Basic Operation Principle of 802MIP

by Actiontec Electronics, Inc.

The Wireless LAN portion of 802MIP combo card is a 2.4GHz ISM Band DSSS Radio. It is designed to operate using IEEE 802.11b WLAN Standard for use in wireless networking systems. The Radio consists of 4 major ICs, which are ISL3685, HFA3783, ISL3984, ISL3874, and few support ICs. It operates at maximum transmit rate 11Mb/s, back off rates 5.5, 2 and 1 Mb/s. The modulation schemes include CCK (Complementary Code Keying), DQPSK and DBPSK depending on what transmit bit rate it operates at. The radio card interfaces to PC through a MiniPCI bus.

Transmitter path

The Ethernet data comes through the MiniPCI interface, the Host I/O interface to the MAC section of ISL3874. The signal then flows into the data router where it is converted from Ethernet to 802.11b protocol. After the signal is converted, a radio preamble and header is added to it and passed to the I/O of BBP (Base Band Processor) section of ISL3874 via PHY I/O, RADIO I/O. There is also support circuitry, such as outboard SRAM and flash ROM, which contains the firmware controlling the radio.

In TX modulator of BBP section, differential phase shift keying modulation schemes DBPSK, DQPSK and CCK, with data scrambling capability, are fulfilled to provide a variety of data rates--DBPSK for 1 Mb/s, DQPSK for 2 Mb/s and CCK for 5.5 and 11Mb/s. The signal, which now is two separate quadrature components I and Q, then flows to the quad IF chip HFA3783 through D/A converters.

At TX side of BBP, there is also TX ALC (Automatic Level Control) circuitry, which is part of the TX ALC loop. The loop keeps TX output power to be consistent so that prevent the power spectrum from regrowth.
HFA3783 is now the dual up conversion mixers (dual down conversion mixers for RX). The signal upconverts to an IF frequency of 374 MHz and passes into a variable gain amplifier, which is also a part of the ALC loop. Next, it passes through the switched TX/RX shared SAW filter into ISL3685 and then upconverts again to a RF frequency from 2.412~2.462 GHz, depending on the channel selection. The signal flows through a pre-amplifier, two band pass filters, which block all the unwanted emissions such as image components, harmonics and spurious stuff, into ISL3984 power amplifier. The output of the power amplifier is then fed through another band pass filter that is about 85 MHz bandwidth to one of the antennas.

Receiver path
The receive signal traveling through the air is received by the dual diversity antennas. The circuits will switch to the antenna which provides better RSSI (Received Signal Strength Indication). The RF signal then feeds into an 85 MHz band pass filter, which blocks all the unwanted components such as image frequency. The signal again is amplified using the LNA within ISL3685 and mixed down to the IF frequency of 374 MHz. The PLL and synthesizer select the channel frequency using Low Side Injection. The mixer outputs are then fed through the IF SAW filter that provides image rejection into HFA3783, which is now a quad down converter. HFA3783 also provides RSSI to BBP of ISL3874. There is a two stage analog AGC (Automatic Gain Control) circuit which adjusts the gain to compensate the signal strength differences. The output of the twin AGC's provides a constant level signal to the I and Q down converters, which convert the IF to both I and Q signals to BBP. A second frequency synthesizer, which uses ISL3183 as its VCO, feeds the I and Q mixers with a same frequency signal that is phase shifted by 90°.

The I and Q signals that are fed into BBP of ISL3874 are converted into digital signals via a dual A/D converters then flow through the digital AGC control circuit followed by the digital demodulator. The correlation codes that BBP generates properly detect the transmitted complimentary codes. In here the automatic antenna selection is also done by taking RSSI as the reference. The output of the digital demodulator is sent into an I/O interface of MAC section. The digital codes then flow into the PHY I/O interface and into the MAC protocol engine. The MAC of ISL3874 converts the signal protocol from 802.11b to Ethernet and finally passes that data through the HOST I/O interface to the PC.

6. Circuitry description of the Bluetooth card

Reference: Bluetooth Daughter Board hardware specifications

by TDK Systems Europe Ltd.

Refer to circuit drawings in **"**Schematic Diagrams of IBM Bluetooth Daughter Card".

The first page shows the main assembly layout of the card.

Sheet 1 of 3 refers to the blutooth core (control circuit).

Sheet 2 of 3 refers to the RF section.

Sheet 3 of 3 contains no actual circuit information, only the interconnection between vias on the PCB.

Most of the functionality of the circuitry is contained within the CSR Bluecore chip. The PCB contains, in addition to the Bluecore chip, a flash memory (U2), a low noise RF amplifier,(U6) antenna switching (U5), and a linear power supply regulator (U3).

The antenna socket is routed by U5 RF changeover switch to either the input of the low noise RF amplifier U6, or the output of the PA stage, U4. Bluetooth IC U1 delivers the RF send signal via a Multilayer Balun, B1, to U4. Antenna switching is controlled from the Bluecore chip U1.

U4 provides extra power gain to compensate for the fall off in RF output from the U1 at elevated temperatures.

The Bluecore chip contains RF receiver and transmitter circuitry, 10K of 16 bit words of RAM, organized into circular buffers for temporary storage of incoming and outgoing data, a memory manager, DSP as part of the radio block, and internal 16 bit microcontroller. The flash memory U2 serves to hold settings and program code for the Bluecore chip U1.

The Bluecore chip can interface to a USB port, and optionally to an RS232 interface. In this design the USB port only is used.

A separate power supply regulator is used (U3), because it can provide a higher current capability than the regulator within the Bluecore chip, which would need an external pass transistor and extra components. This is a low-dropout regulator providing a nominal 3.0V internal supply.

The Bluecore-01 contains a USB controller and is directly connected via a 40 way Hirose DF12-40DS-0.5V to a mating 40W compatible connector on the motherboard. All functions of the Bluecore IC are controlled via the USB bus from the motherboard. The Bluecore control is also via the USB bus, including firmware upgrades.

An alternative control / programming interface for the Bluecore IC is via it's SPI interface, accessible by fitting the optional connector JP1. This is a contingency measure which will also allow the flash device to be programmed before the USB port is configured.