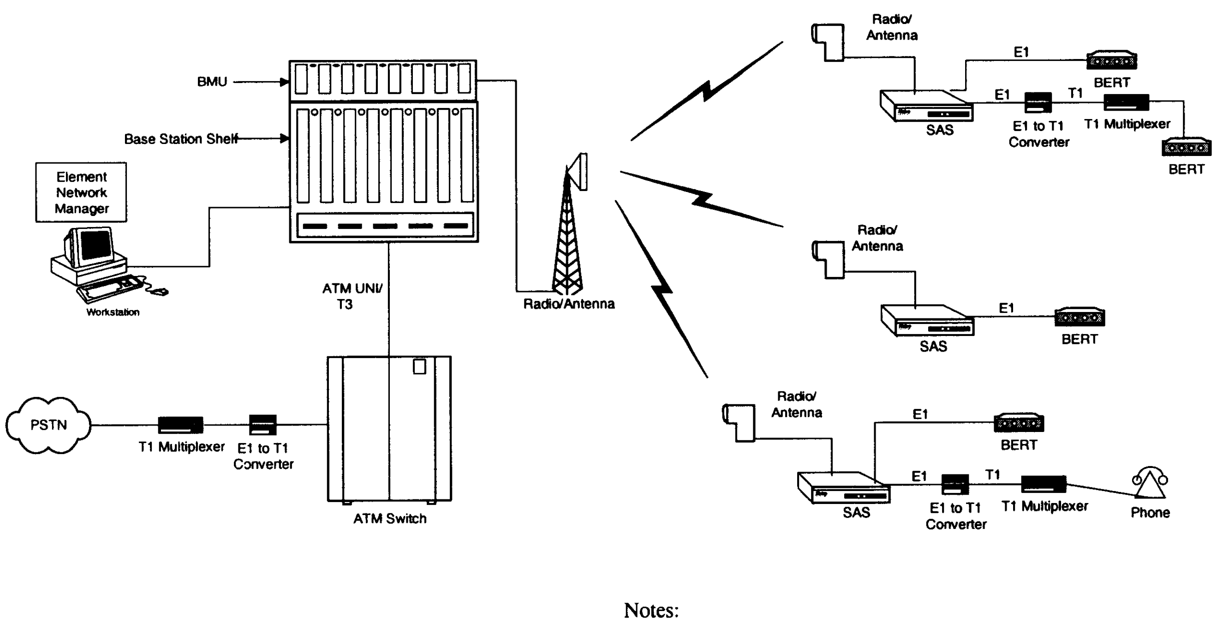
Netro Corporation
Application for FCC Radio Experimental License
(Response to Question 10a)

10a) Program of Experimentation

Netro Corporation will be engaged in testing their point to multi-point 3.5 GHz radio to verify RF performance and broadband capabilities.

The Radio System test will be setup on the roof of Netro's facility in Santa Clara. The configuration will utilize two (2) Base Station Radios and ten (10) Subscriber terminals (ten radios). All radios will operate in full duplex. Figure 1 and Figure la indicate the typical lab setup and radio topology that will be configured at Netro for experimentation.



Notes:
1. All radio units will be placed on the roof of Netro's San Jose facility
2. Lab Base Station System will be configured with two Base Station Radios at 90 degrees sectonzation.
3. Lab System will be configured for 3 Subscriber terminals.

Figure 1: Netro's Lab Configuration

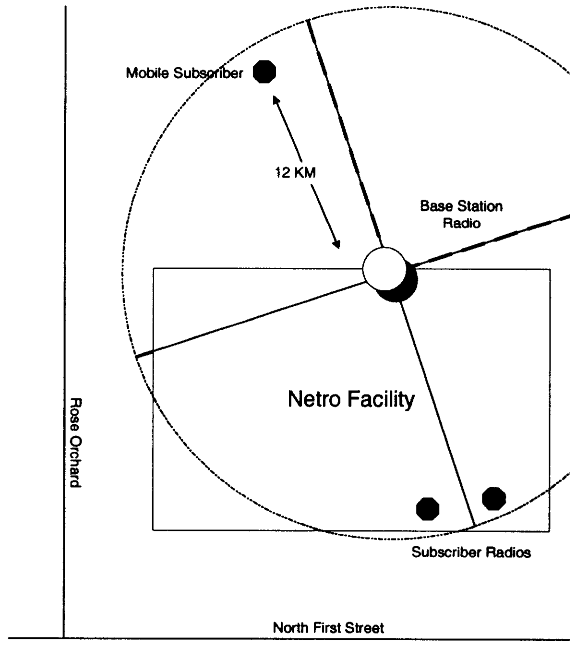


Figure 2: Radio Topology for Lab Test

Members of Netro's technical staff will verify that the microwave radio designed for transmission of high speed digital traffic meets its design specifications. Maximum and minimum RF signals will be verified by operating within its radio specifications. All analysis will be determined by engaging in the following array of tests:

- **Base Station Antenna**
  - Frequency
  - Gain
  - Elevation Beamwidth
  - Sidelobe Envelope
  - Polarization
  - Cross Polarization
  - Front-to-Back Ratio
  - VSWR
  - Base Station Antenna Mechanical Adjustment Ranges

- **Base Station Radio**
  - Transmitter Characteristics
    - *Operating Frequency*
    - *Output power @ 1dB Compression point*
    - *Output Power per Carrier*
    - *Output Power Backoff*
    - *Flatness / Stability*
    - *Output Power Adjustment Range*
    - *Phase Linearity*
    - *MMIC Chip Capacity*
    - *Frequency Stability*
    - *Spurious Output (harmonic & non-harmonic related)*
    - *Out-of-Band Emission Characteristics*
  - Receiver Characteristics
    - *Operating Frequency*
    - *Noise Figure*
    - *RE Input Operating Level*
    - *Input 1P3*
    - *Image Rejection*
    - *Maximum RE Input Level without Damage*
    - *Input Sensitivity*
    - *LO Phase noise (IF set to CW)*

Subscriber Access System (SAS) Radio Requirements

- **Subscriber Radio Antenna**
  - Antenna Types
    - *Planar*
    - *Parabolic*
    - *Lens Horn*
    - *Phased Array*
  - Frequency
  - Gain
  - Half-Power Beamwidth
  - Sidelobe Envelope
  - Polarization
  - Cross Polarization
  - Front-to-Back Ratio
  - VSWR
  - Size
  - Subscriber Access System (SAS) Antenna Mechanical Adjustment Ranges

- **Subscriber Access System (SAS) Radio**

  Transmitter Characteristics

  Operating Frequency
  Output Power @ 1dB Compression point
  Output Power per Carrier
  Output Power Backoff
  Flatness / Stability
  Output Power Adjustment Range
  Frequency Stability
  Spurious Output (harmonic & non-harmonic related)
  Out-of-Band Emission Characteristics

  Receiver Characteristics

  Operating Frequency
  Noise Figure
  RE Input Operating Level
  Input 1P3
  Image Rejection
  Maximum Input Level without Damage
  Input Sensitivity
  LO Phase noise (IF set to CW)

Theory of Operation

AirStar is a wireless point to multi-point telecommunications system that provides broadband fixed local ioop access. As a complete product family, AirStar is built on advanced ATM and digital microwave technology. It provides a bandwidth efficient, cost effective, and future proof solution for service providers. A multiple service (voice, data, video and Internet access) network can be easily deployed based on the AirStar product family.

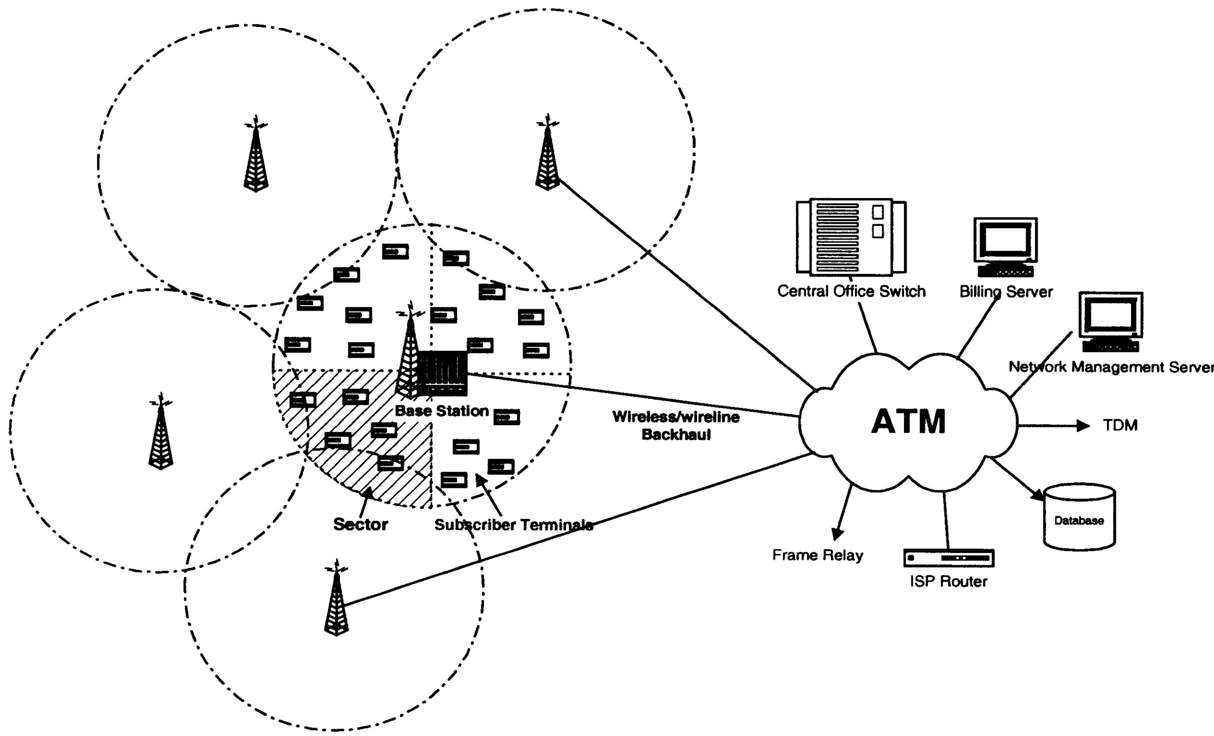


Figure 3: AirStar Network Topology

An AirStar network is built on a sectorized cellular based topology shown in Figure 1. Each AirStar cell consists of a Base Station (BS), which is typically located at a point of presence on a tall building in a downtown area typically; a number of Subscriber Terminals (ST's), which are located at customer premises; and a Network Management System (NMS). All the cells are connected either through existing wireline links or wireless backhaul to the ATM backbone, from which subscribers can either be cross-connected or access multiple services, such as PSTN, Frame Relay, TDM, Internet.

In order to ensure the quality of an multiple-service network, to provide the flexibility and scalability of the network and to take the advantage of the statistical multiplexing gain from the nature of wireless and ATM technology, Netro has invented a sophisticated MAC layer protocol, called CellMAC (patent pending). The Ce1lMAC running between the base station and subscriber terminals allocates bandwidth dynamically and instantaneously. Hence, the subscribers of the AirStar system share bandwidth in the air, and are served by the BS on a bandwidth-on-demand basis.

When a subscriber needs transmission bandwidth, that bandwidth is granted by the BS on an instantaneous basis. When a subscriber is on-hook (circuit-switched applications) or has no data to send (cell/packet-switched applications), the bandwidth is available for other subscribers in the sector to use. This is a key advantage of the AirStar system as it provides users to access the full bandwidth that is available for bursty data applications and offers the network operator to statistically multiplex (oversubscribe) users in a cell, which allows for the most efficient use of the bandwidth. AirStar's also ensures the Quality of Service for all classes of service, such as CBR, VBR, UBR, etc.

Equipment Description

AirStar Subscriber Overview

Subscribers are organized into sectors as shown in Figure 2. The AirStar has a capacity of 41.4 Mb/s per sector in the trial release using 4-QAM modulation based on a 40 MHz channel allocations. Users share the bandwidth in the Sector and are granted access by the BS.

Figure 4: AirStar Topology (1 Sector Shown)

Sectors are wedge-shaped regions served by one Base Station Radio Unit (BRU) as shown in the above figure. Sectors can be 15^0, 30^0, 45^0, 60^0, or 90^0 in width. Omnidirectional operation is not supported. Maximum number of Sectors per BS is 24 (using 150 Sectors), and minimum number of Sectors per BS is 1 (if only 90^0 coverage is required). Four 90^0 sectors will provide complete coverage within a cell for entry-level capacity (i.e. 4x41 Mb/s). As the number of Subscribers in the cell grows, Sectors can easily be split by only changing the antenna at the Base Radio Unit (BRU). No visit to the Subscriber stations is required, as may be required with other types of PMP equipment.

Subscriber Radio Unit (SRU)

The AirStar is designed to be compact, easy to install, and to require minimum power. Figure 4 shows the compact SRU for 3.5 GHz (other frequencies are available). This SRU is typically mounted on a building exterior wall or rooftop at the customer location, and aimed at the nearest BS. The integral high-performance lens corrected horn antenna, while only 105 mm in diameter, has a gain of 27 dBi and a beamwidth of approximately So. The SRU design balances the need for small size with the need for maximum range (distance) to the BS and minimum interference to other nearby links (frequency reuse factor). Installation of the SRU is as simple as installing a DBS (Direct Broadcast Satellite) antenna.

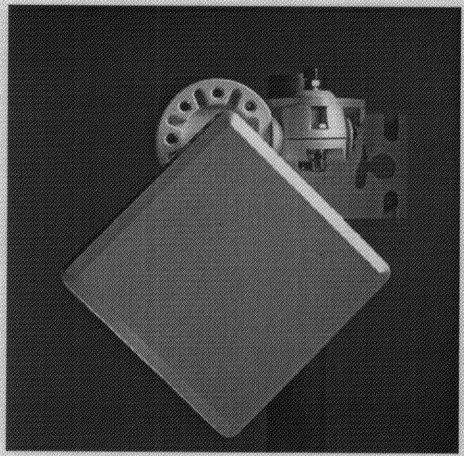


Figure 5: AirStar Subscriber Radio Unit (SR U) at 3.5 GHz

Subscriber Access System (SAS)

A single, small-diameter (6 mm) coaxial cable connects the SRU to the indoor Subscriber Access System (SAS). All signals necessary to the operation and management of the equipment are multiplexed onto the coax (transmit signal,receive signal, DC power, control, telemetry and alarms). Installation of the coax is a simple matter of crimping connectors to both ends of the coax after pulling coax through the conduit or other duct space. The SAS is shown in Figure 5. This unit is approximately the size of a TV set-top box, and has 2xTl and l0BaseT interfaces.

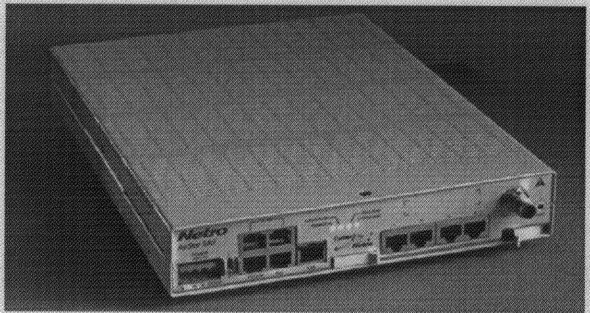


Figure 6: Subscriber Access System (SAS)

AirStar Base Station Overview

Base Station Shelf (BSS)

The Base Station Shelf is an indoor shelf with several circuit packs. The Central Processing Unit and associated Base Sector Controller provide the final digital signal processing and interface to the ATM network through a DS3 UNI v3.1.

Base Station Controller Sector Module (BSCSM)

The Base Station Controller Sector Module is a module that plugs into the base station shelf and controls a physical sector of the base station coverage. For the field trial the BSCSM will control two sub-carriers of 7 MHz each and provide a capacity of 8 Mb/s for user traffic. It is possible to provide 32 Mb/s by using two BSCSMs per sector.

Base Station Modem Unit (BMU)

The Base Station Modem Unit is an indoor module providing IF signal processing, conversion to digital information and preliminary digital signal processing.

Base Station Radio Unit (BRU)

At the Base Station, each Sector can be equipped with up to 4 subcarriers, each having a capacity of 8 Mb/s using 16-QAM. Equipping four subcarriers will provide the maximum capacity per Sector of 32 Mb/s using 16-QAM. The Base Station Radio Unit is shown in Figure 6. The configuration shown is for 2 operational channels, for a capacity of 8 Mb/s per Sector, and one standby unit in a 1:2 redundancy mode.

Figure 7 :Base Station Radio Unit (BR U) -2 channel, Redundant Configuration shown

3.5 GHz System Performance Specifications

Frequency Plan

The initial release of product supports the ERC 14-03 channel plan from 3.4 GHz to 3.6 GHz only supporting channel spacings of 3.5 MHz and 7 MHz with a 100 MHz T/R spacing. This channel plan includes support for Germany, Austria, Switzerland, France and Ireland. *It does not provide support for the UK channel plan.* The 3.5 GHz radio is designed with a 250 KHz tuning step size, and in the future can support any arbitrary *Nx250 KHz* channel spacing as defined in ERC 14-03. *Product for these alternate channel plans may be developed at a later demand if sufficient demand becomes apparent.*
The 3.5 GHz frequency plan is addressed with two pairs of base station and subscriber radios. Each radio can tune over 45 MHz. The AirStar system is configured so that the upper duplex frequency is used for Base Station transmit, and the lower duplex frequency is used for Base Station receive. For Subscriber Terminals, the scheme is reversed. Although ERC 14-03 does not specify which duplex band is used for upstream or downstream, this particular relationship has been specified in Switzerland. Therefore, Netro has chosen to follow the Swiss regulations for all 3.5 GHz applications.

	Upstream			Downstream	
10 MHz	Band 1	Band 3	Center Gap	Band 2	Band 4
3.4	3.410 3.455	3.500		3.510	3.555 3.600

3.5 GHz Range and Availability

The system gain, defined as transmit power output minus receive sensitivity, for 3.5 GHz radios is 107 dB for 4QAM operation in 7 MHz channels. For 16QAM operation, the system operates up to 10 km for link availability up to 99.999% for rain regions up to ITU-R Region K. For 4QAM operation, the system is operates up to 20 km for link availability up to 99.997% for rain regions up to ITU-R Region K.

Radio Performance Specifications

Table 1:: 3.5 GHz Radio Performance Specifications

Parameter	Value	Note
Frequency Range (GHz)	3.41 to 3.6	See Channel Plan
Transmit/Receive Spacing	100 MHz	
Tuning Range	45 MHz	Four Bands
Tuning Step Size	250 KHz	
Maximum Transmit Power Set Point	+20 dBm +17 dBm	4QAM 16QAM
Transmit Power Accuracy at Maximum Set Point	± 1 dB ± 3 dB	0 to +20 dBm -30 to 0 dBm
Transmit Power Control Dynamic Range	20 dB 50 dB	BRUs SRUs
Noise Figure	7 dB 9 dB	Typical Max.
Receiver Sensitivity, 10^{-6} CLR 7 MHz 4QAM 3.5 MHz 16QAM	 -87 dBm -85 dBm -83 dBm -81 dBm	 Typical Max. Typical Max.

BRU Antenna Performance Specifications

Planar technology is employed for the sectorized BRU antennas for the 3.5 GHz band. The performance specifications are listed in the following tables.

Table 2: 3.5 GHz Sectorized BRU Antenna Gain

Polarization	Azimuth Pattern (Degrees)	Gain (dBi) Minimum	Typical
Vertical	90°	11	14
Horizontal	90°	11	14

Table 3: 3.5 GHz Antenna Performance Specifications

Parameter	Value	Note
Operating Frequency	3.4 to 3.6 GHz	
Size	25 cm x 80 cm	Width x Height
Elevation Pattern	15° @ -3dB	Typical
Cross Polar Discrimination	25 dB	Minimum
Antenna Class per ETSI EN 302 085 V1.1.1	CS3+	
Rejection at 1.5 x Sector Angle	30 dB	Min

SRU Antenna Performance

The 3.5 GHz subscriber terminal supports an integral planar antenna with the characteristics as in **Error! Reference source not found.**.

Table 4: 3.5 GHz SRU Integral Antenna Performance Specifications

Parameter	Value	Notes
Frequency	3.4 to 3.6 GHz	
Size	30 cm x 30 cm	Width x Height
Gain	18 dBi 17 dBi	Nominal Minimum
Beamwidth, 3 dB	16° 20°	Nominal Maximum
Cross polar discrimination	20 dB	Minimum
Front Aspect Dimensions	305mm x 305mm	
Antenna Class per ETSI EN 302 085	TS3	

For the 3.5 GHz SRU, the mechanical interface is a single bolt attachment to the SRU support cradle. The SRU cradle mounts to an outside wall or other mounting surface at the subscriber premises. Panning in both azimuth and elevation is possible with a simple locking mechanism.

Channel Plan

For systems with 3.5 MHz channel spacing:
lower half band $f_n = 3408.25 + 3.5n$
upper half band: $f_n' = 3508.25 + 3.5n$, $n = 1, \ldots 25$

Table 5: ETSI 3.5 GHz 3.5 MHz Channel Plan

Channel	Band 1 Upstream (MHz)	Band 2 Downstream (MHz)	Channel	Band 3 Upstream (MHz)	Band 4 Downstream (MHz)
1	3411.75	3511.75	13	3453.75	3553.75
2	3415.25	3515.25	14	3457.25	3557.25
3	3418.75	3518.75	15	3460.75	3560.75
4	3422.25	3522.25	16	3464.25	3564.25
5	3425.75	3525.75	17	3467.75	3567.75
6	3429.25	3529.25	18	3471.25	3571.25
7	3432.75	3532.75	19	3474.75	3574.75
8	3436.25	3536.25	20	3478.25	3578.25
9	3439.75	3539.75	21	3481.75	3581.75
10	3443.25	3543.25	22	3485.25	3585.25
11	3446.75	3546.75	23	3488.75	3588.75
12	3450.25	3550.25	24	3492.25	3592.25
13	3453.75	3553.75	25	3495.75	3595.75

For systems with 7 MHz channel spacing:
lower half band $f_n = 3406.5 + 7n$
upper half band: $f_n' = 3506.5 + 7n$, $n = 1, \ldots 12$

Table 6: ETSI 3.5 GHz 7 MHz Channel Plan

Channel	Band 1 Upstream (MHz)	Band 2 Downstream (MHz)	Channel	Band 3 Upstream (MHz)	Band 4 Downstream (MHz)
1	3413.50	3513.50	7	3455.50	3555.50
2	3420.50	3520.50	8	3462.50	3562.50
3	3427.50	3527.50	9	3469.50	3569.50
4	3434.50	3534.50	10	3476.50	3576.50
5	3441.50	3541.50	11	3483.50	3583.50
6	3448.50	3548.50	12	3490.50	3590.50

Spectral Mask

The 3.5 GHz system with 4QAM operation conforms to the System Type A spectral mask as defined in ETSI EN 301 021 V1.2.1 and as shown in **Error! Reference source not found.**.

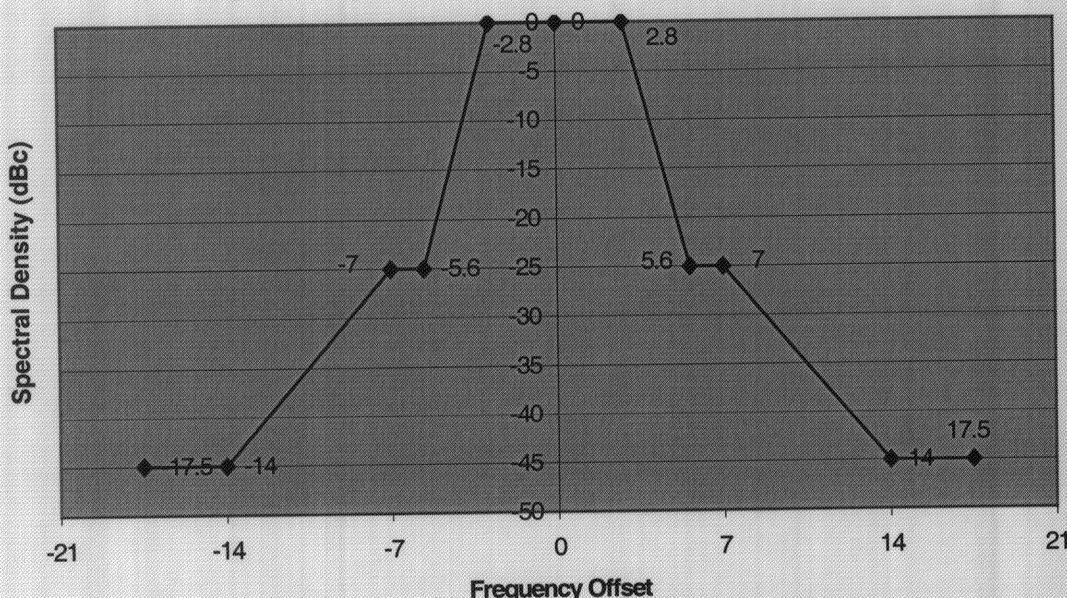


Figure 8: 3.5 GHz 4QAM Spectrum Mask For 7 MHz Channel

The 3.5 GHz system with 16QAM operation conforms to the System Type B spectral mask as defined in ETSI EN 301 021 V1.2.1 and as shown in **Error! Reference source not found.**.

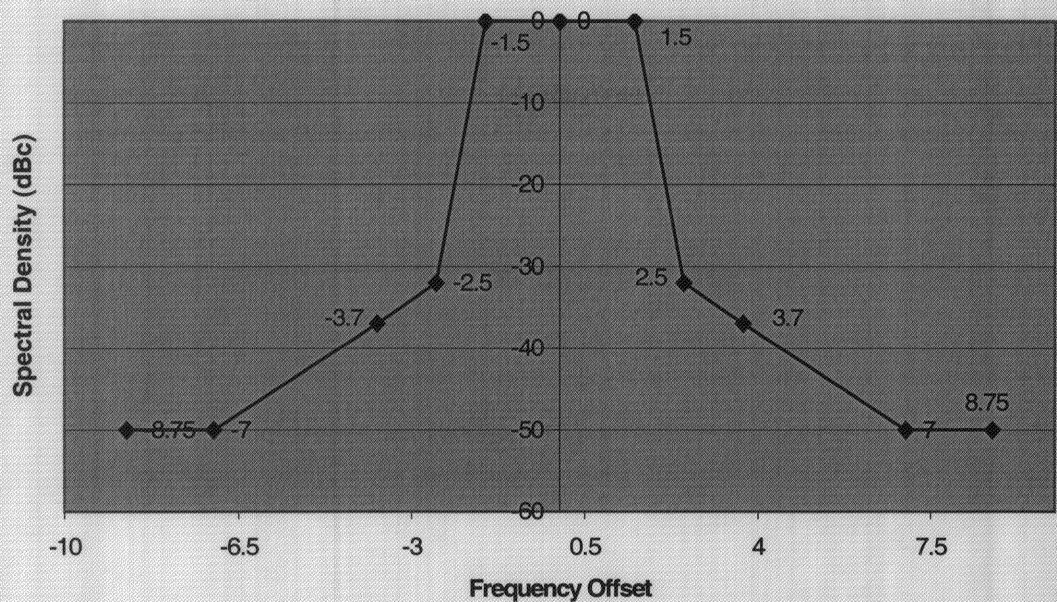


Figure 9: 3.5 GHz 16QAM Spectrum Mask For 3.5 MHz Channel