

BAB V

KESIMPULAN

1. Dari hasil rancangan ini untuk *frekuensi* 23 GHz dengan ketinggian antenna dari permukaan laut 38 meter pada BTS Spotec dan ketinggian antenna dari permukaan laut 45 meter pada Kolektor BTS Simpang Batu Sari menunjukkan masih ada jarak dari *LOS* sebesar 6,193 meter.
2. Dari hasil perhitungan rancangan untuk *Uplink* diperoleh *RSL* sebesar -35 dBm dan *Fade Margin* sebesar 46 dB (Reliabilitasnya = 99,9972 %) sedangkan untuk *Downlink* diperoleh *RSL* sebesar -35,38 dBm, dan *Fade Margin* sebesar 45,62 dB (Reliabilitasnya = 99,9968 %). Kualitas penerimaan sinyal melebihi dari *Reliability* standart 99,995 %.
3. Dari hasil perhitungan dalam rancangan diperoleh *Eb/No* untuk *Uplink* didapat sebesar 60,85 dB dan untuk *Downlink* sebesar 60,47 dB. Sedangkan untuk mencapai standar $BER = 10^{-6}$ (QPSK), diperlukan *Eb/No* sebesar 10,6 dB sehingga kualitas penerimaan sinyal diatas standar ($BER < 10^{-6}$).

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3. Gouzali Syadam Drs, BC, TT, "Prinsip Dasar Teknologi Jaringan Telekomunikasi", Angkasa, Bandung, 1997
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10., Nokia Corp "*Instruction Manual Flexihopper Digital Radio Sistem*"

The logo of Universitas Darma Persada is a large, light yellow flower-like emblem with eight petals. Inside the emblem, the text "UNIVERSITAS" is at the top and "DARMA PERSADA" is at the bottom, both in a light grey font. In the center of the emblem is a smaller, faded version of the university's crest, which features a shield with a book and a lamp, topped with a crown. The main title "LAMPIRAN 1" is written in a large, bold, black serif font across the middle of the emblem.

LAMPIRAN 1

Terrain Data

Terrain Data - SPOTECMD1-SMPGBATUSARIMD1.pl4

SPOTECMD1SMPGBATUSARIMD1

Call Sign	JKB114	JKB031
Station Code	BLD_24_TW_9	GF_SST
Latitude	0 611 54.38 S	06 11 46.28 S
Longitude	106 45 39.60 E	106 46 22.80 E
True azimuth (°)	079 23 20.21	259 23 15.55
Calculated Distance (km)	1.351	
Profile Distance (km)	1.351	
Ellipsoid	GRS80	
UTM zone	48S	48S
Easting (km)	694.847	696.176
Northing (km)	9314.536	9314.780
Elevation (m)	10.91	15.26

Distance (km)	Elevation (m)	Ground	Structure (m)
0.000	10.91	AG	18.0 m Building - Off Path Structure
0.040	10.18	AG	18.0 m Building - Start of Range
0.100	9.09	AG	
0.200	10.57	AG	
0.300	12.87	AG	
0.400	13.36	AG	
0.500	13.14	AG	
0.600	13.44	AG	
0.700	13.72	AG	
0.800	13.27	AG	
0.900	15.10	AG	
1.000	15.67	AG	
1.100	11.26	AG	
1.130	11.10	AG	End of Range
1.167	10.90	AG	17.0 m Tree
1.200	10.73	AG	17.0 m Building - Start of Range
1.300	14.05	AG	End of Range
1.351	15.26	AG	

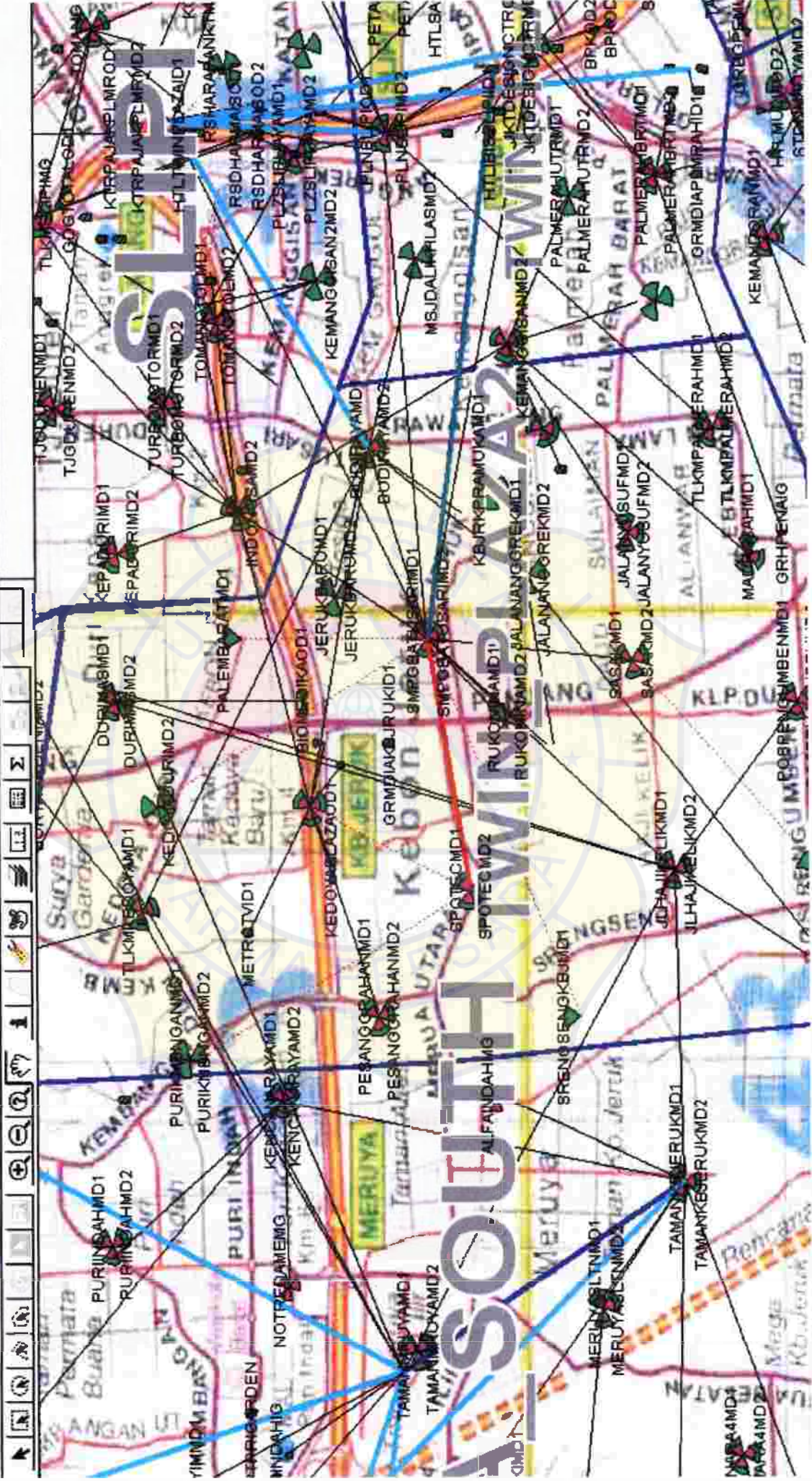
Ground Elevations - AMSL, Structure & Antenna Heights - AGL

Ground Type

PG - Poor, AG - Average, GG - Good, FW - Fresh Water, SW - Salt Water

Off Path Building at 0.000 km-

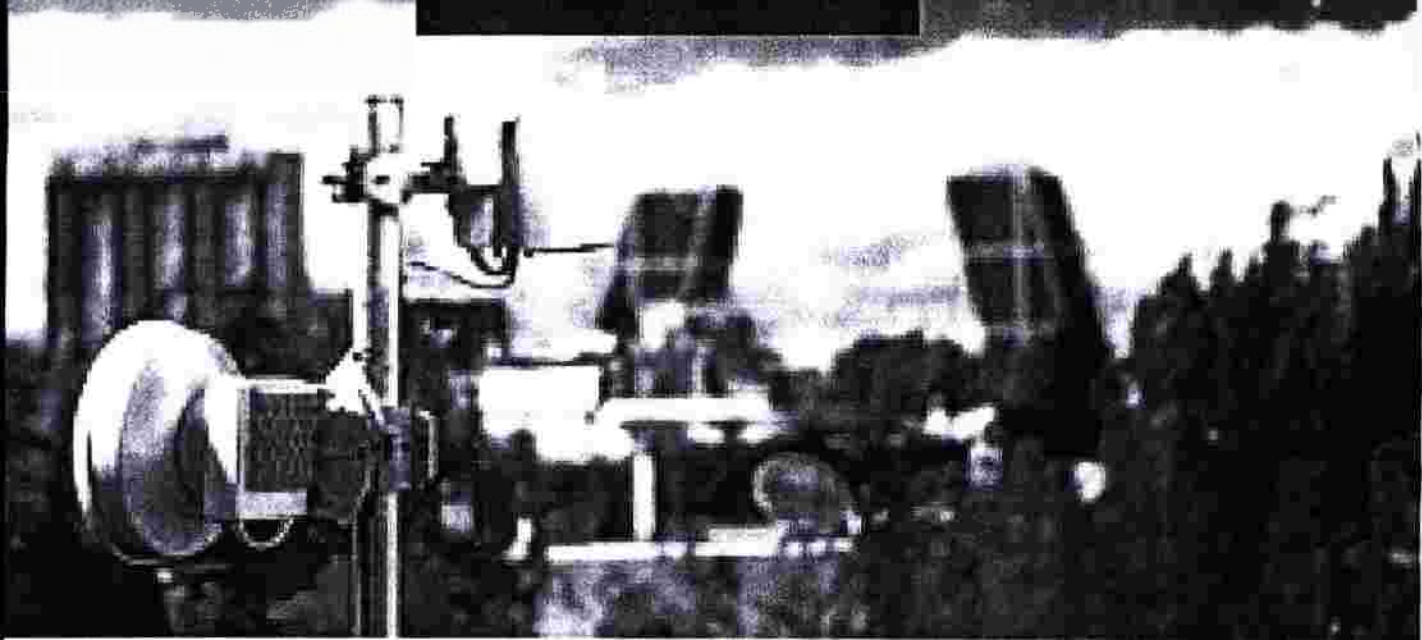
Distance Off Path (m)	5.0
Ground Elevation (m)	10.9
Structure Height (m)	18.0



The logo of Universitas Darma Persada is a large, light yellow flower-like emblem with eight petals. Inside the emblem, the text "UNIVERSITAS" is written in a semi-circle at the top and "DARMA PERSADA" at the bottom. In the center of the emblem is a smaller, faint version of the university's crest, which features a shield with a crown on top and a figure holding a staff.

LAMPIRAN 3

Spesifikasi Alat



Nokia FlexiHopper™ Microwave Radios – fast set up of transmission links

Nokia FlexiHopper™ Microwave Radios allow transmission links to be established rapidly. These versatile radios can be set up quickly and easily to meet a variety of transmission needs, bringing cost savings and helping rapid network rollout.

Operating in the 13, 15, 18, 23, 26 and 38 GHz frequency bands, Nokia FlexiHopper Microwave Radios can be used for many communication needs providing connections e.g. in cellular, fixed and dedicated networks.

The Nokia FlexiHopper Microwave Radio comprises an outdoor unit and an indoor unit, which can be selected from four different models. In the Nokia MetroSite™ and Nokia UltraSite™ solution the indoor unit (FC RRI or FXC RRI) is fully integrated in the base station. The radio and BTS is connected using a single Nokia Flexbus™ cable allowing fast and simple installation. Nokia FlexiHopper Microwave Radios can also be easily deployed from existing Nokia Talk-family Base Station sites with the BTS integrated RRIC indoor unit. This offers a cost effective way to maximise the usage of existing sites. Another option is to use the modular FIU 19 indoor unit which provides general telecommunications interfaces and mounts to a standard 19" rack.

A totally new level of flexibility
Nokia FlexiHopper Microwave Radios bring a new level of versatility when both network capacity and coverage are required.

All the features below can be used to tailor and reconfigure the transmission for fast and low cost rollout and expansion, even when last minute changes are unavoidable.

- Four different indoor unit types.
- A single indoor unit can support multiple Nokia FlexiHopper Microwave Radios and/or Nokia MetroHopper Radios.
- Nokia Flexbus interconnections between units – Nokia Flexbus is also used for carrying connections between separate indoor units via a single cable.
- Radio and software controlled cross connection integrated.
- Software programmable transmission capacity.

Fast and easy to install

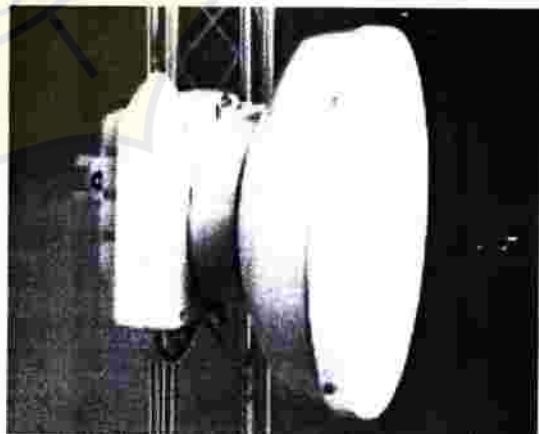
Lightweight and compact size of the Nokia FlexiHopper Microwave Radio simplify site acquisition and installation. In many cases, Nokia FlexiHopper Microwave Radio can be installed in locations unsuitable for other transmission methods. Valuable space on the site is saved and complicated cabling avoided, as one indoor unit is capable of supporting several outdoor units. Indoor units

are simply plugged into position in other Nokia equipment environment and Nokia Flexbus cable used to connect the units together.

Access you can rely on

Nokia FlexiHopper Microwave Radios help improve your network's availability by offering superior transmission reliability. A variety of advanced features are used to achieve an availability better than any leased line solution. These include:

- Adaptive level control with quality measure (ALCO) adjusts power to maintain transmission quality regardless of the weather.



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- Forward error correction improves radio performance in demanding conditions.
- Automatic fading margin measurement during commissioning.
- Several protection methods: hot standby, frequency and space diversity.
- High Mean Time Between Failure ratio.

When combined with Nokia's network reliability features, such as loop protection, you can achieve virtually

error free transmission in even the most demanding conditions.

Main benefits

- Nokia Flexbus single cable interconnections together with integrated software controlled cross connections provide revolutionary easy and flexible site configurations.
- Four different indoor units, either fully Nokia integrated or 19", for all transmission requirements.

- Common indoor unit platform for both Nokia FlexiHopper Microwave Radios and Nokia MetroHopper Radios.
- One indoor unit supports multiple outdoor units – saves equipment and installation costs and reduces space requirements.
- Versatile design with a single platform for all frequencies.
- Compact and easy to install outdoor unit with integrated low profile or square antennas speed up roll out.

Technical Specifications of Nokia FlexiHopper Microwave Radio / Outdoor Unit

General	13	15	18	23	26	38
Frequency range (GHz)	12.76– 13.24	14.51 – 15.34	17.71– 19.69	21.23–23.60	24.55 –26.45	37.05 –39.44
Transmission capacity	2 x 2, 4 x 2, 8 x 2 or 16 x 2 Mbit/s (Software programmable)					
Modulation	QPSK					
Channel spacing (MHz)	3.5–28.0 depending on capacity					
Power consumption	max 25 W					
Operational temperature	-45 to +50 °C					
Weight and dimensions	5.5 kg 230x 210x210	4.6kg 230x210x 165			4.0 kg 230 x 210 x 120	
Antenna type	Integrated low profile antenna with vertical/horizontal polarisation Compact square antenna					
Antenna gain (dBi)	35.5 – 45.0	32.0 –46.2	34.4 –48.2	31.0 –49.5	32.3 –46.9	35.0–44.3
Transmitter	Typical values in dBm					
Output power	20 dBm			18 dBm		16 dBm
Power adjustment range	25 dB					
Receiver Threshold level at antenna port	Typical values in dBm BER 10 ⁻³ /BER 10 ⁻⁶					
Capacity (Mbit/s)						
2 x 2	-93/-90			-92/-89		-90/-87
4 x 2	-90/-87			-89/-86		-89/-86
8 x 2	-87/-84			-86/-83		-86/-83
16 x 2	-84/-81			-83/-80		-83/-80

Technical Specifications of Indoor Units

Base Station Integrated Indoor Unit	Integration into	Number of Outdoor Units
FC RRI	Nokia MetroSite and Nokia UltraSite Base Stations	1
FXC RRI	Nokia MetroSite and Nokia UltraSite Base Stations and Nokia MetroHub Transmission Node	1 – 2
RRIC	Nokia Intratalk BTS and Nokia Citytalk BTS	1 – 2
19" Indoor Unit FIU 19	Integration into Standard 19" rack and Nokia Extratalk cabinet	Number of Outdoor Units* 1 – 3
Main Channels	4 – 16 x 2 Mbit/s, ITU-T G703, 75 ohm SMB or 120 ohm TD	
Electrical interface	EIA-232 or ITU-T V.11: max. 9600 bit/s ITU-T V.11 or ITU-T G.703: max. 64 kbit/s	
Auxiliary data channels (plug-in-unit)	Four programmable I/O interfaces	
Weight and dimensions	2.45kg, 2/3 U x 440 x 300	
Power consumption	max 17 W	

*Nokia FlexiHopper Microwave Radios and Nokia MetroHopper Radios can be mixed and one Nokia FlexiHopper Microwave Radio can be protected

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0800 Libris
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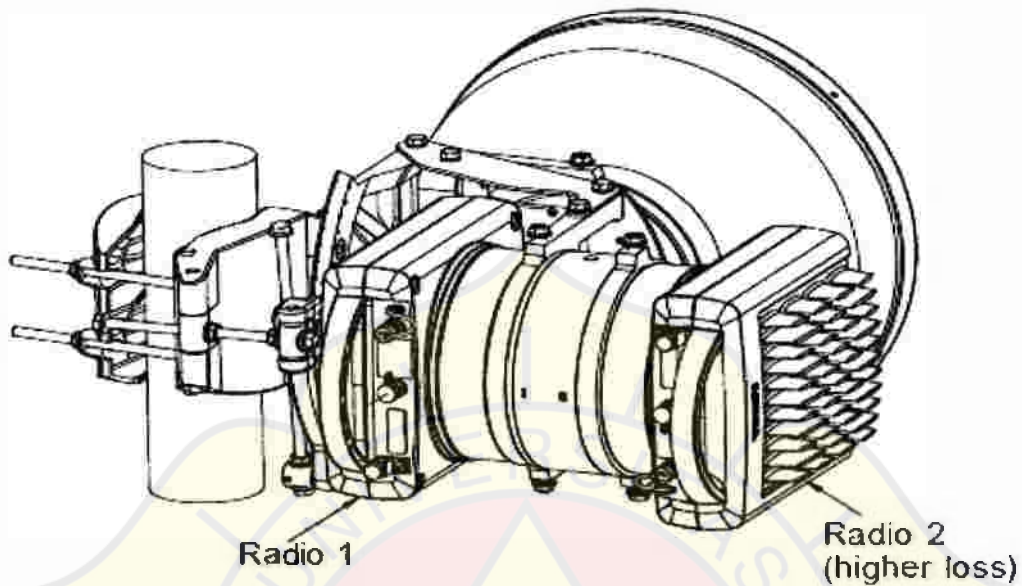


Figure 33. Nokia FlexiHopper 18, 23, or 26 in 1-antenna HSB operation

Table 52. Coupler dimensions

Dimensions of the 13/15 GHz coupler	Height 300 mm Width 430 mm Depth 260 mm Weight 6.8 kg
Dimensions of the 18 - 26 GHz coupler	Height 250 mm Width 280 mm Depth 300 mm Weight 5.0 kg
Dimensions of the 38 GHz coupler	Height 250 mm Width 240 mm Depth 300 mm Weight 4.8 kg

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Table 42. Antenna connector

Frequency band	Waveguide flange
13 GHz	UBR120
15 GHz	UBR140
18, 23, 26 GHz	UBR220
38 GHz	UBR320

Table 36. Receiver threshold at antenna connector

Frequency band	Capacity (Mbit/s)	BER 10 ⁻³ threshold (dBm)		BER 10 ⁻⁶ threshold (dBm)	
		Typical	Guaranteed	Typical	Guaranteed
13, 15, 18, 23 GHz	2 x 2	-93	-89	-90	-86
	4 x 2	-90	-86	-87	-83
	8 x 2	-87	-83	-84	-80
	16 x 2	-84	-80	-81	-77
26 GHz	2 x 2	-92	-88	-89	-85
	4 x 2	-89	-85	-86	-82
	8 x 2	-86	-82	-83	-79
	16 x 2	-83	-79	-80	-76
38 GHz	2 x 2	-90	-86	-87	-83
	4 x 2	-89	-85	-86	-82
	8 x 2	-86	-82	-83	-79
	16 x 2	-83	-79	-80	-76

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Power levels

Table 32. Maximum transmit power and noise figure at antenna connector

Frequency band	Transmit power (dBm), nominal	Receive noise figure (dB), typical over temperature
13, 15 GHz	20	<6.5
18, 23 GHz	18	<7
26 GHz	18	<7.5
38 GHz	16	<8

Table 33. Minimum transmit power

Frequency band	Capacity (Mbit/s)	Minimum transmit power (dBm), nominal
13, 15 GHz	All capacities	-6
18, 23, 26, 38 GHz	2 x 2	-10
	4 x 2	-7
	8 x 2	-4
	16 x 2	-1

Table 2. Antenna and alignment unit

Frequency band	Antenna size alternatives				
13 GHz		60 cm	120 cm	180 cm	
15 GHz		30 cm	60 cm	120 cm	180 cm
18 GHz		30 cm	60 cm	120 cm	180 cm
23 GHz	20 cm	30 cm	60 cm	120 cm	180 cm
26 GHz	28 cm	30 cm	60 cm	120 cm	
38 GHz	20 cm ¹	30 cm	60 cm		

¹) Available with the Nokia FlexiHopper alignment unit or with the Nokia MetroHopper alignment bracket and the fastener

Modulation and demodulation

Table 24. Modulation

Modulation method	$\pi/4$ -DQPSK
Demodulation method	Partially differential

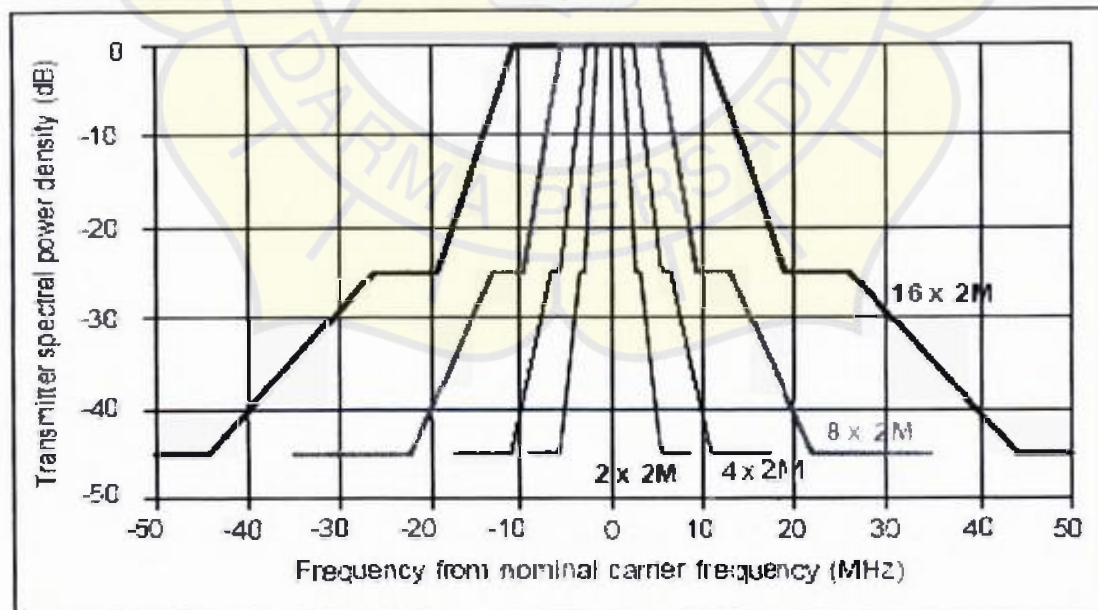


Figure 27. Spectrum mask

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Table 20. Nokia FlexiHopper 23, frequency tuning range

Subband	2x2 Mbit/s capacity		4x2 Mbit/s capacity		8x2 Mbit/s capacity		16x2 Mbit/s capacity	
	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)	Lowest channel (MHz)	Highest channel (MHz)
1232 MHz duplex spacing, subbands A - C and A' - C'								
A	21225.75	21622.25	21227.50	21620.50	21231.00	21617.00	21238.00	21610.00
B	21585.75	21982.25	21587.50	21980.50	21591.00	21977.00	21598.00	21970.00
C	21945.75	22342.25	21947.50	22340.50	21951.00	22337.00	21958.00	22330.00
A'	22457.75	22854.25	22459.50	22852.50	22463.00	22849.00	22470.00	22842.00
B'	22817.75	23214.25	22819.50	23212.50	22823.00	23209.00	22830.00	23202.00
C'	23177.75	23574.25	23179.50	23572.50	23183.00	23569.00	23190.00	23562.00
1008 MHz duplex spacing, subbands M - N and M' - N'								
M	22003.75	22400.25	22005.50	22398.50	22009.00	22395.00	22016.00	22388.00
N	22193.75	22589.00	22195.50	22588.50	22199.00	22585.00	22206.00	22578.00
M'	23011.75	23408.25	23013.50	23406.50	23017.00	23403.00	23024.00	23396.00
N'	23201.75	23597.00	23203.50	23596.50	23207.00	23593.00	23214.00	23586.00

Antenna and alignment unit

Electrical characteristics

Table 45. Antenna specifications

Frequency band	Antenna size	Gain (low/mid/high-band) (dBi)	Gain tolerance (dB)	3 dB beam-width	F/B ratio (Vert./Horiz. pol.) (dB)	XPD (dB)	Return loss (dB)
23 GHz	20 cm	30.5/31.0/31.5	±0.5	45°	56	30	15
	30 cm	35.0/35.5/36.0	±0.9	2.7°	61	30	17.7
	60 cm	40.1/40.6/41.1	±0.8	1.5°	65	30	17.7
	120 cm	45.5/46.0/46.5	±0.5	0.7°	72	30	17.7
	180 cm	48.9/49.5/50.0	±0.5	0.5°	75	32	20

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Frequencies

Table 19. Frequency bands, sub-bands and duplex-spacings

Outdoor unit	ITU-R Rec.	Frequency band (GHz)	Duplex spacing (MHz)	Number of subbands	Sub-band bandwidth (MHz)	CEPT
Nokia FlexiHopper 7	F.785-7	7.125-7.435	161 ¹	4+4 (A to D)	56	-
		7.425-7.725	154 ¹	4+4 (E to H)	65	-
		7.415-7.725	161 ¹	4+4 (I to L)	58	-
		7.240-7.560	161 ¹	4+4 (M to P)	65	-
		7.440-7.740	166 ¹	3+3 (Q to S)	65	-
Nokia FlexiHopper 8	F.386-6	7.725-8.275	311.32 ¹	3+3 (A to C)	125	-
		8.280-8.495	119 ¹	3+3 (D to F)	42	-
		8.275-8.500	126 ₁	3+3 (G to I)	42	-
Nokia FlexiHopper 13	F.497-6	12.75-13.25	266	3+3 (A to C)	84	REC 12-02
Nokia FlexiHopper 15	F.636-3	14.5-15.35	420 ¹	3+3 (A to C)	150	-
		14.5-15.35	644 ¹	1+1 (M)	203	-
		14.5-15.35	728 ¹	1+1 (N)	119	REC 12-07
Nokia FlexiHopper 18	F.595-8	17.7-19.7	1010	4+4 (A to D)	270	REC 12-03
Nokia FlexiHopper 23	F.637-3	21.2-23.6	1232 ¹	3+3 (A to C)	400	-
		22.0-23.6	1008 ¹	2+2 (M,N)	400	T/R 13-02

Table 76. Electrical specifications for FlexiHopper 90 cm antenna at 23 GHz

Frequency/ Size	(23 GHz); 21200-23600 MHz/ 90 cm (2.5 ft)
Type, Item	Single T55075.09
Gain	Low 42.8/ Middle 43.3/ High 43.8 dBi (min 41.9/ max 44.6 dBi)
BW(-3 dB)	1.2 deg
FB	68 dB
XPD/ Isolation	30 dB
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3

Table 77. Electrical specifications for FlexiHopper 120 cm antenna at 23 GHz

Frequency/ Size	(23 GHz); 21200-23600 MHz/ 120 cm (4 ft)
Type, Item	Single T55075.15/ Dual T55075.65
Gain	Low 45.5/ Middle 45.9/ High 46.5 dBi (min 45.3/ max 46.7 dBi)
BW(-3 dB)	0.8 deg
FB	72 dB
XPD/ Isolation	30 dB/ 35 dB (Dual)
RL	17.7 dB
RPE ETSI EN 300 833 V1.4.1	R3 C3



NOKIA FLEXIHOPPER - FREQUENCY CHANNEL ALLOCATION

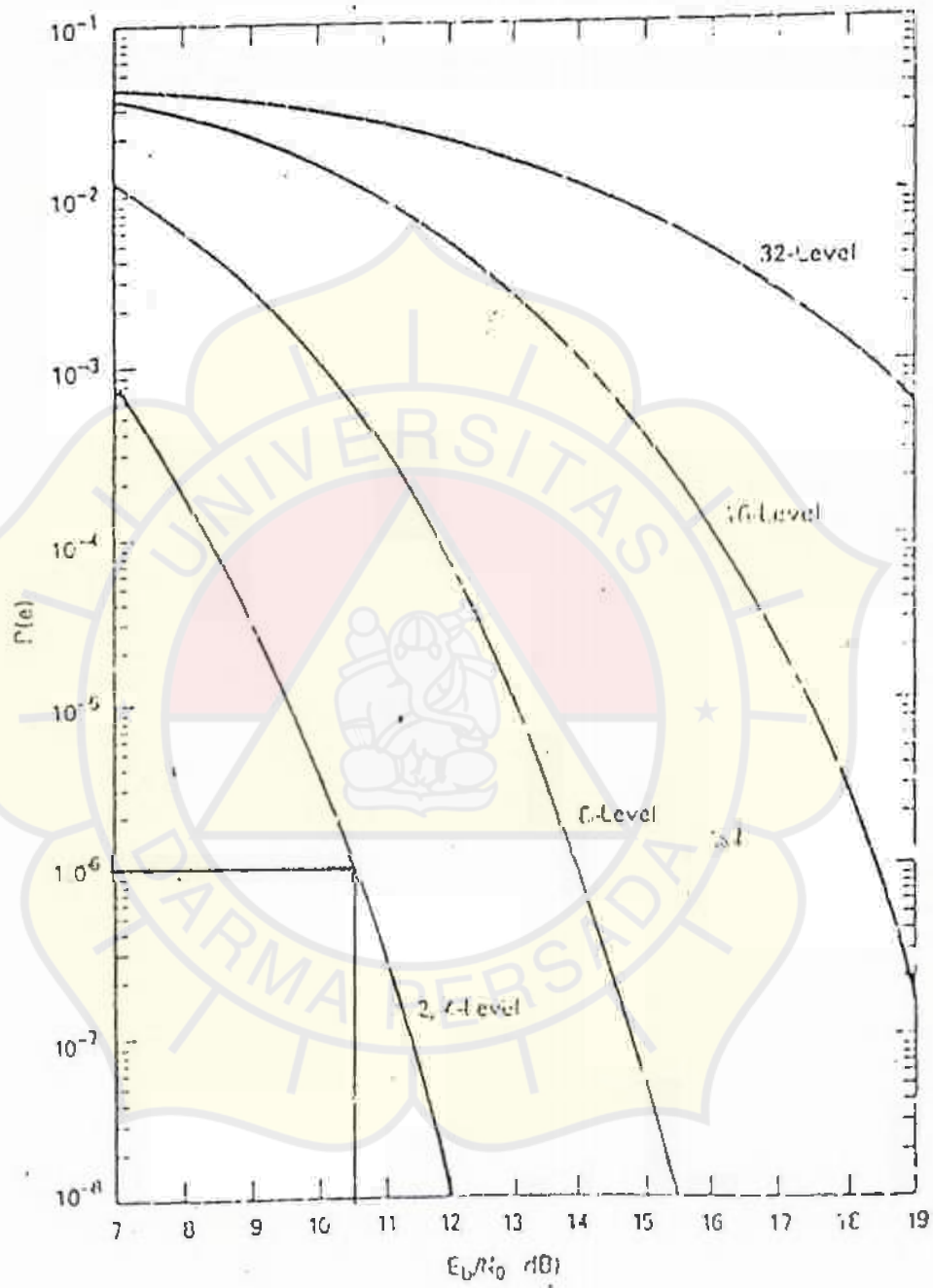
Freq. Band : 22000.00 - 23600.00 MHz
 Traffic Capacity : 4x2/8x2/16x2Mbps
 Duplex Separation : 1008 Mhz

FLEXIHOPPER FREQUENCY CHANNEL ALLOCATION				
FREQUENCY BAND/SUB-BAND	FREQUENCY RANGE (MHz)		CHANNEL NO.	CAPACITY
	Tx	Rx		
23GHz/N	22211	23219	1	8E1/16E1
	22225	23233	2	8 E1
	22239	23247	3	8E1/16E1
	22253	23261	4	8 E1
	22267	23275	5	8E1/16E1
	22281	23289	6	8 E1
	22295	23303	7	8E1/16E1
	22309	23317	8	8 E1
	22323	23331	9	8E1/16E1
	22337	23345	10	8 E1
	22351	23359	11	8E1/16E1
	22365	23373	12	8 E1
	22379	23387	13	8E1/16E1
	22393	23401	14	8 E1
	22407	23415	15	8E1/16E1
	22421	23429	16	8 E1
	22435	23443	17	8E1/16E1
	22449	23457	18	8 E1
	22463	23471	19	8E1/16E1
	22477	23485	20	8 E1
	22491	23499	21	8E1/16E1
	22505	23513	22	8 E1
	22519	23527	23	8E1/16E1
	22533	23541	24	8 E1
	22547	23555	25	8E1/16E1
	22561	23569	26	8 E1
	22575	23583	27	8E1/16E1
13GHz/C	12898	13164	1	8 E1
	12912	13178	2	8E1/16E1
	12926	13192	3	8 E1
	12940	13206	4	8E1/16E1
	12954	13220	5	8 E1
	12968	13234	6	8 E1

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7GHz/C	7191	7352	1	8E1
	7205	7366	2	8E1/16E1
	7219	7380	3	8E1
	7233	7394	4	8E1

SDH FREQUENCY CHANNEL ALLOCATION			
FREQUENCY BAND/SUB-BAND	FREQUENCY RANGE (MHz)		CHANNEL NO.
	Tx	Rx	
13GHz/A	12765	13031	1
	12793	13059	2
	12821	13087	3
13GHz/B	12849	13115	4
	12877	13143	5
13GHz/C	12905	13171	6
	12933	13199	7
	12961	13227	8
7GHz (HARRIS)	7442	7603	1
	7470	7631	2
	7498	7659	3
	7526	7687	4
	7554	7715	5
7GHz (CERAGON)	7563.5	7724.5	1
	7591.5	7752.5	2
	7619.5	7780.5	3
	7647.5	7808.5	4
	7675.5	7836.5	5



DATA PRIBADI PENULIS



NAMA : **INDRATAN DWILAKSONO**

NIM : 00210007

TTL : Padang, 29 September 1981

Jenis Kelamin : Laki-laki

Agama : ISLAM

Warga Negara: Indonesia

Alamat : Komplek Villa Pola Mas I Blok F No.7 Andalas Padang

Sumatera Barat. Phone : (0751-29965). HP: 08129613807

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● SMPN 5 Padang Timur – Sumatera Barat {1994 – 1997}

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● Universitas Darma Persada, Pondok Kelapa – Jakarta Timur

{2000–2007}