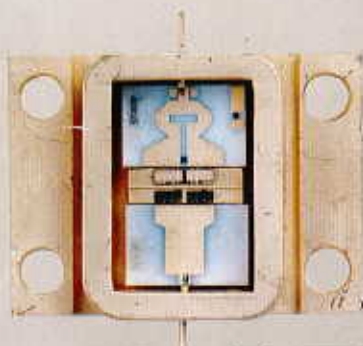
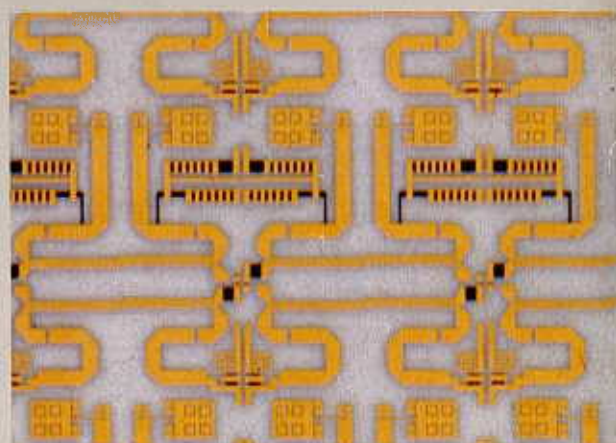


NEC

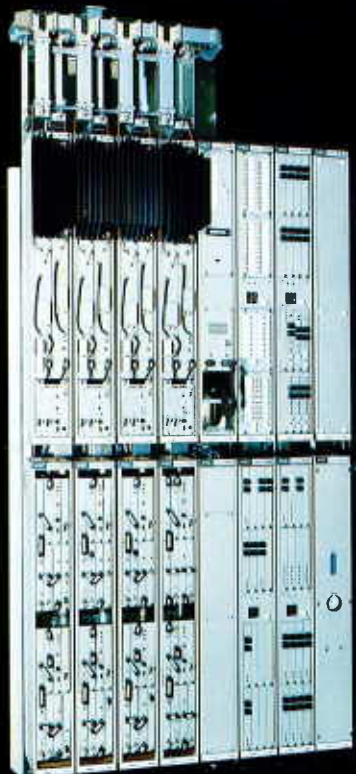


500 SERIES MICROWAVE RADIO SYSTEMS



Nippon Electric Co., Ltd.

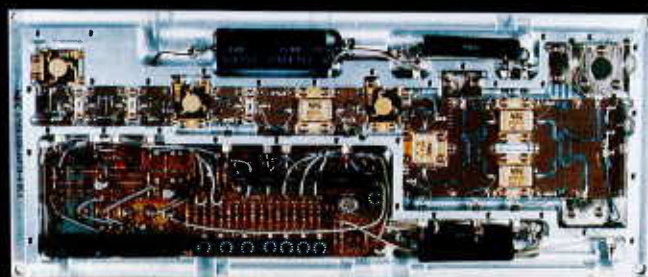
NEC's 500 Series
Prepackaged, Single-Rack Radio Relay Systems



Low Noise FET RF Amplifier



Main IF Amplifier



5 Watt FET RF Power Amplifier

Features

GREATER RELIABILITY VIA ADVANCED TECHNOLOGY

- 300,000 hours MTBF
- Advanced NEC-developed integrated circuits throughout
- The latest connection technology for fewer failures

HIGHER PERFORMANCE

- Various transmission capacities of up to 2700 channels
- High-efficiency RF power amplifier (solid-state or TWT)
- 3.5 dB noise figure
- 3 ppm frequency stability via automatic phase-locked local oscillator
- Full conformance with the latest CCIR Recommendations

ANALOG & DIGITAL SIGNAL COMPATIBILITY

- Heterodyne transmitter-receiver with both analog and digital transmission capabilities

WIDEBAND DESIGN

- Identical local oscillator used for transmitter and receiver
- Half band tunable local oscillator by replacing quartz crystal
- RF amplifier covering half the CCIR frequency band
- Frequency converter operating over the CCIR frequency band with no alignment required

TOTAL SYSTEM ECONOMY

- Economical equipment
- Easy and quick installation
- Common spare modules
- Easy system expansion
- Essentially maintenance-free



Application Flexibility

- Covers 2 to 15 GHz
- Capacity of up to 2700 FDM telephone channels or 140 MB digital signals
- Drop and insertion of maximum 300 telephone channels at IF repeater stations
- DAV transmission of 2 MB data, 300 FDM telephone channels, 4 analog or 6 digital sound programs, etc.
- Space diversity with various types of phase Combiners or the economical IF switch
- Accepts wider range of line voltage: $-20 \sim -35\text{V DC}$ or $-36 \sim -75\text{V DC}$
- Easy system expansion
- Simple system modification

IF Repeating Radio Systems

RF Repeating Radio Systems												
Capacity (CH) \ RF Band	2 GHz	4 GHz	5 GHz	6 GHz	6 GHz Upper	7 GHz	8 GHz	11 GHz	13 GHz	15 GHz		
2700/TV	—	—	5G2700	—	6G2700	—	—	11G2700	—	—		
1800/TV	—	4G1800	—	6G1800	6G1800	—	8G1800	11G1800	—	—		
1260/TV	—		—			—			—	—		
960/TV	2G960		—			7G960	8G960		13G960	—		
600/TV			—							—		
300/TV			—							—		

Baseband Repeating Radio Systems

Capacity (CH) \ RF Band	2 GHz	4 GHz	5 GHz	6 GHz	6 GHz Upper	7 GHz	8 GHz	11 GHz	13 GHz
960	2GD960	—	—	—	6GD960	7GD960	8GD960	11GD960	13GD960
600	2GD600	—	—	—	6GD600	7GD600	8GD600	11GD600	13GD600
300	2GD300	—	—	—	6GD300	7GD300	8GD300	11GD300	13GD300
120	2GD120	—	—	—	6GD120	7GD120	8GD120	11GD120	13GD120
60	2GD60	—	—	—	6GD60	7GD60	8GD60	11GD60	13GD60
TV	—	—	—	—	6GDV	7GDV	8GDV	11GDV	13GDV

Digital Radio Systems with 30 CH Hierarchy

Capacity Mbit (CH) \ RF Band	2 GHz	6 GHz	6 GHz Upper	7 GHz	8 GHz	11 GHz	13 GHz	15 GHz
139.3 (1920)	—	—	6G 140 MB	—	—	11G 140 MB	—	15G 140 MB
34.4 x 3 (1440)	—	6G 100 MB	6G 100 MB	7G 100 MB	8G 100 MB	11G 100 MB	13G 100 MB	15G 100 MB
34.4 x 2 (960)	—	6G 68 MB	6G 68 MB	7G 68 MB	8G 68 MB	11G 68 MB	13G 68 MB	—
34.4 (480)	2G 34 MB	6G 34 MB	6G 34 MB	7G 34 MB	8G 34 MB	11G 34 MB	13G 34 MB	—
8.4 x 2 (240)	2GD 17 MB	—	—	7GD 17 MB	—	—	—	—
8.4 (120)		—	—		—	—	—	—
2 x 2 (60)		—	—		—	—	—	—
2 (30)	2GD 4 MB	—	—	—	—	—	—	—

Refer to Catalog No. E42-033

Digital Radio Systems with 24 CH Hierarchy

Capacity Mbit (CH) \ RF Band	2 GHz	6 GHz	6 GHz Upper	7 GHz	8 GHz	11 GHz	13 GHz	15 GHz
44.7 x 3 (2016)	—	—	—	—	—	11G 135 MB	—	—
44.7 x 2 (1344)	—	6G 90 MB	—	—	8G 90 MB	11G 90 MB	—	—
77.2 (1152)	—	6G 78 MB	—	—	—	11G 78 MB	—	—
44.7 (672)	2G 45 MB	—	—	—	—	11G 45 MB	—	—
14.6 (216)	2G 14 MB	—	—	—	—	—	—	—
6.3 (96)	2G 6 MB	—	—	—	—	—	—	—

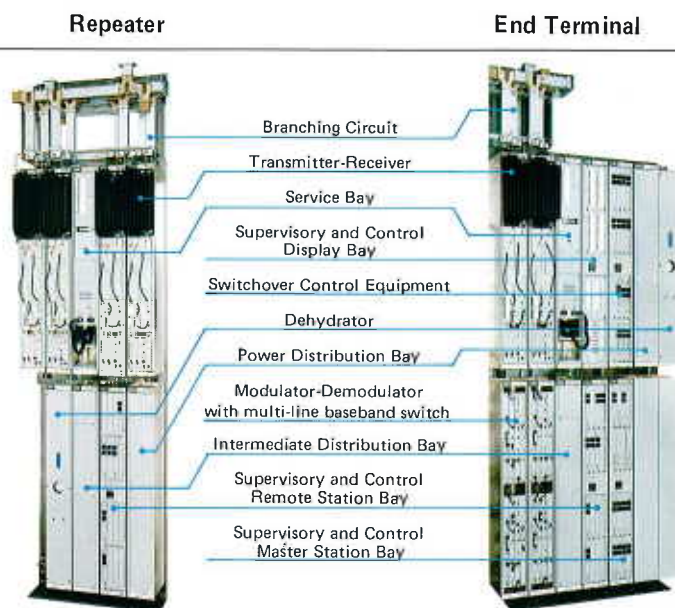
Refer to Catalog No. E42-033

System Configuration

(Example)

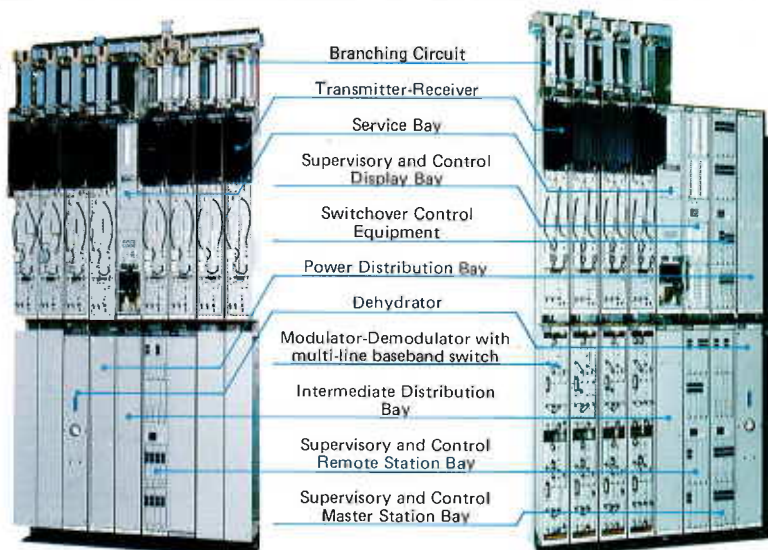
Heterodyne Repeating 6 GHz 1800 Channels 1 + 1 System

Equipment Assembly	Repeater	End Terminal
• Branching Circuit	1	1
• Transmitter-Receiver	4	2
• Modulator-Demodulator with multi-line baseband switch	0	2
• Service Bay	1	1
• Supervisory and Control Equipment		
Remote Station Bay	1	1
Master Station Bay	0	1
Display Bay	0	1
• Switchover Control Equipment	0	1
• Dehydrator	1	1
• Power Distribution Bay	1	1
• Intermediate Distribution Bay	1	1
• Frame (650 mm)	1	1
• Frame (260 mm)	0	1



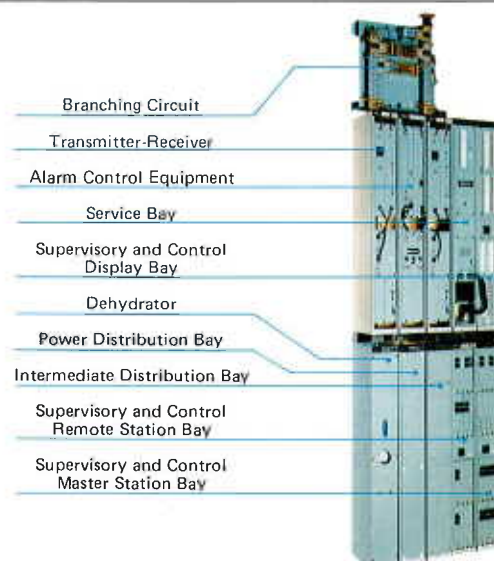
Heterodyne Repeating 6 GHz 1800 Channels 3 + 1 System

Equipment Assembly	Repeater	End Terminal
• Branching Circuit	1	1
• Transmitter-Receiver	8	4
• Modulator-Demodulator with multi-line baseband switch	0	4
• Service Bay	1	1
• Supervisory and Control Equipment		
Remote Station Bay	1	1
Master Station Bay	0	1
Display Bay	0	1
• Switchover Control Equipment	0	1
• Dehydrator	1	1
• Power Distribution Bay	1	1
• Intermediate Distribution Bay	1	1
• Frame (650 mm)	1	1
• Frame (260 mm)	2	2



Baseband Repeating 7 GHz 300 Channels Twin Path System

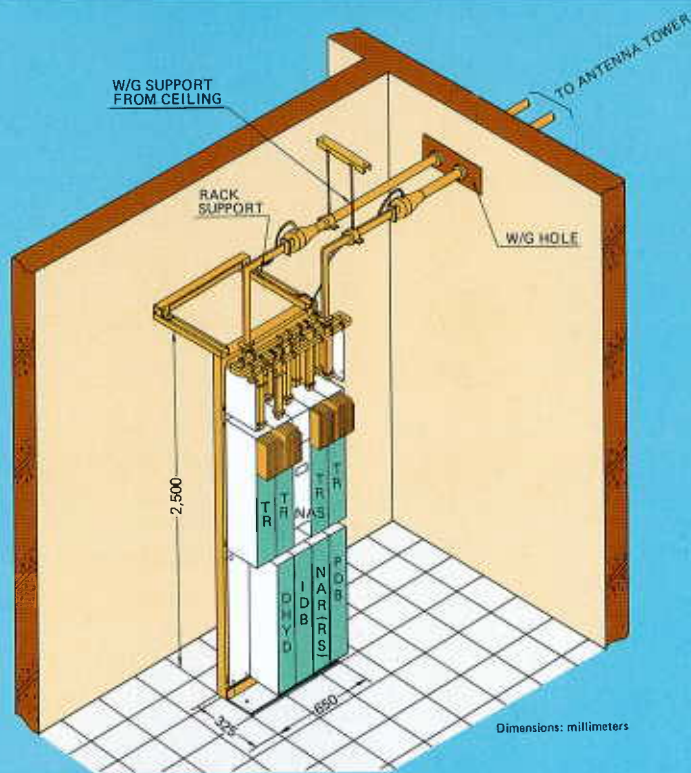
Equipment Assembly	Repeater	End Terminal
• Branching Circuit	1	1
• Transmitter-Receiver	4	2
• Alarm Control Equipment	2	1
• Service Bay	1	1
• Supervisory and Control Equipment		
Remote Station Bay	1	1
Master Station Bay	0	1
Display Bay	0	1
• Dehydrator	1	1
• Power Distribution Bay	1	1
• Intermediate Distribution Bay	1	1
• Frame (650 mm)	1	1



Prealigned Station

- One-rack package for station configuration
- Self-contained ancillary equipment
- Few interface points: only power and feeder connection with rack needed
- No in-station test required: equipment has been pretested at the factory and no performance degradation expected during transportation
- No skill required for installation and maintenance

**In-Station Configuration for 1 + 1
Radio Relay System (Repeater Station)**



Legend

- TR: Transmitter-Receiver
 IDB: Intermediate Distribution Bay
 PDB: Power Distribution Bay
 NAR (RS): Supervisory and Control Equipment for Remote Station
 NAS: Service Bay

Each component measures 130 (width) x 225 (depth) x 950 (height) mm.

How NEC's 500 Series Saves Time and Money

	In Factory				Transportation	On Site			
	Manufacturing	Module Inspection	Mounting, Wiring & Inspection	Packing		Unpacking	Installation	Wiring & Local Test	System Test
Conventional Equipment									
500 Series Equipment									

Performance Summary

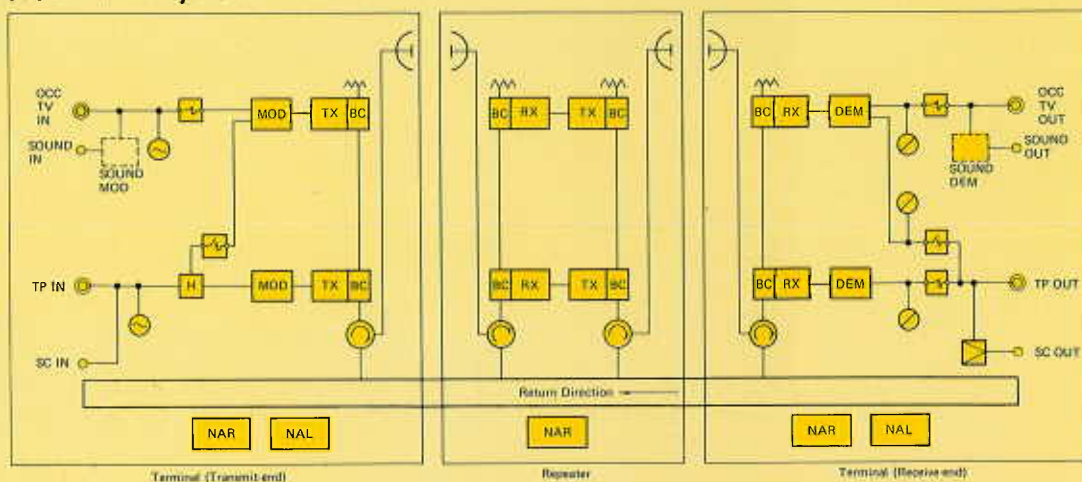
IF Repeating Radio Systems

	Type of Equipment	Frequency Arrangement		Transmit Channel Capacity	Transmitter Output Power (at Test Point)	Noise Figure (at Test Point)	Transmitter Output Power vs. Power Consumption at -24V
		CCIR Rec. No.	Radio Frequency Band				
IF FREQUENCY : 70 MHz	TR-2G960	382-2	1700 ~ 2300 MHz	300/600/960 CH or Color TV + 1 sound CH	26/33/36 dBm	3 dB	26/33/36 dBm 36/40/72 W
	TR-4G1800	382-2 OIRT-1, 2	3803.5 ~ 4203.5 MHz 3400 ~ 3900 MHz	300/600/960/1260/1800 CH or Color TV + 4 sound CHs	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-6G1800	383-1 OIRT	5925 ~ 6425 MHz 5670 ~ 6170 MHz	960/1260/1800 CH or Color TV + 4 sound CHs	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-6G1800	Based on 384-2	6430 ~ 7110 MHz	960/1260/1800 CH or Color TV + 4 sound CHs	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-7G960	Based on 385-1 CONTEL	7425 ~ 7725 MHz	300/600/960 CH or Color TV + 1 sound CH	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-8G960	386-1	8200 ~ 8500 MHz	300/600/960 CH or Color TV + 1 sound CH	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-8G1800	386-1 ANNEX	7725 ~ 8275 MHz	960/1260/1800 CH or Color TV + 4 sound CHs	27/30/34.5/37 dBm	3.5 dB	27/30/34.5/37 dBm 45/53/70/85 W
	TR-11G1800	387-3	10700 ~ 11700 MHz	1800 CH or Color TV + 4 sound CHs	33 dBm (FET) 41 dBm (TWT)	5.5 dB	33/41 dBm 55/84 W
	TR-13G960	497-1	12750 ~ 13250 MHz	960 CH or Color TV + 1 sound CH	30 dBm (FET)	5.5 dB	30 dBm 55 W
IF FREQUENCY : 140 MHz	TR-5G2700	Rep 287-3	4400 ~ 5000 MHz	2700 CH	42 dBm (TWT)	4.5 dB	42 dBm 80 W
	TR-6G2700	384-2	6430 ~ 7110 MHz	2700 CH	42 dBm (TWT)	4.5 dB	42 dBm 80 W
	TR-11G2700	Based on 387-3	10700 ~ 11700 MHz	2700 CH	41 dBm (TWT)	6.0 dB	41 dBm 84 W

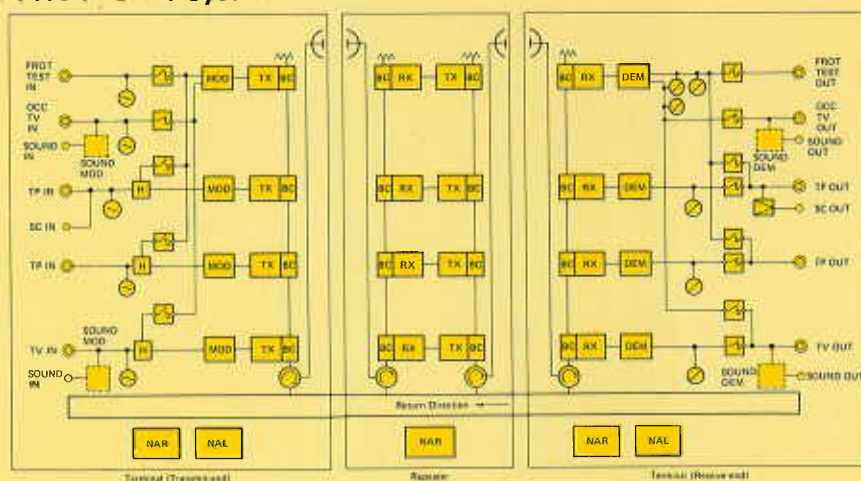
Baseband Repeating Radio Systems

Type of Equipment	Frequency Arrangement		Transmit Channel Capacity	Transmitter Output Power (at Test Point)	Noise Figure (at Test Point)	Transmitter Output Power vs. Power Consumption at -24V
	CCIR Rec. No.	Radio Frequency Band				
TR-2GD300	283-3 382-2	1700 ~ 2300 MHz	60/120/300 CH	28/31/35 dBm	2.8 dB	28/31/35 dBm 55/65/95 W
TR-2GD960	382-2	1700 ~ 2300 MHz	600/960 CH	31/35 dBm	2.8 dB	31/35 dBm 70/100 W
TR-6GD300	384-2	6430 ~ 7110 MHz	60/120/300 CH	20/30 dBm	3.5 dB	20/30 dBm 50/85 W
TR-7GD300	385-1 CONTEL	7125 ~ 7725 MHz	60/120/300 CH	20/30 dBm	3.5 dB	20/30 dBm 50/85 W
TR-8GD300	386-1	7725 ~ 8500 MHz	60/120/300 CH	19/29 dBm	4 dB	19/29 dBm 50/85 W
TR-6GD960	384-2	6430 ~ 7110 MHz	600/960 CH	30 dBm	3.5 dB	30 dBm 95 W
TR-6GDV	384-2	6430 ~ 7110 MHz	Color TV + 1 sound CH	30 dBm	3.5 dB	30 dBm 95 W
TR-7GD960	385-1 CONTEL	7125 ~ 7725 MHz	600/960 CH	30 dBm	3.5 dB	30 dBm 95 W
TR-7GDV	385-1 CONTEL	7125 ~ 7725 MHz	Color TV + 1 sound CH	30 dBm	3.5 dB	30 dBm 95 W
TR-8GD960	386-1	7725 ~ 8500 MHz	600/960 CH	29 dBm	4 dB	29 dBm 95 W
TR-8GDV	386-1	7725 ~ 8500 MHz	Color TV + 1 sound CH	29 dBm	4 dB	29 dBm 95 W
TR-11GD300	387-3	10700 ~ 11700 MHz	60/120/300 CH	27 dBm	4.5 dB	27 dBm 95 W
TR-11GD960	387-3	10700 ~ 11700 MHz	600/960 CH	27 dBm	4.5 dB	27 dBm 105 W
TR-11GDV	387-3	10700 ~ 11700 MHz	Color TV + 1 sound CH	27 dBm	4.5 dB	27 dBm 105 W
TR-13GD300	497-1	12750 ~ 13250 MHz	60/120/300 CH	27 dBm	5 dB	27 dBm 95 W
TR-13GD960	497-1	12750 ~ 13250 MHz	600/960 CH	27 dBm	5 dB	27 dBm 105 W
TR-13GDV	497-1	12750 ~ 13250 MHz	Color TV + 1 sound CH	27 dBm	5 dB	27 dBm 105 W

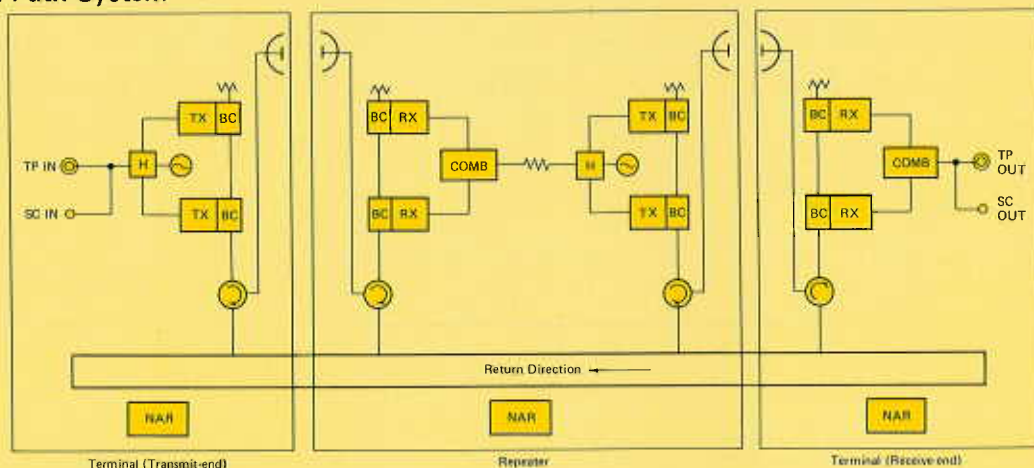
TP + PROT: 1 + 1 System



TP + TP + TV + PROT: 3 + 1 System



TP Twin Path System



CCIR Recommendations

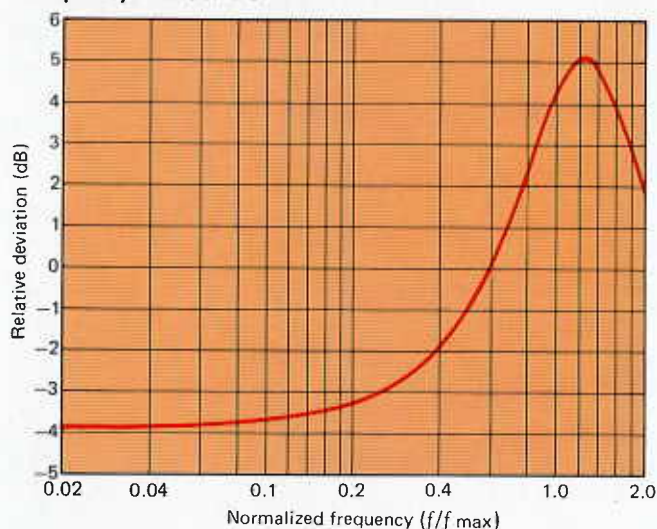
NOISE in a real circuit which differs from the hypothetical reference circuit.

Telephony: Rec. 395-2

Length (L)	Noise	One-minute mean power for more than 20% of any month	Time percentage of any month exceeding 47500 pW one-minute mean power
1. $50 \text{ km} \leq L \leq 840 \text{ km}$		$3L + 200 \text{ pW}$	$(280/2500) \times 0.1\%$ $L \leq 280 \text{ km}$ $(L/2500) \times 0.1\%$ $L > 280 \text{ km}$
2. $840 \text{ km} < L \leq 1670 \text{ km}$		$3L + 400 \text{ pW}$	$(L/2500) \times 0.1\%$
3. $1670 \text{ km} < L \leq 2500 \text{ km}$		$3L + 600 \text{ pW}$	$(L/2500) \times 0.1\%$

PREEMPHASIS Characteristics

Telephony: Rec. 275-2



INTERCONNECTION at Baseband Frequencies

Rec. 380-3

Maximum number of telephone traffic channels	Limits of band occupied by telephone channel (kHz)	Frequency limits of baseband (kHz)	Nominal impedance at baseband (Ω)	Relative power level per channel (dBr)	
				Radio equipment output	Radio equipment input
60	60-300	60-300	75 unbal.	-15	-45
120	60-552	60-552	75 unbal.	-15	-45
300	60-1300	60-1364	75 unbal.	-18	-42
600	60-2540	60-2792	75 unbal.	-20	-45
960	60-4028	60-4287	75 unbal.	-20	-45
1260	60-5636	60-5680	75 unbal.	-28	-37
1800	312-8204	300-8248	75 unbal.	-28	-37
2700	312-12388	300-12435	75 unbal.	-28	-37

Return loss $\geq 24 \text{ dB}$

FREQUENCY DEVIATION

Telephony: Rec. 404-2

200 kHz r.m.s./channel (60 to 1260 channels)
140 kHz r.m.s./channel (1260, 1800, 2700 channels)
For 1 mW, 800 Hz tone at a point of zero relative level, without preemphasis.

CONTINUITY PILOTS, Frequencies and Deviations
Rec. 401-2

System capacity (channels)	Continuity pilot frequency (kHz)	Deviation (r.m.s.) produced by the pilot (kHz)
24	116 or 119	20
60	304 or 331	25, 50, 100
120	607	25, 50, 100
300	1499, 3200 or 8500	100 or 140
600	3200 or 8500	140
960	4715 or 8500	140
900		
1260	6199	100 or 140
1200	8500	140
1800	9023	100
2700	13627	100
TV	8500	140
	9023	100

INTERMEDIATE FREQUENCY Characteristics

Rec. 403-3

Center frequency: 70 MHz
140 MHz (2700 CH)
Output level: 0.5V r.m.s. (+5.2 dBrm +1.0 dB, -1.5 dB)
Input level: 0.3V r.m.s. (+0.8 dBrm +1.0 dB, -1.5 dB)
Nominal impedance: 75 Ω (unbalanced)
Return loss: $\geq 26 \text{ dB}$
within a frequency band including the baseband and the continuity pilot frequency on both sides of the center frequency.

SERVICE CHANNELS

Rec. 400-2

The service channels will be used to provide:

- Omnibus voice circuits
- Express voice circuits
- Supervisory circuits
- Control and operational circuits

The telephone service channels:

Frequency band: 300 to 3400 Hz
Allowable noise power in any hour: 20,000 pW0p, up to 280 km

PERMISSIBLE NOISE POWER

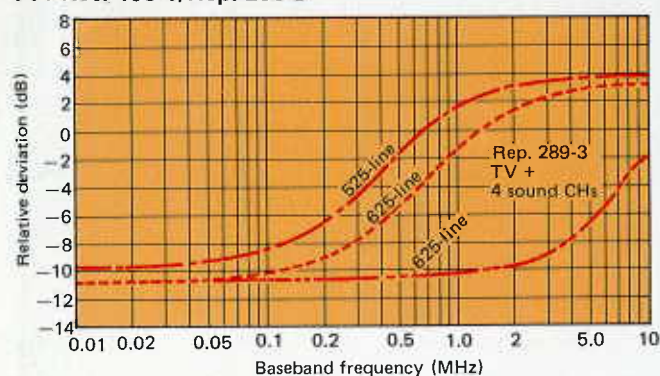
TV: Rec. 555

The nominal amplitude of the luminance signal to the r.m.s. amplitude of the weighted noise ratio should not fall below the following provisional values.

- 1) 57 dB for more than 20% of a month
- 2) 45 dB for more than 0.1% of a month

PREEMPHASIS Characteristics

TV: Rec. 405-1/Rep. 289-3



INTERCONNECTION at Video Signal Frequencies

Rec. 270-2

Nominal impedance: 75Ω (unbalanced)
 Nominal amplitude: 1V peak-to-peak
 Nominal upper limit:

System (See Report 624-1)	M	B, C, G, H	D, K, L	I
Number of lines	525	625	625	625
Nominal upper limit of video-frequency band f_c (MHz)	4	5	6	5.5

FREQUENCY DEVIATION

TV: Rec. 276-2

8 MHz peak-to-peak/1V peak-to-peak

NOISE for Sound-Program Circuits

Rep. 375-2

The signal-to-weighted noise ratio: 57 dB/2500 km
 When the 9 dBm signal level is applied at a point of zero relative level in the sound-program circuit.

SOUND CHANNEL Characteristics (TV + 1 sound)

Rec. 402-2

Simultaneous transmission of a monochrome TV signal and a single sound channel.

Frequency of subcarrier (MHz) 7.5
 Modulation characteristics of subcarrier:
 Nominal input impedance of audio channel (Ω) 600 (bal.)
 Maximum audio signal at a zero relative level point (dB rel. 0.775V r.m.s.) +9
 Audio bandwidth (Hz) 30-10,000
 Deviation of subcarrier (for a sinusoidal test tone of maximum level) 140 kHz r.m.s.

Deviation of IF and RF carrier:

The amplitude of the unmodulated subcarrier should be such as to produce a deviation of the IF and RF carrier of: 300 kHz r.m.s.

SOUND CHANNEL Characteristics (TV + 4 sounds)

Rep. 289-3

Simultaneous transmission of TV and a maximum of four sound channels.

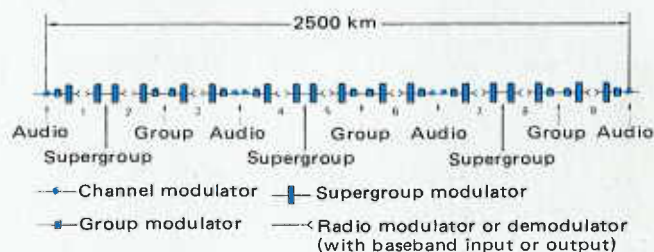
Frequency of subcarriers:

Plan	Frequency (kHz)				
A	7020	7500	8065	8590	
B ₁	7000	7360	7765	8215	
B ₂		7360	7765	8215	8710

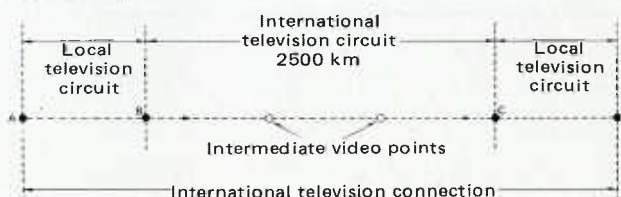
Maximum audio signal at zero relative level point (dB rel. 0.775V r.m.s.) +9
 Audio-frequency bandwidth (Hz) 30-15,000
 Deviation of subcarrier (for a sinusoidal test tone of maximum level) ±100 kHz
 Deviation of IF and RF carrier (due to each of the four subcarrier frequencies) Approx. 300 kHz r.m.s.

HYPOTHETICAL REFERENCE CIRCUIT

Telephony: Rec. 392

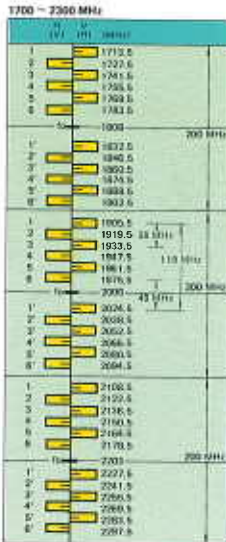


TV: Rec. 567

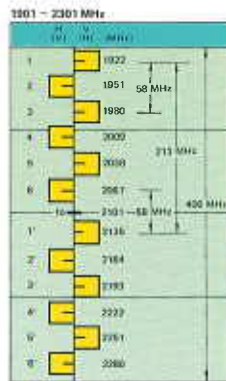


Radio Frequency Arrangement

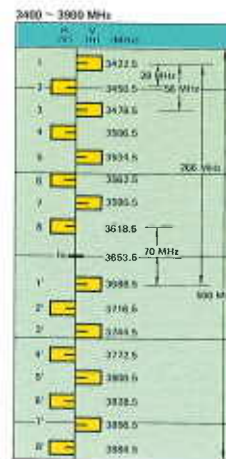
2 GHz Band
CCIR Rec. 283-3
60 to 300 CH



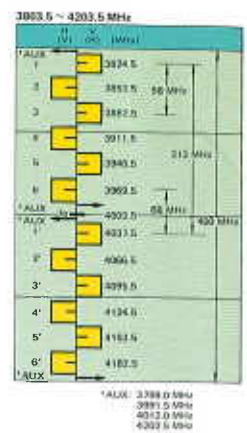
2 GHz Band
CCIR Rec. 382-2
600 to 1800 CH



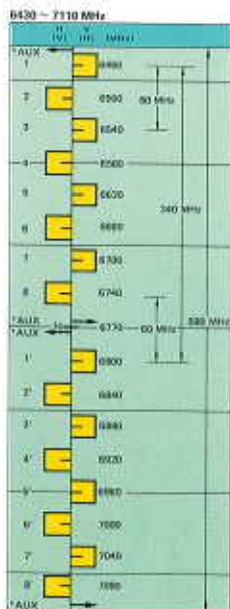
4 GHz Band
DIT 2 Standard
up to 1800 CH



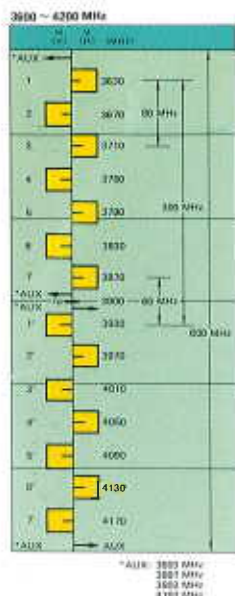
4 GHz Band
CCIR Rec. 382-2
600 to 1800 CH
CCIR Rec. 389-2
AUX CH



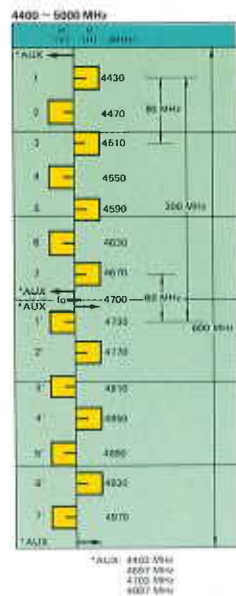
6 GHz Band
CCIR Rec. 384-2
2700 to up to 1260 CH
CCIR Rec. 283-2
AUX CH



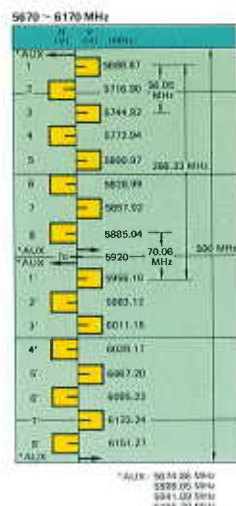
4 GHz Band
Based on Rep. 287-3
3600 CH



5 GHz Band
Rep. 287-3
2700/3600 CH

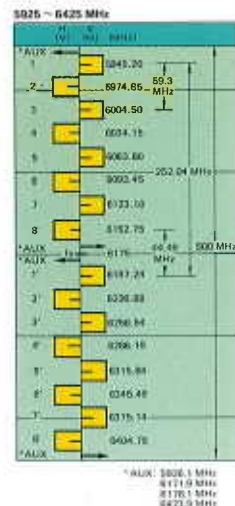


6 GHz Band
OIRT Standard
up to 1800 CH
and AUX CH

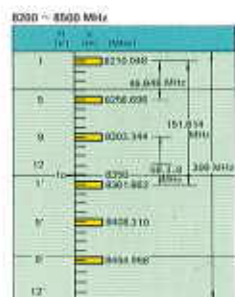


6 GHz Band
CCIR Rec. 389-1
1800 CH

CCIR Rec. 389-2
AUX CH

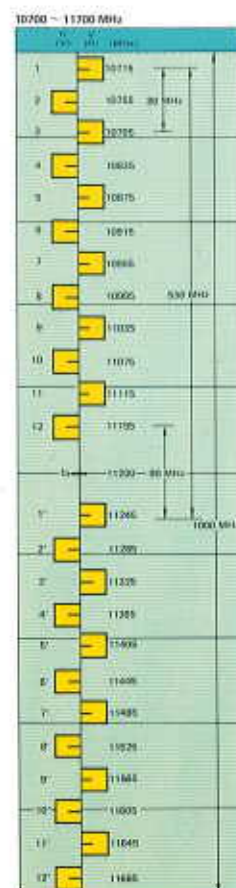


8 GHz Band
CCIR Rec. 386-1
960 CH

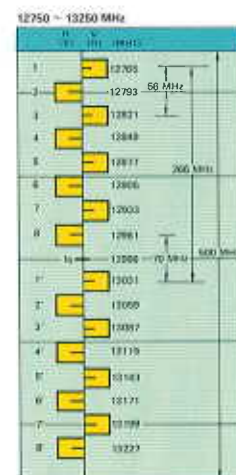


11 GHz Band
CCIR Rec. 387-3
600 to 1800 CH

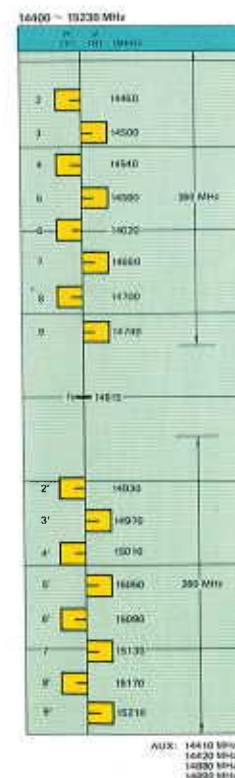
CCIR Rec. 389-2
AUX CH



13 GHz Band
CCIR Rec. 407-1
960 CH

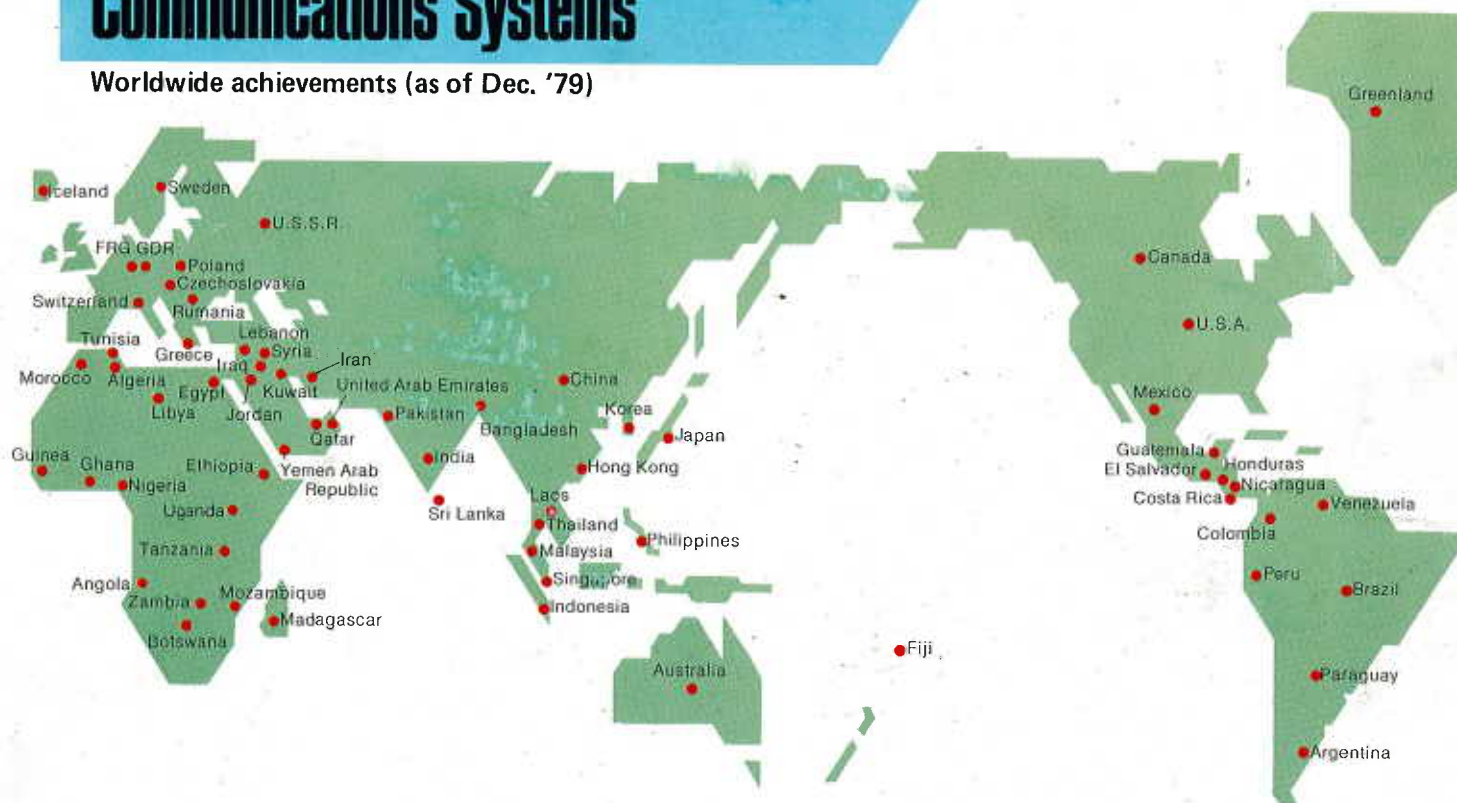


15 GHz Band
Japan Standard
2700 CH



NEC's Contribution to Global Microwave Communications Systems

Worldwide achievements (as of Dec. '79)



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