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Frequency and Network Planning for FM Sound and Analogue TV Broadcasting

Broadcasting Plans

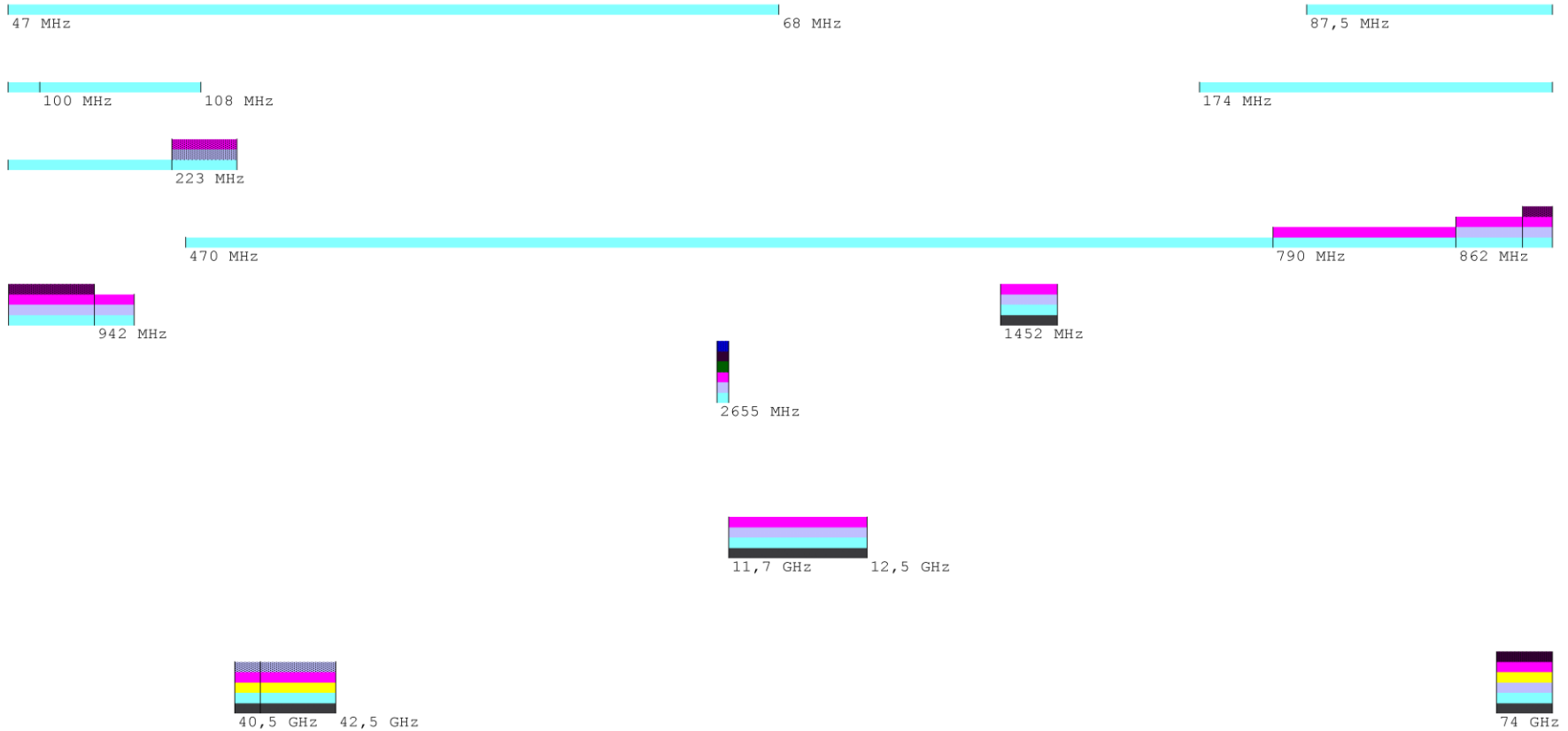
- Geneva 2006 (GE06D, GE06A)
 - Region 1, digital sound and television, bands 174-230, 470-862 MHz. Updates to ST61 for analogue TV
- Stockholm 1961 (ST61), updated Geneva 1985 (GE85)
 - European Broadcasting Conference in the VHF and UHF bands (sound and television)
- Geneva 1984 (GE84)
 - Regional Administrative Conference for the Planning of VHF Sound Broadcasting (Region 1 and Part of Region 3)
- Geneva 1989 (GE89)
 - Regional Administrative Conference for the Planning of VHF/UHF Television Broadcasting in the African Broadcasting Area and Neighbouring Countries
- Geneva 1975 (GE75)
 - Regional Administrative LF/MF Broadcasting Conference (Regions 1 and 3)
- Rio de Janeiro 1981 (RJ81)
 - Regional Administrative MF Broadcasting Conference (Region 2)
- Rio de Janeiro 1988 (RJ88)
 - Regional Administrative Radio Conference to Establish a Plan for the Broadcasting Service in the Band 1 605 - 1 705 kHz in Region 2

Broadcasting Plans

- Plans determine pre-defined and agreed frequencies, characteristics and locations of stations
- The plans define coordination distances as a function of transmitter power, effective antenna height and type of radio propagation
- Changes of station characteristics from the plan require coordination
- Transmitters generating a field strength higher than a certain *minimum usable field strength minus a protection ratio* at the border of a neighbouring country should be coordinated
- Establishment of a station in a plan needs a notification to the ITU

Broadcasting allocations

ITU Region 1, 47 MHz - 76 GHz



■ Broadcasting service
■ Broadcasting-satellite service
■ Earth exploration-satellite service

■ Fixed service
■ Fixed-satellite service
■ Mobile service
■ Radio astronomy service

■ Radiolocation service
■ Space research service

Interference calculations

Important parameters

- Protection ratio, PR [dB]
 - The required difference in dB between the level of the wanted signal and the level of the interfering signal to achieve the required quality of reception
- Usable field strength, E_u [dB μ V/m]
 - The required field strength of a wanted signal to achieve the required quality of reception, considering multiple interfering signals and their corresponding protection ratios
- Nuisance field strength, E_n [dB μ V/m]
 - The equivalent required field strength of a wanted signal to achieve the required quality of reception, considering a single interfering signal and its corresponding protection ratio
- Interferer field strength, E_i [dB μ V/m]
 - The field strength of a single interfering signal

Interference calculations

- Nuisance field strength, E_n [dB μ V/m]:

$$E_n = E_i + PR$$

- Usable field strength, E_u [dB μ V/m]:

$$E_u = \text{Sum} [E_n]$$

- Selectable summation methods (“Sum” above) for multiple interferers:
 - Power-sum
 - Log-normal
 - k-LNM (Log-normal with a coefficient k)

Protection ratios and minimum usable field strengths (sound)

- Protection ratios for FM Sound account for
 - Transmitter spectrum properties and receiver selectivity
 - Protection at transmitter frequency +/- 10.7 MHz (local oscillator frequency of receivers)
- ITU BS.412 “Planning standards for terrestrial FM sound broadcasting at VHF” [To BS.412](#)
- Minimum usable field strengths, 10 m above ground:

Areas	Services	
	Monophonic [dB μ V/m]	Stereophonic [dB μ V/m]
Rural	48	54
Urban	60	66
Large cities	70	74

Applicable ITU recommendations (TV)

- ITU-R Rec. BT.655 Radio-frequency protection ratios for AM vestigial sideband terrestrial television systems interfered with by unwanted analogue vision signals and their associated sound signals
- ITU-R Rec. BT.804 Characteristics of TV receivers essential for frequency planning with PAL/SECAM/NTSC television systems (data on intermediate frequencies)
- ITU-R Rec. IS.851 Sharing between the broadcasting service and the fixed and/or mobile services in the VHF and UHF bands (protection ratios)
- ITU-R Rec. BT.470 Conventional television systems (frequency-related data for various television systems)
- ITU-R Rec. BT.417 Minimum field strengths for which protection may be sought in planning a television service, 1991
- ITU-R BS.707 Transmission of multisound in terrestrial television systems PAL B, D1, G, H and I, and SECAM D, K, K1 and L (frequency-related data and level-related data for various sound systems)

Protection ratios (TV)

- Protection ratios for analogue TV account for
 - Transmitter spectrum properties and receiver selectivity
 - Protection at transmitter frequency +/- receiver intermediate frequency (+ or - as applicable for system type)
 - Protection at transmitter frequency +/- 2 x receiver IF (image, + or - as applicable for system type)
- Frequency accuracy: Non-controlled, Non-precision, Precision offset
- ITU BT.655 “Radio-frequency protection ratios for AM vestigial side-band terrestrial television systems interfered with by unwanted analogue vision signals and their associated sound signals” [To BT.655](#)

Minimum usable field strengths (TV)

- Minimum usable field strengths, 10 m above ground:

Band	I	III	IV	V
dB μ V/m	48	55	65 (I)	70 (I)

(I) The values shown for Bands IV and V should be increased by 2 dB for system K.

- In sparsely populated regions, where better receivers and antennas are likely to be used:

Band	I	III	IV	V
dB μ V/m	46	49	58	64

Coordination with aeronautical services

- Very high power in broadcast transmitters may cause significant interference in critical aeronautical systems
- MF/HF
 - Extreme field strengths causing EMC problems in aircraft (not a frequency management problem)
 - Overloading of aircraft HF receivers
- FM in 87.5 - 107.9 MHz band, Television
 - Intermodulation, blocking and adjacent channel types of interference in radionavigational aids
 - VHF Marker beacon (75 MHz)
 - VHF Omni-directional range (VOR, ~110 MHz)
 - Instrument landing system (ILS localizer ~110 MHz, Glide path ~330 MHz)

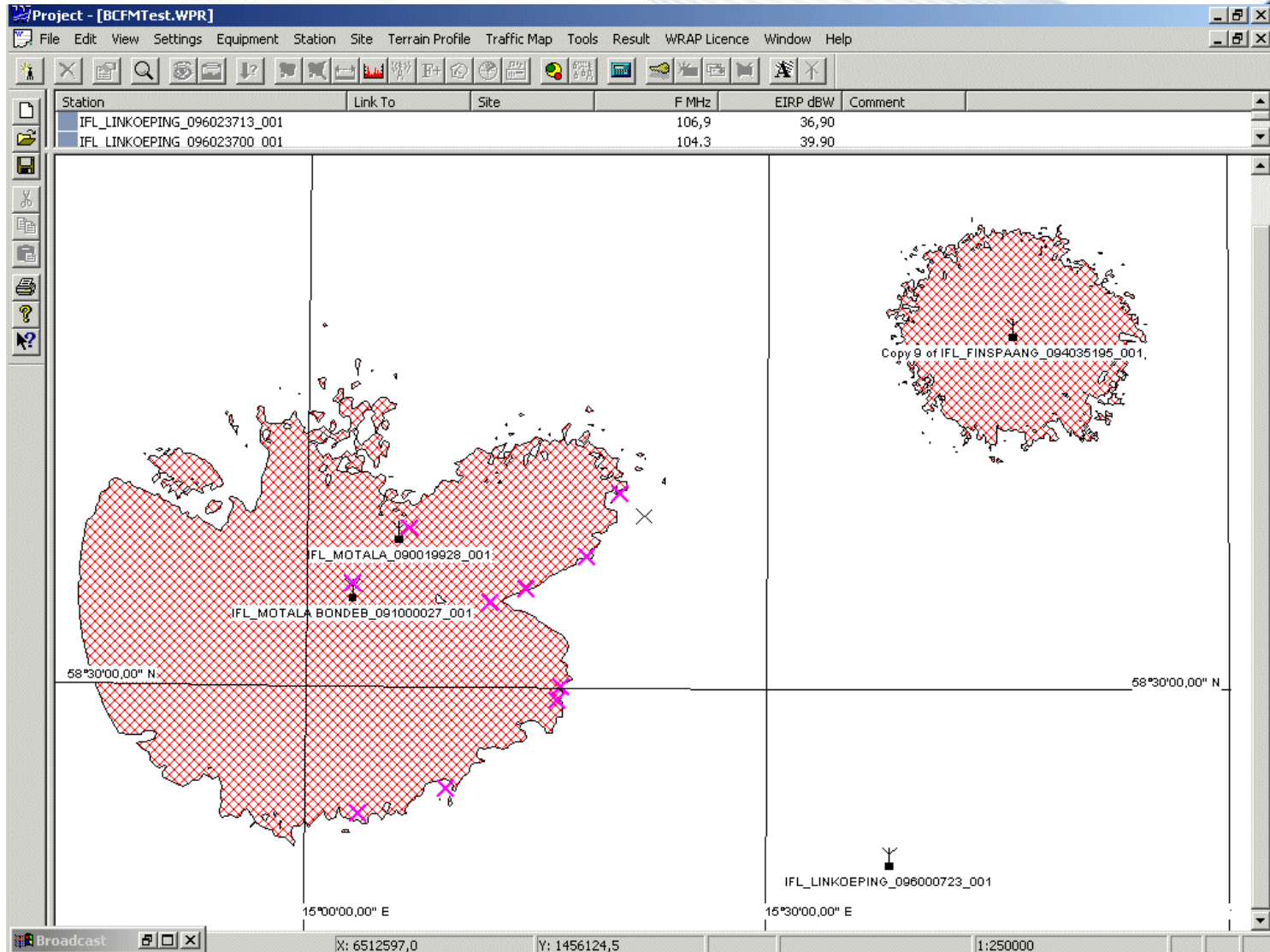
Methods for compatibility analysis

- Recommendation ITU-R SM.1009-1
 - Compatibility between the sound-broadcasting service in the band of about 87-108 MHz and the aeronautical services in the band 108-137 MHz
 - Defines interference types, level criteria, test point patterns and calculation methods
- Straightforward calculations of
 - Intermodulation frequencies and levels
 - Adjacent channels interference
 - To be calculated in specified test points [To SM.1009-1](#)

Interference evaluation - Test points

- Test points are placed automatically at
 - The edge of the service area in the direction of the interferer, as close to the interfering station as possible
 - For no service area: The point where the wanted transmitter generates the minimum usable field strength
- The minimum distance between a test point and interfering transmitters can be defined
- Test points can be placed manually in the map
- Parameters evaluated at each test point:
 - Individual nuisance field from each interferer, $E_n = E_i + PR$
 - Usable field strength, $E_u = \text{Sum} [E_n]$
 - Wanted signal field strength, E_w
 - Margin, $M = E_w - E_u$

Test points - Automatic



Statistical considerations

- Propagation models should be used with settings to give the median location statistics value and the desired time statistics value
- Median values are presented for
 - Nuisance field, E_n
 - Usable field strength, E_u
 - Wanted signal field strength, E_w
- The Margin, M , value considers the selected probability of interference
 - $M = E_w - E_u$
 - M has a log-normal distribution with parameters
 - Median: $M_{50\%} = E_{w50\%} - E_{u50\%}$
 - Standard deviation, S : $S^2 = (S_w)^2 + (S_u)^2$
 - A frequency is assignable if $M \geq 0$ for selected probability

Interference result

Broadcast [Print...] [Settings...] [Allotment...] [Assign...] [Calculate] [OK] [Cancel]

FQA Interference

Station: IFL_SOEDERKOEPI... IFL_LINKOEPI... IFL_KISA_090019711_001 IFL_MOTALA_BONDEB_098015773_001 IFL_FINSPAANG_094035195_001 IFL_VALDEMARSVIK_090027192_001

As Interfered As Interferer

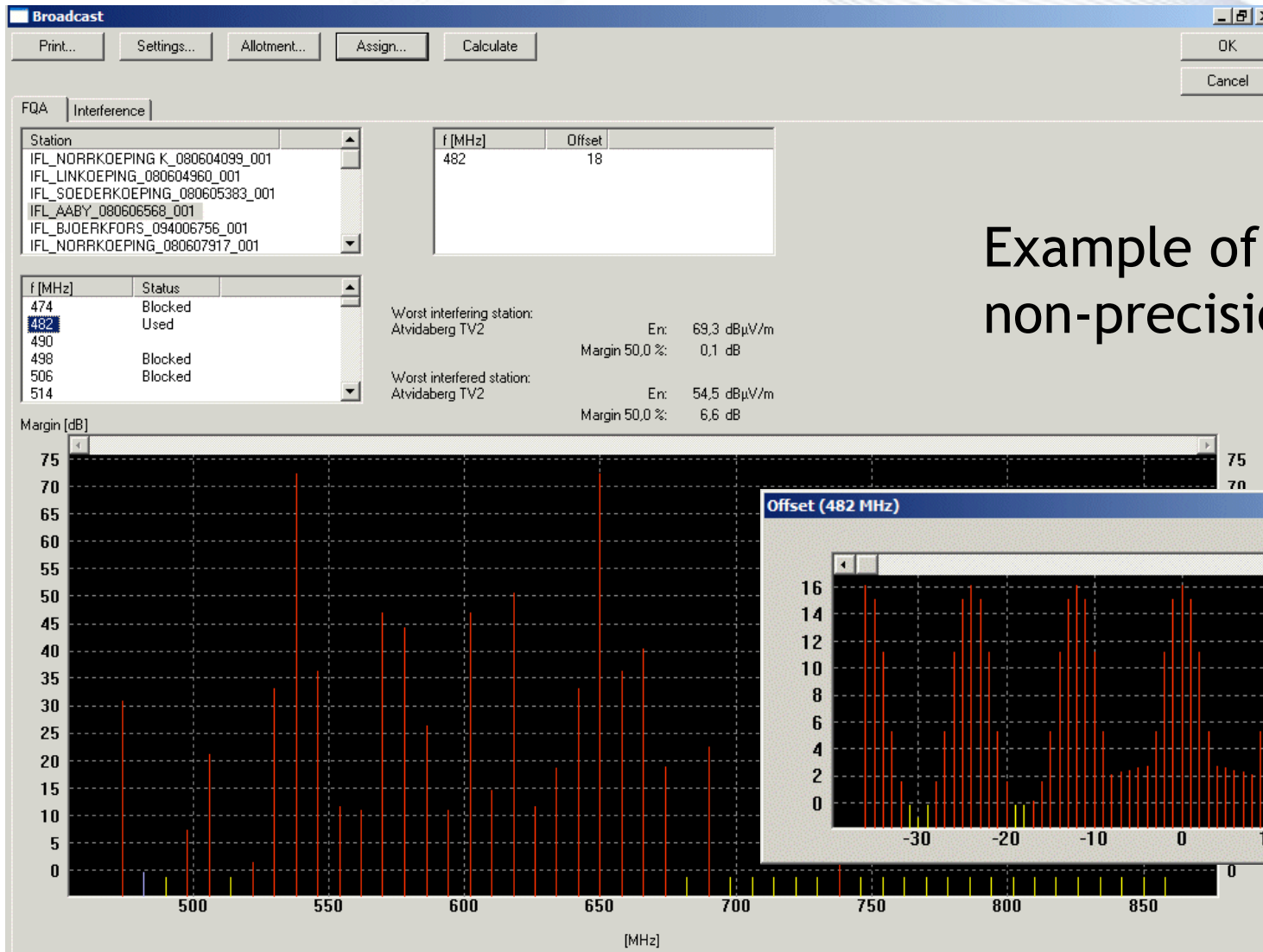
Test points: Get from map Show in map Add... Edit... Delete

Min usable field strength [dBµV/m] 66

Label	Longitude	Latitude	f [MHz]	M 1.0 % [dB]	Eu [dBµV/m]	EW [dBµV/m]
IFL_MOTALA_BONDEB_098015773_001 - IFL_LINKOEPI..._096023713_001	15°12'37.84" E	58°30'32.82" N	96.4	-27.76	68.12	66.76
IFL_MOTALA_BONDEB_098015773_001 - IFL_LINKOEPI..._096023700_001	15°12'37.84" E	58°30'32.82" N	96.4	-27.76	68.12	66.76
IFL_MOTALA_BONDEB_098015773_001 - IFL_VALDEMARSVIK_090027228_001	15°13'02.86" E	58°30'49.78" N	96.4	-28.47	68.46	66.40
IFL_MOTALA_BONDEB_098015773_001 - IFL_KISA_090019747_001	15°07'56.10" E	58°27'50.86" N	96.4	-23.88	63.88	66.58
IFL_MOTALA_BONDEB_098015773_001 - IFL_NORRKOEPING_090019983_001	15°13'56.18" E	58°34'05.11" N	96.4	-30.83	71.16	66.65
IFL_MOTALA_BONDEB_098015773_001 - IFL_MOTALA_090019978_001	15°06'38.35" E	58°35'25.53" N	96.4	-35.54	86.18	77.11
IFL_MOTALA_BONDEB_098015773_001 - IFL_LINKOEPI..._096000729_001	15°12'37.84" E	58°30'32.82" N	96.4	-27.76	68.12	66.76
IFL_MOTALA_BONDEB_098015773_001 - IFL_VALDEMARSVIK_090027212_001	15°13'02.86" E	58°30'49.78" N	96.4	-28.47	68.46	66.40
IFL_MOTALA_BONDEB_098015773_001 - IFL_NORRKOEPING_090019965_001	15°13'56.18" E	58°34'05.11" N	96.4	-30.83	71.16	66.65
IFL_MOTALA_BONDEB_098015773_001 - IFL_MOTALA_090019961_001	15°06'38.35" E	58°35'25.53" N	96.4	-35.54	86.18	77.11
IFL_MOTALA_BONDEB_098015773_001 - IFL_SOEDERKOEPI..._090023203_001	15°08'30.07" E	58°32'56.75" N	96.4	-32.10	72.44	66.88
IFL_MOTALA_BONDEB_098015773_001 - IFL_LINKOEPI..._096000726_001	15°12'37.84" E	58°30'32.82" N	96.4	-27.76	68.12	66.76
IFL_MOTALA_BONDEB_098015773_001 - IFL_KISA_090019711_001	15°07'56.10" E	58°27'50.86" N	96.4	-23.88	63.88	66.58
IFL_MOTALA_BONDEB_098015773_001 - IFL_FINSPAANG_094035195_001	15°18'15.07" E	58°36'13.70" N	96.4	-33.20	72.75	66.72
IFL_MOTALA_BONDEB_098015773_001 - IFL_VALDEMARSVIK_090027192_001	15°13'02.86" E	58°30'49.78" N	96.4	-28.47	68.46	66.40
IFL_MOTALA_BONDEB_098015773_001 - IFL_MOTALA_095029454_001	15°06'38.35" E	58°35'25.53" N	96.4	-35.54	86.18	77.11

Interferer	f [MHz]	PR [dB]	En [dBµV/m]
IFL_VALDEMARSVIK_090027192_001	95.7	-40.0	-20.59
IFL_SOEDERKOEPI..._090023203_001	97.8	-40.0	-13.83
IFL_LINKOEPI..._096000726_001	97.3	-40.0	1.01
IFL_KISA_090019711_001	96.9	-26.7	30.45
IFL_MOTALA_090019961_001	98.2	-40.0	58.32
IFL_FINSPAANG_094035195_001	96.4	37.0	72.42

Frequency assignment - TV



Example of results for non-precision offset