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HIGH FREQUENCY BAND COMMUNICATION APPLICATION IN MALAYSIA

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2.1 INTRODUCTION

High frequency (HF) radio frequencies are between 3 and 30 MHz.[1] Also known as the decameter band or decameter wave as the wavelengths range from one to ten decameters. Shortwave (2.310 - 25.820 MHz)[1] overlaps and is slightly lower than HF.

Since the ionosphere often reflects HF radio waves quite well (a phenomenon known as skywave), this range is extensively used for medium and long range terrestrial radio communication. However, suitability of this portion of the spectrum for such communication varies greatly with a complex combination of factors[1]:

- Sunlight/darkness at site of transmission and reception
- Transmitter/receiver proximity to terminator
- Season
- Sunspot cycle
- Solar activity
- Polar aurora
- Maximum usable frequency
- Lowest usable high frequency
- Frequency of operation within the HF range

The high frequency band is very popular with amateur radio operators, who can take advantage of direct, long-distance (often inter-continental) communications and the "thrill factor" resulting from making contacts in variable conditions. International shortwave broadcasting utilizes this set of frequencies, as well as a seemingly declining number of "utility" users (marine, aviation, military, and diplomatic interests), who have, in recent years, been swayed over to less volatile means of communication (for example, via satellites), but may maintain HF stations after switch-over for back-up purposes. However, the development of Automatic Link Establishment technology based on MIL-STD-188-141A and MIL-STD-188-141B [2] for automated connectivity and frequency selection, along with the high costs of satellite usage, have led to a renaissance in HF usage among these communities. The development of higher speed modems such as those conforming to MIL-STD-188-110B which support data rates up to 9600 bit/s has also increased the usability of HF for data communications. Other standards development such as STANAG 5066 provides for error free data communications through the use of ARQ protocols[2].

CB radios operate in the higher portion of the range (around 27 MHz)[2], as do some studio-totransmitter (STL) radio links. Some modes of communication, such as continuous wave more code transmissions (especially by amateur radio operators) and single sideband voice transmissions are more common in the HF range than on other frequencies, because of their bandwidth-conserving nature, but broadband modes, such as TV transmissions, are generally prohibited by HF's relatively small chunk of electromagnetic spectrum space.

Noise, especially man-made interference from electronic devices, tends to have a great effect on the HF bands. In recent years, concerns have risen among certain users of the HF spectrum over "broadband over power lines" (BPL) Internet access, which is believed to have an almost destructive effect on HF communications. This is due to the frequencies on which BPL operates (typically corresponding with the HF band) and the

tendency for the BPL "signal" to leak from power lines. Some BPL providers have installed "notch filters" to block out certain portions of the spectrum (namely the amateur radio bands), but a great amount of controversy over the deployment of this access method remains.

2.2 MALAYSIA'S COMMUNICATION AND MULTIMEDIA ACT 1998

Malaysia's Communications and Multimedia Act 1998 (CMA) contains provisions for the regulation of the converging communications and multimedia industries[2]. The CMA, in essence, provides for a regulatory framework to harness the potential of convergence and to drive the growth of the communications and multimedia industry. This regulatory framework is intended to enable and facilitate the development of a more flexible and liberalised market for the communications and multimedia services.

The CMA is based of the following principles[2];

- protection of consumer interest,
- transparency of process,
- promotion of self regulation,
- the creation of a competitive environment for the communications and multimedia industry, and;
- technology-neutral licensing to facilitate convergence.

The objective of this Public Consultation Paper is to ascertain the views of the public on the introduction of Power Line Communications (PLC) systems in Malaysia and gauge public readiness towards its deployment. This consultation also seeks to determine if the Commission should regulate the provisioning of PLC services and the manner in which it should be regulated. The Commission is aware that should it permit PLC deployment, it has to consider the broad implications of PLC to the Malaysian

communications environment and would like to ensure that the appropriate regulatory framework is in place.

The Commission has received expressions of interest from companies to deploy PLC systems in Malaysia. The Malaysian Communications and Multimedia Commission (MCMC) is initiating this public consultation in an effort to gain a comprehensive understanding of the issues involved with the deployment of Power Line Communications (PLC). PLC refers to a variety of broadband services provided over the electricity power grid. There are numerous benefits to PLC and one of them is the provision of the end connectivity to the final subscriber that will increase the availability of broadband thus improving the competitiveness of the broadband service market.

PLC systems used by the power company are for the transmission of specific information concerning the state of the power network, for remote monitoring and SCADA2 applications. All this information is transmitted using relatively low frequencies, and thus having relatively low speed.

Recent technical achievements in the area of PLC make it possible for data to be sent at a much higher speed. This new PLC system uses a much higher frequency i.e., between 1 MHz to 30 MHz which enables a higher transmission rate at around 1 Mbit/sec. However, at a higher frequency than the 50 Hz electrical current, the PLC systems raise a number of issues including interference by PLC equipment to radio-based service PLC refers to the provisioning of communications services such as internet access and telephony over the electricity grid. It uses existing power cables and extensions to enable two-way broadband and phone connectivity between a user and a service provider. Current PLC systems use the low and medium voltage power lines like the ones installed along our roads to distribute broadband services on the frequency range of 1 MHz to 30 MHz. In theory, plugging a computer device into an existing power outlet would connect the user to the Internet by tapping into established national power grid networks. As such, it is also referred as the “third wire” in addition

to phone and cable, and has the potential of providing a solution to the “digital divide” issue[3].

2.3 HF BAND

High frequency communication may (re)use large portions of the radio spectrum for communication, or may use select (narrow) band(s), depending on the technology. Here are nine relatively narrow HF Amateur Radiofrequency bands. In homebrew equipment designed for these bands, a narrow band-pass filter (NBPF) that attenuates frequencies above and below a particular band can be very useful. Harmonic, sub-harmonic, image, intermodulation, overload and mixer spurious products (harmonic intermodulation) are problems that these filters can greatly alleviate in receivers and transmitters.

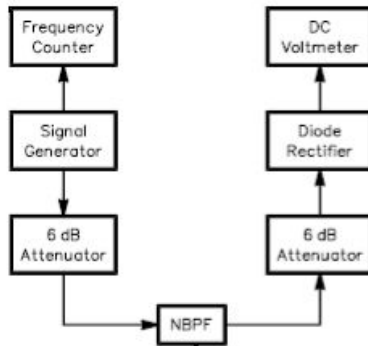


Figure 2.1 Block diagram for a test setup to adjust the NBPF passband[6]

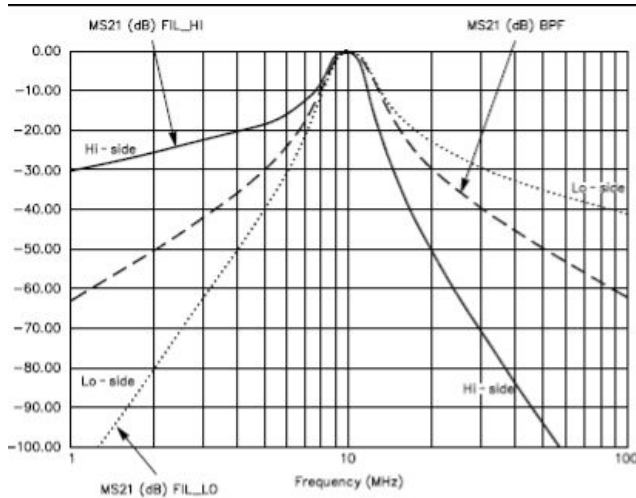


Figure 2.2 ARRL Radio Designer Predicted response of symmetrical low side and high side band-pass filter

2.4 HOME NETWORKING (BROADBAND)

Power line communications can also be used to interconnect home computers, peripherals or other networked consumer peripherals, although at present there is no universal standard for this type of application. Standards for power line home networking have been developed by a number of different companies within the framework of the HomePlug Powerline Alliance and the Universal Powerline Association[1].

2.5 INTERNET ACCESS (BROADBAND OVER POWER LINES)BPL

Broadband over power lines (BPL), also known as power-line Internet or Powerband, is the use of PLC technology to provide broadband Internet access through ordinary power lines. A computer (or any other device) would need only to plug a BPL

"modem" into any outlet in an equipped building to have high-speed Internet access.

BPL seems, at first glance, to offer benefits relative to regular cable or DSL connections: the extensive infrastructure already available would appear to allow people in remote locations to have access to the Internet with relatively little equipment investment by the utility. Also, such ubiquitous availability would make it much easier for other electronics, such as televisions or sound systems, to hook up.

However, variations in the physical characteristics of the electricity network and the current lack of IEEE standards mean that provisioning of the service is far from being a standardized, repeatable process, and the amount of bandwidth a BPL system can provide compared to cable and wireless is in question. Some industry observers believe the prospect of BPL will motivate DSL and cable operators to more quickly serve rural communities[1].

PLC modems transmit in medium and high frequency (1.6 to 80 MHz electric carrier)[1]. The asymmetric speed in the modem is generally from 256 kbit/s to 2.7 Mbit/s(1). In the repeater situated in the meter room the speed is up to 45 Mbit/s[1] and can be connected to 256 PLC modems. In the medium voltage stations, the speed from the head ends to the Internet is up to 135 Mbit/s[1]. To connect to the Internet, utilities can use optical fiber backbone or wireless link.

The system has a number of complex issues, the primary one being that power lines are inherently a very noisy environment. Every time a device turns on or off, it introduces a pop or click into the line. Energy-saving devices often introduce noisy harmonics into the line. The system must be designed to deal with these natural signaling disruptions and work around them.

Broadband over powerlines has developed faster in Europe than in the United States due to a historical difference in power system design philosophies. Power distribution uses step-down transformers to reduce the voltage for use by customers. Since BPL signals cannot readily pass through transformers — their high inductance makes them act as low-pass filters, blocking high-

frequency signals — repeaters must be attached to the transformers. In the U.S., it is common for a small transformer hung from a utility pole to service a single house or a small number of houses. In Europe, it is more common for a somewhat larger transformer to service 10 or 100 houses. For delivering power to customers, this difference in design makes little difference with power distribution, but it means delivering BPL over the power grid of a typical U.S. city will require an order of magnitude more repeaters than would be required in a comparable European city. However, since bandwidth to the transformer is limited, this can increase the speed at which each household can connect, due to fewer people sharing the same line. One possible alternative is to use BPL as the backhaul for wireless communications, by for instance hanging Wi-Fi access points or cellphone base stations on utility poles[1], thus allowing end-users within a certain range to connect with equipment they already have.

In the near future, BPL might also be used as a backhaul for WiMAX networks. The second major issue is signal strength and operating frequency. The system is expected to use frequencies in the 10 to 30 MHz range, which has been used for many decades by amateur radio operators, as well as international shortwave broadcasters and a variety of communications systems (military, aeronautical, etc.). Power lines are unshielded and will act as antennas for the signals they carry, and have the potential to interfere with shortwave radio communications.

Modern BPL systems use OFDM modulation which allows the mitigation of interference with radio services by removing specific frequencies used. A 2001 joint study by the ARRL and HomePlug powerline alliance showed that modems using this technique "in general that with moderate separation of the antenna from the structure containing the HomePlug signal that interference was barely perceptible" and interference only happened when the "antenna was physically close to the power lines".

Much higher speed transmissions using microwave frequencies transmitted via a surface wave propagation mechanism called E-Line have been demonstrated using only a single power line conductor. These systems have shown the potential for symmetric and full duplex communication well in excess of 1 Gbit/s in each direction. Multiple WiFi channels with simultaneous analog television in the 2.4 and 5.3 GHz(1) unlicensed bands have been demonstrated operating over a single medium voltage line. Furthermore, because it can operate anywhere in the 100 MHz - 10 GHz(1) region, this technology can completely avoid the interference issues associated with use of shared spectrum while offering flexibility for modulation and protocols of a microwave system.

2.6 COMBINATION UNITS FOR A 1kW WIDEBAND HF AMPLIFIRE

Based on Philips 4C6 ferrite toroids, input and output combining units are described for combining four 300 W(4) PEP linear wideband amplifiers to produce at least 1 kW PEP in the HF band (1.6 - 30 MHz) (4) with an intermodulation distortion of less than -30 dB.(4)

For long-range communication, the HF band from 1.6 - 30 MHz is used. As the modulation method is mainly SSB, linear amplifiers are required with output powers of 1 kW PEP in many cases. However, the best power amplifiers obtainable only have output powers of 300 to 400 W PEP.(4) For example, Report AN98030 describes a push-pull amplifier using two BLW96 bipolar transistors delivering 400 W PEP(4), while Report NCO8703 describes a push-pull amplifier using two BLF177 MOS(4) transistors delivering 300 W PEP. So four of these amplifiers are required to achieve powers of 1 kW PEP[4].

Table 2.1 Quick-Reference Frequency table[5]

Frequency	Band
1–2 GHz	L Band
2–4 GHz	S Band
4–8 GHz	C Band
8–12 GHz	X Band
12–18 GHz	Ku Band
18–27 GHz	K Band
27–40 GHz	Ka Band
40–75 GHz	V Band
75–110 GHz	W Band
110–300 GHz	mm Band
300–3000 GHz	u mm Band

2.7 AUTOMOTIVE

Power-line technology enables in-vehicle network communication of Data, Voice, Music and Video signals by digital means over Direct Current (DC) battery power-line. Advanced digital communication techniques tailored to overcome hostile and noisy environment are implemented in a small size silicon device. One power line can be used for multiple independent networks.

Prototypes are successfully operational in vehicles, using automotive compatible protocols such as CAN-bus, LIN-bus over power line (DC-LIN) and DC-bus.

Automotive Applications include Mechatronics (e.g. Climate control, Door module, Immobilizer, Obstacle detector), Telematics and Multimedia.[7].

Benefits

- Reduction in cost and weight as compared to ordinary wiring.
- Flexibility of modification.
- Simplicity of installation.
- Operation over 12V - 42V power networks.

Potential problems

- Possibly more expensive, because more complex technologies are to be used in the chips.
- Smaller SNR.

2.8 OPTIMIZATION OF ANTENNA SYSTEMS FOR AUTOMATIC HIGH FREQUENCY COMMUNICATION SYSTEMS

Many HF (high frequency) communication systems have been developed which automatically select operating frequency, route calls, correct transmission errors and log activity. Often these systems do not meet the reasonable expectations of the user because the antenna systems are deficient.

This paper will discuss the special requirements of automatic HF systems, the deficiencies of commonly used antenna systems and alternative designs which employ automatic antenna tuners to satisfy all of the essential requirements for communication at ranges less than 1000 km.[9]

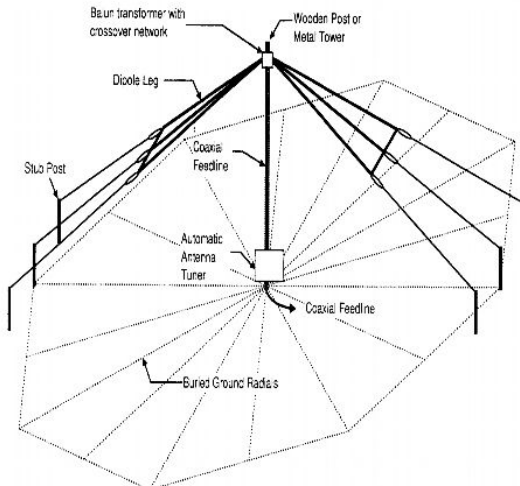


Figure 2.3 Sky wave/Ground wave shore station antenna[9]

2.9 CONCLUSION

High frequency (HF) radio frequencies are between 3 and 30 MHz.[1] Also known as the decameter band or decameter wave as the wavelengths range from one to ten decameters. Shortwave (2.310 - 25.820 MHz)[1] overlaps and is slightly lower than HF. Electrical power is transmitted over high voltage transmission lines, medium voltage distribution, and inside buildings at lower voltages.

Power line communications can be applied at each stage. Most PLC technologies limit themselves to one particular set of wires (for example, premises wiring), but some systems can cross between two levels (for example, both the distribution network and premises wiring). All power line communications systems operate by impressing a modulated carrier signal on the wiring system.

Radiocommunications is the fastest growing segment of the International telecommunications market. With an ever-changing range of new applications, from mobile telephony and data messaging to wireless computer networking, global mobile personal communications by satellite (GMPCS), environmental monitoring systems and subscriber-based satellite television and broadcasting systems, the demand for radio frequency spectrum or 'bands' dedicated to these services is growing at an enormous rate.

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