THE HIGH SPEED POWER LINE COMMUNICATION SOLUTION

Overview

SM2200 is a next generation OFDMA (Orthogonal Frequency Division Multiple Access) power line communication transceiver designed for networking applications. The *SM2200* contains a complete packet data modem with a simple physical layer protocol. When combined with a microcontroller (MCU) it provides a cost effective solution for data links and point-to-point, star or ad hoc networks. Interface to the MCU is a 10MHz serial peripheral interface (SPI) and interrupt request output. The MCU and software can scale to application for the most cost effective and versatile OFDMA PLC product. *SM2200* has been designed with an emphasis on Advanced Metering Infrastructure (AMI) and Automated Meter Reading (AMR) applications where its low cost and high performance features are very attractive.

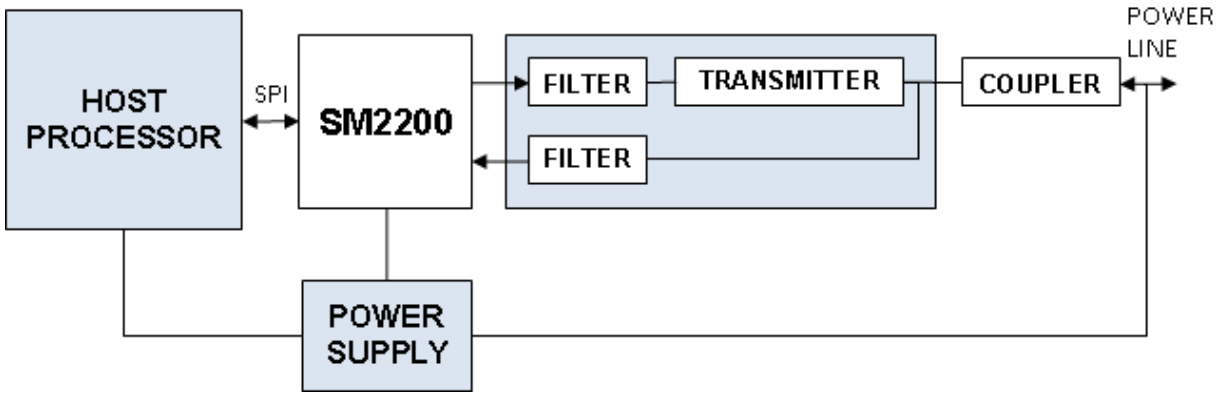
Benefits

- OFDMA transceiver with a choice of 54 frequencies (from a list of 100 factory preset frequencies) grouped into 18 independent channels with a 175kbps maximum data rate
- No embedded user microprocessor allows for power line communications at lower costs and the ability for the user to choose their own MCU
- User selectable between BPSK modulation for higher carrier voltages and higher noise immunity and QPSK modulation for higher data rate
- Independently programmable carrier transmission voltages in 3dB steps with power regulation
- Brute force mode to send the same data on all carriers for redundancy.
- Transmission voltage can be adjusted so that the voltage level can be set above the noise level of a frequency

Features

- Next generation OFDMA transceiver with 175kbps maximum data rate
- 54 carriers grouped into 18 independent OFDM channels allowing frequency division
- BPSK/QPSK selectable modulation
- Narrow band emulation and low frequency mode putting channels in CENELEC frequency range
- Carrier frequency of 5 kHz to 500kHz
- Peak to average ratio minimization with changing carrier frequencies
- Programmable band in use (BIU) threshold for noise avoidance
- Channel in-band noise estimating
- Received packets contain a RSSI (Receive Signal Strength Indication)
- Independently programmable carrier transmission voltages in -3dB steps with power regulation
- Brute force transmission method
- Inbuilt packet duplicate detection
- Error correction and packets protected with CRC
- Power down option reduce power consumption
- Selectable address filtering frees SPI bus and masking to allow routing
- Uses 100ppm crystals for lower cost
- 2 integrated OpAmps
- Operating Temperature -40°C to +85°C

Typical Application Diagram



Applications

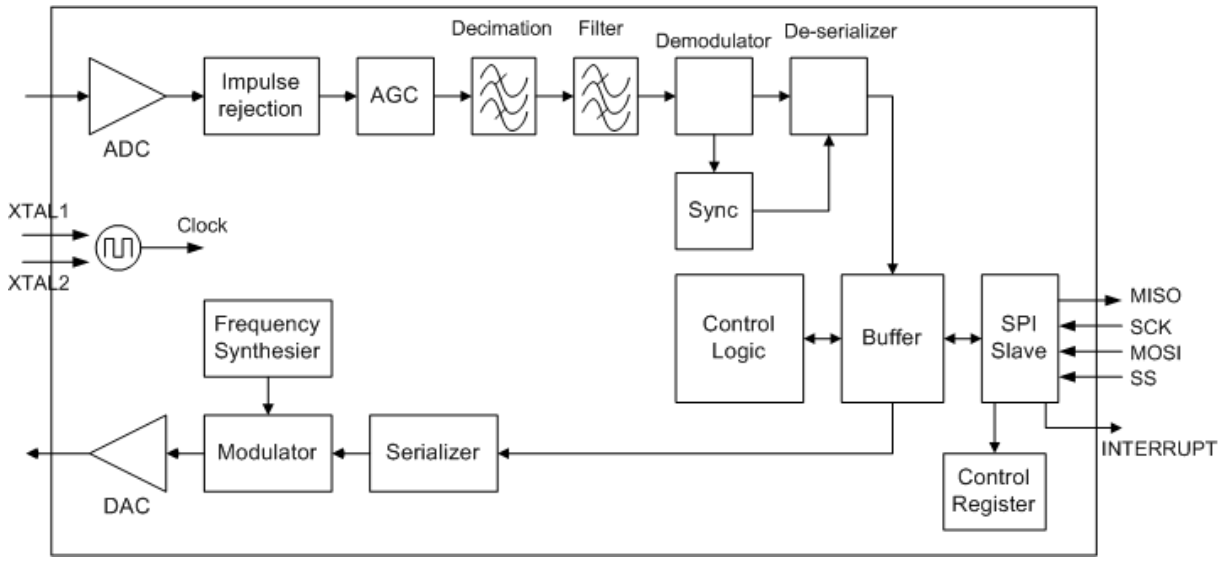
These are a number of applications that the *SM2200* is ideally suited for:

- Advanced Metering Infrastructure (AMR)
- Automated Meter Reading (AMI)
- Smart metering and smart grid
- Street lighting control
- Smart energy home area networking
- Home automation (HA)
- Building automation (BA)
- SCADA (Supervisory Control And Data Acquisition)

As can be seen in the diagram above a SPI and an interrupt are used to interface the *SM2200* to a MCU in order to add communications connectivity to existing or new products. The advantage of the *SM2200* is that these communications will leverage the existing power line infrastructure for the communications channel. This leads to a cost reduction for a system implementation of one of the above examples compared to other communication solutions.

The *SM2200* and the analogue front end are all that has to be added to an existing design for the implementation of power line communications. This also means that devices and products that contain an existing MCU can leverage high speed power line communications at a very low cost. This is an advantage in cost sensitive areas such as metering.

Block Diagram



Power Line Transceiver

Carrier Frequencies

Carriers are arranged into 18 groups of 3 carriers, and each of these 3 carriers represents a channel. This means that there are a total of 54 carriers and 18 channels.

The three carriers within the channel have different functions. The middle carrier of the group of three is known as the master carrier and contains the most information. The upper and lower carriers are known as side carriers. They contain less information and can be switched off. The upper carrier is the carrier with its frequency above the master carrier. The lower carrier is the carrier with the frequency below the master carrier. Switching off the side carriers allows the master frequency to operate more reliably at the cost of reduced data rate. The master carrier contains more information than the side carriers and cannot be turned off.

The master carrier can be set to any one of 100 factory preset values. As specified above the upper and lower carriers are always set as the frequencies above and below the master respectively. Therefore master carriers must be spaced apart at least 3 frequencies apart to allow the operation of the upper and lower carriers. When the two side carriers are switched off then the master carriers need to be only one frequency apart.

Selectable Modulation

The *SM2200* allows the user to change modulation techniques between BPSK and QPSK. In order to improve bandwidth over BPSK, QPSK is used which doubles the bandwidth. The advantage of BPSK is that it is more robust against noise on the power line. If particular frequencies have more in band noise then it may not be possible to communicate reliably using QPSK. In this scenario the modulation can be changed to BPSK to increase reliability.

Communication Medium Metric

The RSSI is an estimate of received signal strength. Each packet received can be interrogated for its estimated signal strength. This is very useful to determine the signal to noise ratio of different nodes on the network. It may be that the noise in a particular band is low but the signal is also attenuated significantly making data transmission unreliable. Network management systems can also interrogate each node for signal to noise ratios to create a database of all transmission path conditions. This produces a deterministic way of finding where repeaters are needed in a difficult environment even if they are dynamic.

Narrowband Emulation Mode

Narrowband mode emulation is to reduce the bandwidth required for each channel. This allows the channels to be compressed into a bandwidth of less than 80kHz, even down to 40kHz to comply with CENELEC mode.

Variable BIU Threshold

The CENELEC EN50065-1: 2001 standard, sub-clause 5 specifies that the Band-In-Use threshold level is set to an amplitude of 86dBµVrms. This level may not always be practical in many installations. Many environments contain noise levels that are in excess of this threshold level making reliable medium access impossible. It is for this reason that *SM2200* offers a variable Band-In-Use threshold to accommodate the ambient noise levels of a wide range of installations, with programmable hysteresis.

The *SM2200* also has a BIU qualification feature. The BIU threshold of a particular bandwidth is often fooled by tonal noise that exceeds the threshold. The BIU qualification checks the signal to make sure it is a BPSK signal. This makes the BUI more meaningful as it is more reliable in distinguishing between noise and a true packet.

Transmission Voltage Levels

The *SM2200* allows the maximum carrier transmission voltages to be independently reduced in 3dB steps. Transmission voltage is maximized in 3 ways:

- Peak to average ratio minimization will keep the ratio low as well as not producing peaks in the signal that could cause clipping in the transmitter amplifier
- Carriers that are not used can be disabled to generate maximum output voltage on the remaining carriers
- Channels that have a good signal to noise ratio can have their output signal reduced to allow other channels to increase theirs

Brute Force Transmission Method

The brute force transmission method uses all the channels available to send the same packet. This uses the redundancy of all the channels to ensure the reliable transmission of data.

Error Correction Mode

Devastating noise on the power lines comes in many forms. Noise that is bursting or impulsive in nature can typically have the effect of destroying a whole byte of data. Most power line communication systems are unable to recover from such noise. If the noise is also repetitive in nature then communications may never normally be possible. When error correction mode is enabled a *SM2200* node has the ability to correct for multiple errors that would normally be unrecoverable in most other systems. Error correction can be enabled and disabled through software.

Address Filtering

Often on a shared medium network there are a lot of packets that are not intended for a particular node. For this reason an address filtering option has been given. This gives two advantages:

- Reduction of traffic on the SPI bus which can often be busy when transferring lots of data
- Relieving the host processor of extra processing responsibility

SPI Input/Output

The *SM2200* interfaces to an external MCU via a 10MHz SPI and an interrupt pin. The MCU is configured as a SPI master and the *SM2200* is configured as a SPI slave. The interrupt pin is used to signal to the MCU that:

- the *SM2200* has received data from the power line
- the *SM2200* has finished sending the data on the power line
- the *SM2200* has detected a BIU change

These interrupts can be enabled and disabled according to the application.

Interrupt Sources

The *SM2200* interfaces to an external MCU via a SPI and an interrupt pin. An interrupt is sent from the *SM2200* to the MCU to inform the MCU that a packet of data has been received, a packet of data has been transmitted, or a BIU has been detected. The type of interrupt is sent on the SPI.

Contact Information

For more information regarding the *SM2200* including technical data sheets, application notes, sample enquiries, demonstration modules, pricing and ordering please contact:

Semitech Semiconductor Pte Ltd

www.semitechsemi.com

sales@semitechsemi.com

Revision (051-06)

Version	Description	Date
0.1	Draft	30/07/2010
1.01	Initial Release	12/10/2010
1.02	Added new Numbering System	12/11/2010
1.03	Updated format	24/11/2010
1.04	Updated block diagram	23/11/2010
1.05	Updated format	03/02/2011
1.06	Added Operating Temperature to the Features	02/05/2011