Introduction to Home Bus

Abstract

This application note introduces the MAX22088, Maxim Integrated's first Home Bus transceiver, which complies with the Home Bus System (HBS) standard requirements while improving communication in harsh environments.

Introduction

A home automation or office network involves at least one controller and one remote device. A typical network will involve multiple controllers and devices. Devices range from heat, ventilation, and air conditioning (HVAC) units to lighting control or basic home appliances. The Home Bus standard, published in 1986 as the ET-2101, was designed to ease communication between these multiple different devices connected to a single bus.

History of the Home Bus Standard

As home and office automation gained in popularity, various companies and universities in Japan recognized the need for a standardized communication to maximize the potential of these systems. In 1981, the Home Bus standard was formally created and, in 1986, it was standardized in Japan by the Electronic Industries Association of Japan (EIAJ) as ET-2101. A supplement to the ET-2101 (ET-2101-1) was later published in 1990.

In 2000, an Extended Home Bus standard was published by the ECHONET Consortium. The Extended Home Bus standard, most commonly in use today, allows for faster data rates, larger buildings, longer cables, and more flexible software than the original ET-2101 standard.

Modern Home Bus has largely been limited to HVAC systems, but the Home Bus standard may be useful in other areas that require a multidrop bus and power-over-data, such as digital signage or other control systems in small- to mid-sized buildings.

The Home Bus Standard

Home automation (HA) systems are designed to allow a mutual exchange of information at any time from any room in a home or building among various appliances, equipment, or security devices. The Home Bus standard was defined to standardize this communication for easy installation and use in a home or office. **Figure 1** shows a typical HA/Home Bus network[2].

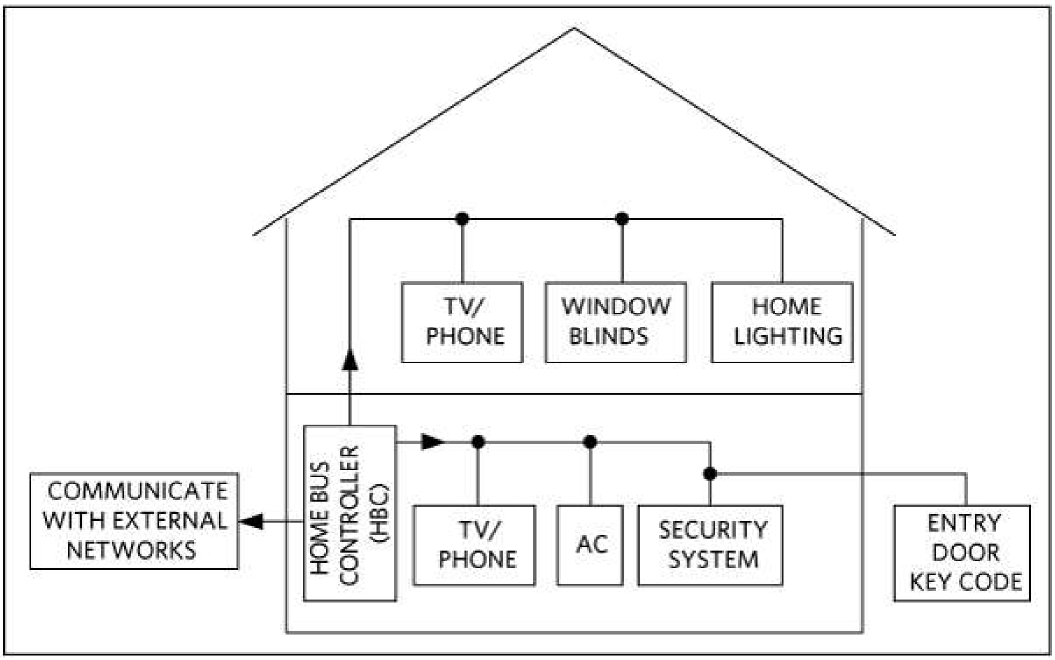

Figure 1. Typical Home Bus Network

To better simplify communication between controllers and devices, the Home Bus standard utilizes the Open Systems Interconnect (OSI) model Layers 1-3 and layer 7 to standardize the physical (PHY) and low-level logic for communication, as shown in **Table 1**.

Table 1. OSI Model Layers

OSI Model

Layer	Function	ET-2101 Home Bus Application
7	Application Layer High-level application programming	Command specifications for communication on a multi-node network
6	Presentation Layer	Not used
5	Session Layer	Not used
4	Transport Layer	Not used
3	Network Layer Structure and management of a multi-node network including addressing and traffic control.	Controlled data transmission over a multi-node network to avoid data collisions or lost data.
2	Data Link Layer Transmissions of data frames between two nodes connected by a physical layer.	Reliable transmission between two nodes (typically a host/controller and a remote device).
1	Physical Layer Raw signal transmission over a physical medium.	Physical medium constraints ensure reliable data link transmission.

Physical Layer of a Home Bus System (Layer 1)

Home Bus communication is transmitted over a single twisted-pair cable in a bus system topology. Cables up to 200m were allowed in the original ET-2101, while the Extended Home Bus standard allows cables up to 1km for medium-sized buildings (e.g., larger homes, apartment buildings, and condominiums, etc.).

In Home Bus communication, data and power (up to 36V) are transmitted over a single pair of wires to a device connected to the bus. Power is inductively coupled on to the Home Bus line from the controller. The Home Bus data lines, H+ and H-, are inverted with each data bit, as shown in Figure 2, ensuring that the power/common-mode offset (not shown in **Figure 2**) remains DC balanced.

Home bus data is transmitted using a baseband transmission at 9.6kbaud ±0.13%. Higher data rates are possible using Extended Home bus. A typical Home Bus waveform is shown in Figure 2[3].

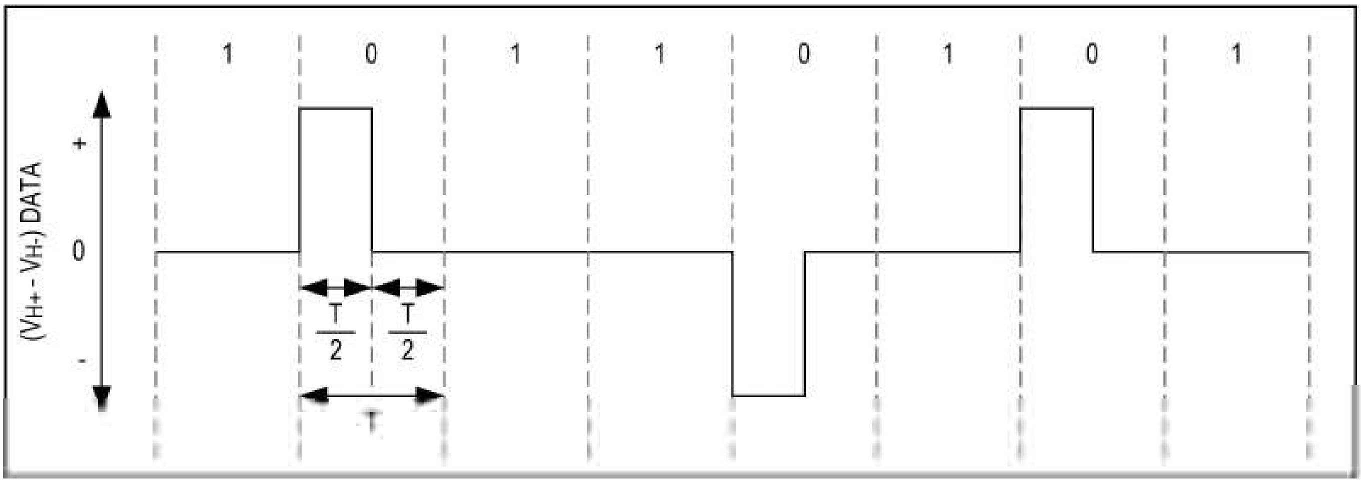

Figure 2. Home Bus Transmission Waveform

Note that the waveform is encoded using alternative mark inversion (AMI) and negative logic with a duty cycle of 50%. Similar to a more standard version of AMI that uses positive logic, a defined input logic sets the Home Bus lines to either a positive or negative state, alternately, in AMI encoding. Negative logic AMI dictates that the Home Bus lines are toggled on an incoming '0' logic state, instead of a '1'. Using Figure 3[3] as a reference, **Table 2**[3] shows the minimum receiving and transmitting voltage levels between the H+ and H- lines.

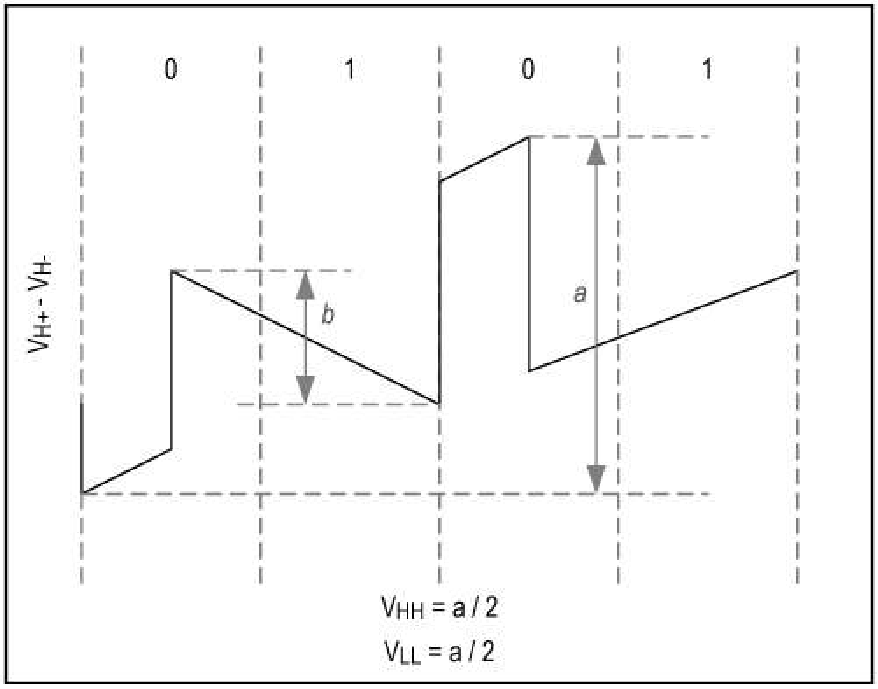

Figure 3. Home Bus Waveform Thresholds

Table 2. Home Bus Logic Transmitting and Receiving Thresholds

Logic	Receiving Level Threshold	Transmitting Level Threshold
0	**V_{LL} = 0.6V**	**V_{LL} = 0.6V**
1	**V_{HH} = 1.4V**	**V_{HH} = 2.5V**

Like early Ethernet technology, the Home Bus standard uses the carrier-sense multiple access with collision detection (CSMA/CD) method for transmission protocol. Packet priority and collision detection procedures are outlined in some detail in the extended Home Bus documentation.

Like standard UART communication, Home Bus does not include a transmitted clock and uses a START-STOP synchronization to decode data on the bus. A single Home Bus character contains 11 bits in total, as shown in **Figure 4**[3, 4]. Data is transmitted LSB-first and has even parity.

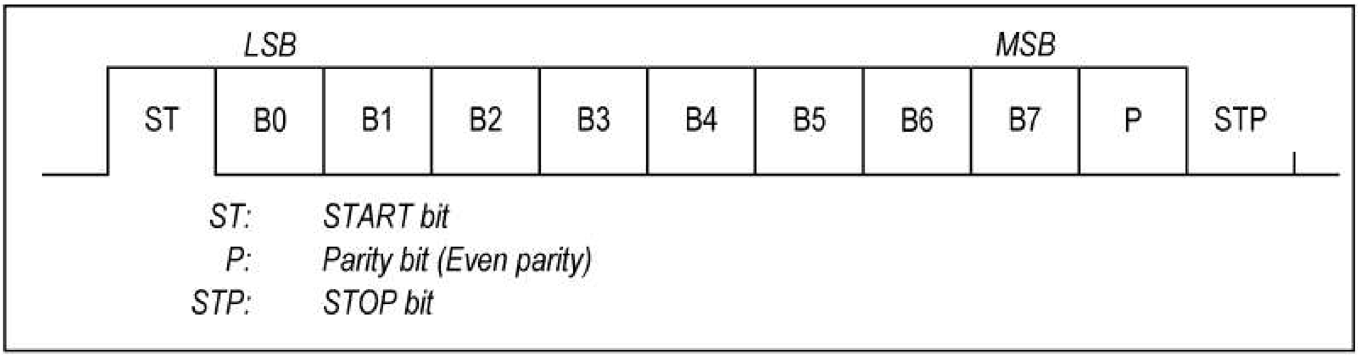

Figure 4. Home Bus Character Byte

Data Link Layer of a Home Bus System (Layer 2)

A packet on the Home Bus network takes one of the two following forms: a data packet or a command packet. As shown in **Figure 5**[3], a data packet contains a priority code (PR), source address/self-code (SC), destination address/destination code (DC), control code (CC) (bit 4 of the CC byte must be '0'), byte count/data length code (BC) (1 to 256 bytes), data bytes, a frame check code (FCC), a dummy code, and ACK/NACK response bits for error detection and control. A command packet is similar to a data packet but includes up to 255 command and operation codes instead of data (**Figure 6**[3]) before the FCC.

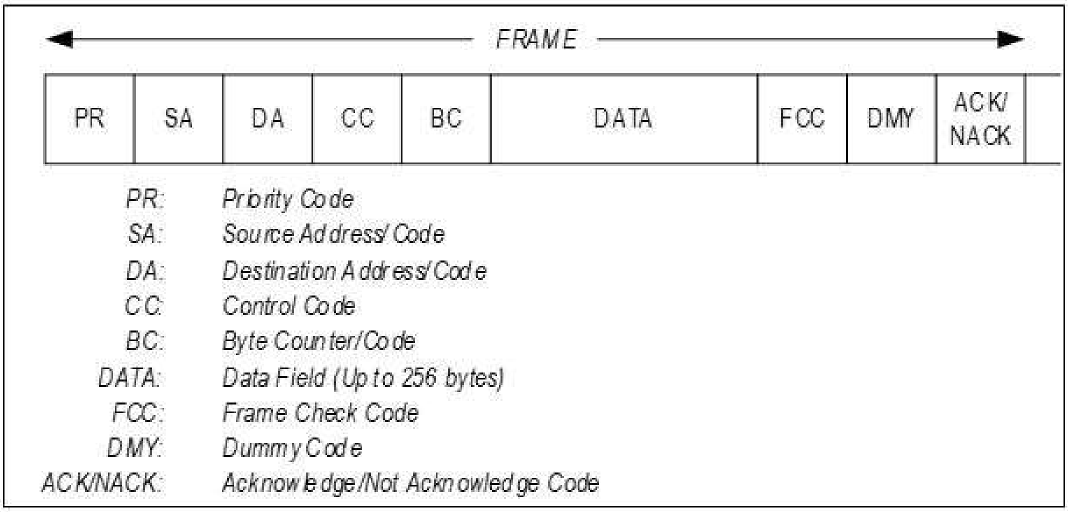

Figure 5. Home Bus Data Packet

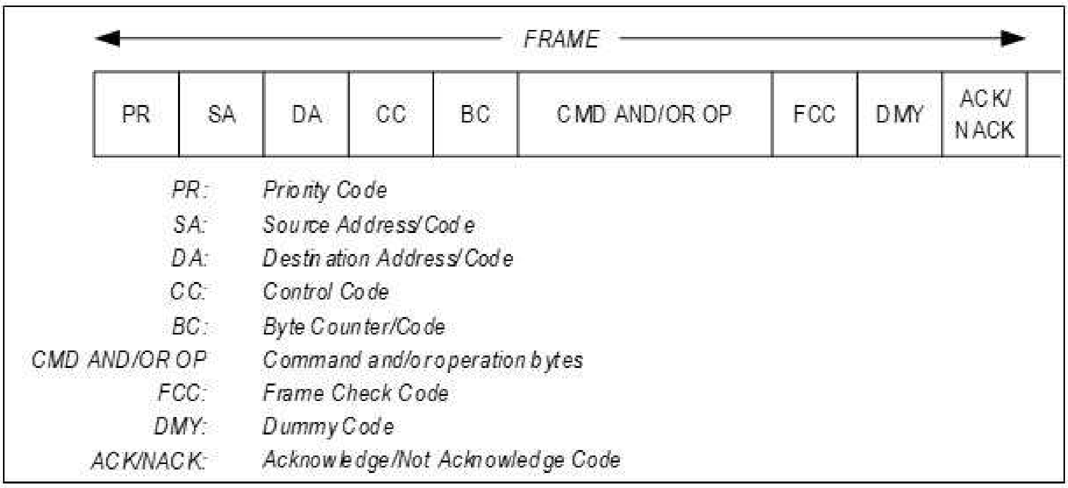

Figure 6. Home Bus Command Packet

Network Layer (Layer 3) and Application Layer (Layer 7) of a Home Bus System

Layers 3 and 7 of the OSI model arethe network layer and application layer, respectively.

The network layer performs larger-scale network routing functions and handles delivery issues. A network includes at least two nodes, connected by a common medium. Each node on a network has an individual address and each node connected on a network can communicate with any other node by providing both a message and the address of the destination node. A number of layer-management protocols include routing protocols, group management, network-layer information and error, and network-layer address assignment are defined in the ISO 7498/4 and belong to the OSI model layer 3 network protocol[1].

While not much data is available on the Home Bus application of Layer 7, the Extended Home Bus standard defines layer 7 in terms of three items: the header code (HD), common system commands, and the communication sequence[3]. The HD code is defined to delineate extended Home Bus systems from standard systems. Common system commands include basic commands forms, operation codes, and operand codes. The Extended Home Bus standard also includes a detailed description of two basic communication sequences: basic communication and a startup communication sequence.

MAX22088 Home Bus Transceiver

Maxim Integrated has recently introduced the MAX22088, its first Home Bus transceiver. The MAX22088 complies with the Home Bus standard requirements while improving communication in harsh environments. The MAX22088 is designed to optimize a Home Bus network by eliminating the need for a large AC-block inductor on remote devices (reducing size requirements for HA network components and appliances). It is configurable to operate up to 200kbps with adjustable receiver thresholds and dynamic cable termination for improved communication. The MAX22088 is rated for operation up to ±8kV Contact Discharge and ±15kV Air Gap ESD Protection and survives up to ±1kV surge events with selected external components.

The MAX22088 has been designed for operation in Home Bus systems but is not only limited to those networks. The MAX22088 can be used to transmit data over any compatible system. For example, Maxim's Application Note 7226: How to Transmit UART Packets Using Home Bus System (HBS) Compatible Transceiver, highlights the use of the MAX22088 with standard UART protocol.

Maxim also offers the MAX22088 evaluation board to simplify testing and quickly integrate the MAX22088 in an existing Home Bus system.

References/Other Resources

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