SMSC™
STANDARD
MICROSYSTEMS
CORPORATION

COM20020 3.3V ULANC
Universal Local Area Network Controller with 2K x 8 On-Board RAM

FEATURES

- New Features
  - Data Rates up to 5 Mbps
  - Programmable Reconfiguration Times
- 24 Pin DIP, 28 Pin PLCC Package
- Ideal for Industrial/Factory/Building Automation and Transportation Applications
- Deterministic, (ANSI 878.1), Token Passing ARCNET Protocol
- Minimal Microcontroller and Media Interface Logic Required
- Flexible Interface For Use With All Microcontrollers or Microprocessors
- Automatically Detects Type of Microcontroller Interface
- 2Kx8 On-Chip Dual Port RAM
- Command Chaining for Packet Queuing
- Sequential Access to Internal RAM
- Software Programmable Node ID
- Eight, 256 Byte Pages Allow Four Pages TX and RX Plus Scratch-Pad Memory
- Next ID Readable
- Internal Clock Scaler and Clock Multiplier for Adjusting Network Speed
- Operating Temperature Range of -40°C to +85°C
- Self-Reconfiguration Protocol
- Supports up to 255 Nodes
- Supports Various Network Topologies (Star, Tree, Bus...)
- CMOS, Single +3.3V Supply
- Duplicate Node ID Detection
- Powerful Diagnostics
- Receive All Packets Mode
- Flexible Media Interface:
  - Traditional Hybrid Interface For Long Distances up to Four Miles at 2.5Mbps.
  - RS485 Differential Driver Interface For Low Cost, Low Power, High Reliability

ORDERING INFORMATION

Order Numbers:

COM20020ILJP3V
28 PLCC Package

COM20020IP3V
24 DIP Package

DISCONTINUED DATASHEET

GENERAL DESCRIPTION

SMSC's COM20020 is a member of the family of Embedded ARCNET Controllers from Standard Microsystems Corporation. The device is a general purpose communications controller for networking microcontrollers and intelligent peripherals in industrial, automotive, and embedded control environments using an ARCNET protocol engine. The small 24 pin package, flexible microcontroller and media interfaces, eight- page message support, and extended temperature range of the COM20020 make it the only true network controller optimized for use in industrial, embedded, and automotive applications. Using an ARCNET protocol engine is the ideal solution for embedded control applications because it provides a deterministic token-passing protocol, a highly reliable and proven networking scheme, and a data rate of up to 5 Mbps when using the COM20020.

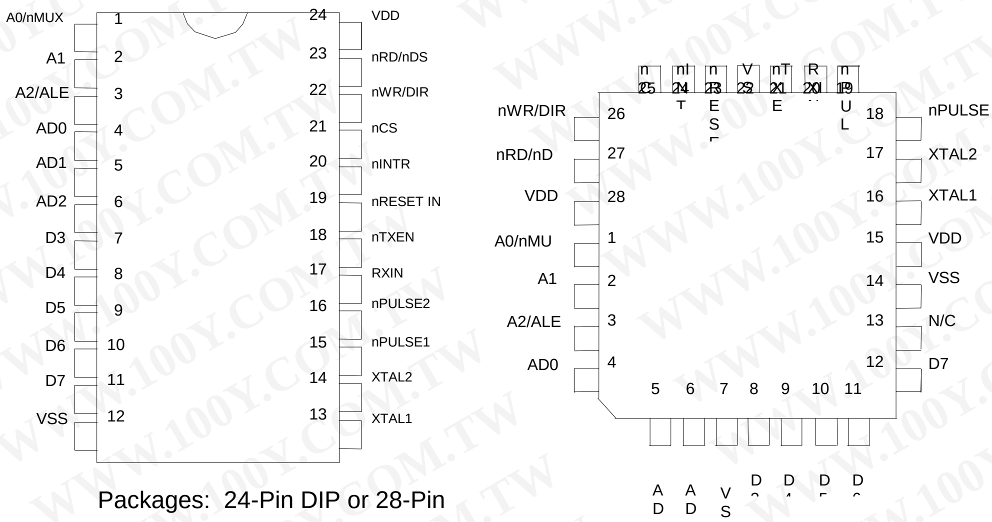
A token-passing protocol provides predictable response times because each network event occurs within a predetermined time interval, based upon the number of nodes on the network. The deterministic nature of ARCNET is essential in real time applications. The integration of the 2Kx8 RAM buffer on-chip, the Command Chaining feature, the 5 Mbps maximum data rate, and the internal diagnostics make the COM20020 the highest performance embedded communications device available. With only one COM20020 and one microcontroller, a complete communications node may be implemented.

TABLE OF CONTENTS

For more details on the ARCNET protocol engine and traditional dipulse signaling schemes, please refer to the ARCNET Local Area Network Standard, available from Standard Microsystems Corporation or the ARCNET Designer's Handbook, available from Datapoint Corporation.

For more detailed information on cabling options including RS485, transformer-coupled RS-485 and Fiber Optic interfaces, please refer to the following technical note which is available from Standard Microsystems Corporation: Technical Note 7-5 - Cabling Guidelines for the COM20020 ULANC.

PIN CONFIGURATION



Packages: 24-Pin DIP or 28-Pin

Ordering

COM2002 I P

PACKAGE TYPE: P = Plastic, LJP =

TEMP RANGE:

I = Industrial: -40°C to

DEVICE TYPE: 20020 = Universal Local Area Network (with 2K x 8

DISCONTINUED DATASHEET

DESCRIPTION OF PIN FUNCTIONS

DIP PIN NO.	PLCC PIN NO.	NAME	SYMBOL	DESCRIPTION
MICROCONTROLLER INTERFACE				
1-3	1-3	Address 0-2	A0/nMUX, A1,A2/ALE	Input. On a non-multiplexed mode, A0-A2 are address input bits. (A0 is the LSB) On a multiplexed address/data bus, nMUX tied Low, A1 is left open, and ALE is tied to the Address Latch Enable signal. A1 is connected to an internal pull-up resistor.
4-11	4-6,8-12	Data 0-7	AD0-AD2, D3-D7	Input/Output. On a non-multiplexed bus, these signals are used as the data lines for the device. On a multiplexed address/data bus, AD0-AD2 act as the address lines (latched by ALE) and as the low data lines for the device. D3-D7 are always used for data only. These signals are connected to internal pull-up resistors.
23	27	nRead/nData Strobe	nRD/nDS	Input. On a 68XX-like bus, nDS is an active low signal issued by the microcontroller as the data strobe signal to strobe the data onto the bus. On a 80XX-like bus, nRD is an active low signal issued by the microcontroller to indicate a read operation.
22	26	nWrite/ Direction	nWR/DIR	Input. On a 68XX-like bus, DIR is issued by the microcontroller as the Read/nWrite signal to determine the direction of data transfer. In this case, a logic "1" selects a read operation, while a logic "0" selects a write operation. In this case, data is actually strobed by the nDS signal. On an 80XX-like bus, nWR is an active low signal issued by the microcontroller to indicate a write operation. In this case, a logic "0" on this pin, when the COM20020 is accessed, enables data from the data bus to be written to the device.
19	23	nReset in	nRESET	Input. This active low signal executes a hardware reset.
20	24	nInterrupt	nINTR	Output. This active low signal is generated by the COM20020 when an enabled interrupt condition occurs.

DIP PIN NO.	PLCC PIN NO.	NAME	SYMBOL	DESCRIPTION
21	25	nChip Select	nCS	Input. This active low signal selects the COM20020 for an access.
TRANSMISSION MEDIA INTERFACE				
16,15	19,18	nPulse 2, nPulse 1	nPULSE2, nPULSE1	Output (nPULSE1), Input/Output (nPULSE2). In Normal Mode, these active low signals carry the transmit data information, encoded in pulse format, as DIPULSE waveform. When the device is in Backplane Mode, the nPULSE1 signal driver is programmable (push/pull or open-drain), while the nPULSE2 signal provides a clock with frequency of double the data rate. nPULSE1 is connected to a weak internal pull-up resistor on the open/drain driver in backplane mode.
17	20	Receive In	RXIN	Input. This signal carries the receive data information from the line tranceiver.
18	21	nTransmit nEnable	nTXEN	Output. This signal is used *prior to the Power-up* to enable the line drivers for transmission. The polarity of the signal is programmable through the nPULSE2 pin. *nPULSE2 floating before Power-up: nTXEN active low (Default option)* *nPULSE2 grounded before Power-up: nTXEN active high (This option is only available in Backplane Mode)*
13,14	16,17	Crystal Oscillator	XTAL1, XTAL2	An external crystal should be connected to these pins. Oscillation frequency range is from 10 to 20 MHz. If an external TTL clock is used instead, it must be connected to XTAL1 with a 390Ω pull-up resistor, and XTAL2 should be left floating.
24	15,28	Power Supply	V_{DD}	+3.3 Volt Power Supply pin.
12	7,14,22	Ground	V_{SS}	Ground pin.

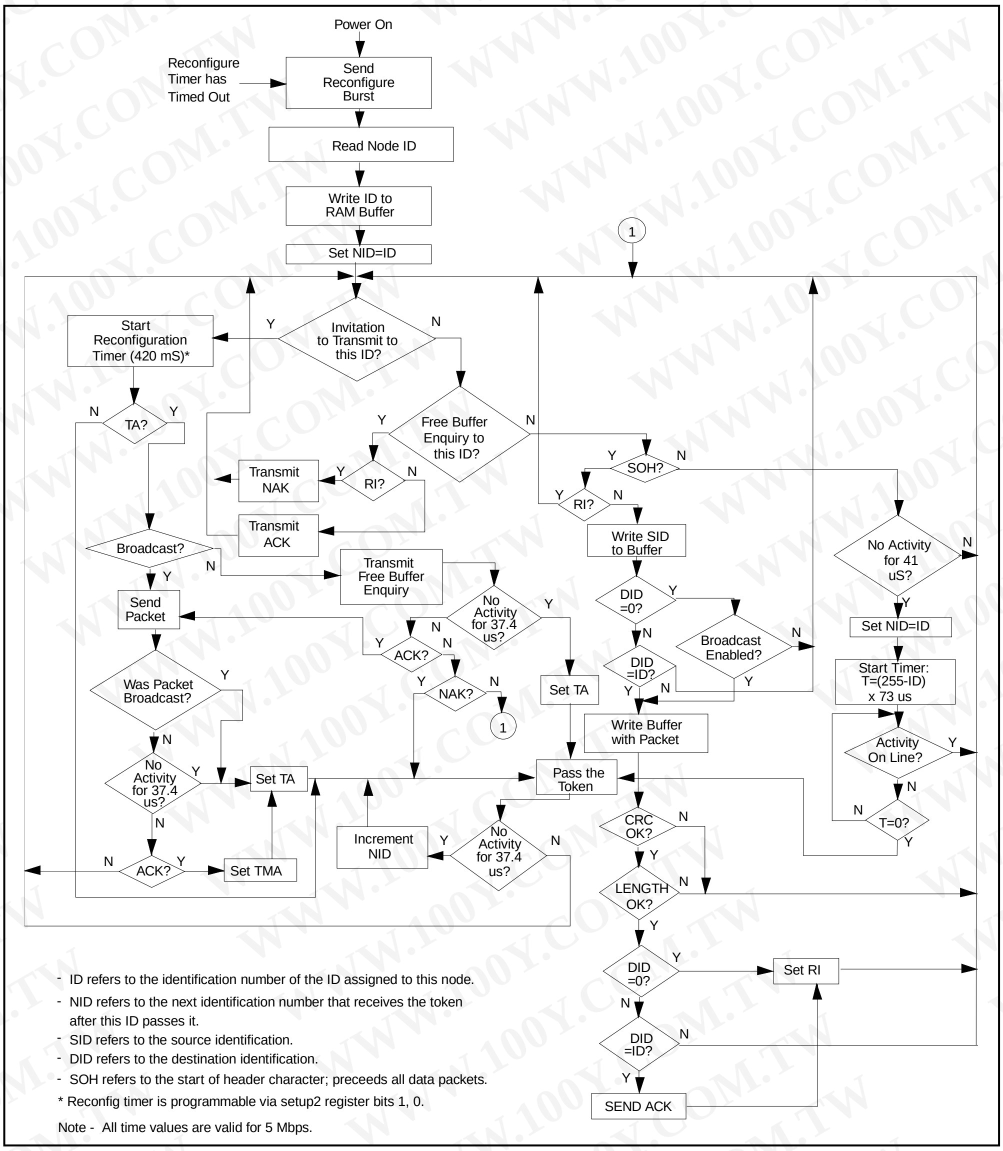


FIGURE 1 - COM20020 OPERATION

PROTOCOL DESCRIPTION

NETWORK PROTOCOL

Communication on the network is based on a token passing protocol. Establishment of the network configuration and management of the network protocol are handled entirely by the COM20020's internal microcoded sequencer. A processor or intelligent peripheral transmits data by simply loading a data packet and its destination ID into the COM20020's internal RAM buffer, and issuing a command to enable the transmitter. When the COM20020 next receives the token, it verifies that the receiving node is ready by first transmitting a FREE BUFFER ENQUIRY message. If the receiving node transmits an ACKnowledge message, the data packet is transmitted followed by a 16-bit CRC. If the receiving node cannot accept the packet (typically its receiver is inhibited), it transmits a Negative AcKnowledge message and the transmitter passes the token. Once it has been established that the receiving node can accept the packet and transmission is complete, the receiving node verifies the packet. If the packet is received successfully, the receiving node transmits an ACKnowledge message (or nothing if it is not received successfully) allowing the transmitter to set the appropriate status bits to indicate successful or unsuccessful delivery of the packet. An interrupt mask permits the COM20020 to generate an interrupt to the processor when selected status bits become true. Figure 1 is a flow chart illustrating the internal operation of the COM20020 connected to a 20 MHz crystal oscillator.

DATA RATES

The COM20020 is capable of supporting data rates from 156.25 Kbps to 5 Mbps. The following protocol description assumes a 5 Mbps data rate. To attain the faster data rates, the clock frequency may be doubled by the internal clock multiplier (see next section). For slower data rates, an internal clock divider scales down the clock frequency. Thus all timeout values are scaled as shown in the following table:

Example: IDLE LINE Timeout @ 5 Mbps = 41 μs. IDLE LINE Timeout for 156.2 Kbps is 41 μs * 32 = 1.3 ms

INTERNAL CLOCK FREQUENCY	CLOCK PRESCALER	DATA RATE	TIMEOUT SCALING FACTOR (MULTIPLY BY)
40 MHz	Div. by 8	5 Mbps	1
20 MHz	Div. by 8	2.5 Mbps	2
	Div. by 16	1.25 Mbps	4
	Div. by 32	625 Kbps	8
	Div. by 64	312.5 Kbps	16
	Div. by 128	156.25 Kbps	32

Selecting Clock Frequencies Above 2.5 Mbps

To realize a 5 Mbps network, an external 40 MHz clock must be input. However, since 40 MHz is near the frequency of FM radio band, it is not practical for use for noise emission reasons. Therefore, higher frequency clocks are generated from the 20 MHz crystal as selected through two bits in the Setup2 register, CKUP[1,0] as shown below. The selected clock is supplied to the ARCNET controller.

CKUP1	CKUP0	CLOCK FREQUENCY (DATA RATE)
0	0	20 MHz (Up to 2.5Mbps) Default (Bypass)
0	1	40 MHz (Up to 5Mbps)
1	0	Reserved
1	1	Reserved

This clock multiplier is powered-down (bypassed) on default. After changing the CKUP1 and CKUP0 bits, the ARCNET core operation is stopped and the internal PLL in the clock generator is awakened and it starts to generate the 40 MHz. The lock out time of the internal PLL is 8uSec typically. After more than 8 µsec (this wait time is defined as 1 msec in this data sheet), it is necessary to write command data '18H' to the command register to re-start the ARCNET core operation. This clock generator is called “clock multiplier”.

Changing the CKUP1 and CKUP0 bits must be one time or less after releasing hardware reset.

The EF bit in the SETUP2 register must be set when the data rate is over 5 Mbps.

NETWORK RECONFIGURATION

A significant advantage of the COM20020 is its ability to adapt to changes on the network. Whenever a new node is activated or deactivated, a NETWORK RECONFIGURATION is performed. When a new COM20020 is turned on (creating a new active node on the network), or if the COM20020 has not received an INVITATION TO TRANSMIT for 420mS, or if a software reset occurs, the COM20020 causes a NETWORK RECONFIGURATION by sending a RECONFIGURE BURST consisting of eight marks and one space repeated 765 times. The purpose of this burst is to terminate all activity on the network. Since this burst is longer than any other type of transmission, the burst will interfere with the next INVITATION TO

TRANSMIT, destroy the token and keep any other node from assuming control of the line.

When any COM20020 senses an idle line for greater than 41µS, which occurs only when the token Is lost, each COM20020 starts an internal timeout equal to 73µs times the quantity 255 minus its own ID. The COM20020 starts network reconfiguration by sending an invitation to transmit first to itself and then to all other nodes by decrementing the destination Node ID. If the timeout expires with no line activity, the COM20020 starts sending INVITATION TO TRANSMIT with the Destination ID (DID) equal to the currently stored NID. Within a given network, only one COM20020 will timeout (the one with the highest ID number). After sending the INVITATION TO TRANSMIT, the COM20020 waits for activity on the line. If there is no activity for 37.4µS, the COM20020 increments the NID value and transmits another INVITATION TO TRANSMIT using the NID equal to the DID. If activity appears before the 37.4µS timeout expires, the COM20020 releases control of the line. During NETWORK RECONFIGURATION, INVITATIONS TO TRANSMIT are sent to all NIDs *(1-255).*

Each COM20020 on the network will finally have saved a NID value equal to the ID of the COM20020 that it released control to. At this point, control is passed directly from one node to the next with no wasted INVITATIONS TO TRANSMIT being sent to ID's not on the network, until the next NETWORK RECONFIGURATION occurs. When a node is powered off, the previous node attempts to pass the token to it by issuing an INVITATION TO TRANSMIT. Since this node does not respond, the previous node times out and transmits another INVITATION TO TRANSMIT to an incremented ID and eventually a response will be received.

The NETWORK RECONFIGURATION time depends on the number of nodes in the network, the propagation delay between nodes, and the highest ID number on the network, but is typically within the range of 12 to 30.5 mS.

BROADCAST MESSAGES

Broadcasting gives a particular node the ability to transmit a data packet to all nodes on the network simultaneously. ID zero is reserved for this feature and no node on the network can be assigned ID zero. To broadcast a message, the transmitting node's processor simply loads the RAM buffer with the data packet and sets the DID equal to zero. Figure 4 illustrates the position of each byte in the packet with the DID residing at address 0X01 or 1 Hex of the current page selected in the "Enable Transmit from Page fnn" command. Each individual node has the ability to ignore broadcast messages by setting the most significant bit of the "Enable Receive to Page fnn" command to a logic "0".

EXTENDED TIMEOUT FUNCTION

There are three timeouts associated with the COM20020 operation. The values of these timeouts are controlled by bits 3 and 4 of the Configuration Register and bit 5 of the Setup 1 Register.

Response Time

The Response Time determines the maximum propagation delay allowed between any two nodes, and should be chosen to be larger than the round trip propagation delay between the two furthest nodes on the network plus the maximum turn around time (the time it takes a particular COM20020 to start sending a message in response to a received message) which is approximately 6.4 µS. The round trip propagation delay is a function of the transmission media and network topology. For a typical system using RG62 coax in a baseband system, a one way cable propagation delay of 15.5 µS translates to a distance of about 2 miles. The flow chart in Figure 1 uses a value of 37.4 µS (15.5 + 15.5 + 6.4) to determine if any node will respond.

Idle Time

The Idle Time is associated with a NETWORK RECONFIGURATION. Figure 1 illustrates that during a NETWORK RECONFIGURATION one node will continually transmit INVITATIONS TO TRANSMIT until it encounters an active node. All other nodes on the network must distinguish between this operation and an entirely idle line. During NETWORK RECONFIGURATION, activity will appear on the line every 41 µS. This 41 µS is equal to the Response Time of 37.4 µS plus the time it takes the COM20020 to start retransmitting another message (usually another INVITATION TO TRANSMIT).

Reconfiguration Time

If any node does not receive the token within the Reconfiguration Time, the node will initiate a

NETWORK RECONFIGURATION. The ET2 and ET1 bits of the Configuration Register allow the network to operate over longer distances than the 2 miles stated earlier. The logic levels on these bits control the maximum distances over which the COM20020 can operate by controlling the three timeout values described above. For proper network operation, all COM20020's connected to the same network must have the same Response Time, Idle Time, and Reconfiguration Time.

LINE PROTOCOL

The ARCNET line protocol is considered isochronous because each byte is preceded by a start interval and ended with a stop interval. Unlike asynchronous protocols, there is a constant amount of time separating each data byte. *On a 5 Mbps network,* each byte takes exactly 11 clock intervals of 200ns each. As a result, one byte is transmitted every 2.2 µS and the time to transmit a message can be precisely determined. The line idles in a spacing (logic "0") condition. A logic "0" is defined as no line activity and a logic "1" is defined as a negative pulse of 100nS duration. A transmission starts with an ALERT BURST consisting of 6 unit intervals of mark (logic "1"). Eight bit data characters are then sent, with each character preceded by 2 unit intervals of mark and one unit interval of space. Five types of transmission can be performed as described below:

Invitations To Transmit

An Invitation To Transmit is used to pass the token from one node to another and is sent by the following sequence:

- An ALERT BURST
- An EOT (End Of Transmission: ASCII code 04H)
- Two (repeated) DID (Destination ID) characters

ALERT BURST	EOT	DID	DID

Free Buffer Enquiries

A Free Buffer Enquiry is used to ask another node if it is able to accept a packet of data. It is sent by the following sequence:

- An ALERT BURST
- An ENQ (ENQuiry: ASCII code 85H)
- Two (repeated) DID (Destination ID) characters

ALERT BURST	ENQ	DID	DID

Data Packets

A Data Packet consists of the actual data being sent to another node. It is sent by the following sequence:

- An ALERT BURST
- An SOH (Start Of Header--ASCII code 01H)
- An SID (Source ID) character
- Two (repeated) DID (Destination ID) characters
- A single COUNT character which is the 2's complement of the number of data bytes to follow if a short packet is sent, or 00H followed by a COUNT character if a long packet is sent.
- N data bytes where COUNT = 256-N (or 512-N for a long packet)
- Two CRC (Cyclic Redundancy Check) characters. The CRC polynomial used is: $X^{16} + X^{15} + X^{2} + 1$.

ALERT BURST	SOH	SID	DID	DID	COUNT	data	data	CRC	CRC

Acknowledgements

An Acknowledgement is used to acknowledge reception of a packet or as an affirmative response to FREE BUFFER ENQUIRIES and is sent by the following sequence:

- An ALERT BURST
- An ACK (ACKnowledgement--ASCII code 86H) character

ALERT BURST	ACK

Negative Acknowledgements

A Negative Acknowledgement is used as a negative response to FREE BUFFER ENQUIRIES and is sent by the following sequence:

- An ALERT BURST
- A NAK (Negative Acknowledgement--ASCII code 15H) character

ALERT BURST	NAK