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73M2901CE SMS and Half Duplex V.23 Operation

Introduction

V.23 is a FSK modem standard that is defined by ITU regulations. V.23 has been around for many years and has evolved to suite a number of different applications areas. It is actually a derivative of the Bell 202 standard used in the U.S., but was adapted to operate over European networks that required some changes to be made to the operating frequencies. The forward or main channel can communicate with Bell 202, but the back or low speed channels are not compatible.

V.23 can be used in several different ways to suite the specific application in which it is used. There are some applications that use it in its original form on dial up PSTN lines with a forward 1200 bps channel and a reverse 75bps low speed channel. The reverse channel is usually connected to a terminal, and is usually the “master” side since it is usually the side that is used to make the call and is controlled by a live operator. The other end is the “slave” side and it sends the bulk of the data that is requested. In some cases it is desirable to turn this line around to send data from the master side as is done with PAVI operation in France (see the Teridian Semiconductor V.23 PAVI applications note for details on these modes). It can also be used for 1200 bps operation in both directions, either full duplex over 4 wires (2 wires for each direction) or half duplex on 2 wires or “ping pong” mode where only one channel is transmitting and the other receiving at a given time. This app note explains the operation of this mode and a specific application of this mode called “SMS” or Short Message Service that is common in European mobile telephone applications.

SMS Description

SMS is described in ETSI ES 202 986 V1.1.2 (2002-01) and is a messaging service that has been in existence in Europe since about 1997. It is similar in service to the text messaging used in the U.S. Messages are passed between two customers by way of a store and forward protocol in which the source and destination do not communicate directly. This service uses the same modulation as used for FSK based Caller ID in many countries. The protocols are similar to, but not the same as, Caller ID. In this app note we will not detail all the operations of the SMS protocol since this is available in the specifications, which may be subject to change. Rather, this application note describes the use of the 73M2901CE single chip modem and how it can be used to support SMS. Since SMS is a specific application of V.23 half duplex, this note also describes the use of V.23 half duplex in a more general sense.

The 73M2901CE IC has some unique commands and modes that were included specifically for SMS, but are also needed for V.23 half duplex operation in general.

There are a number of terms, abbreviations, and commands that are used for SMS and half duplex. Here some that will be used repeatedly in this document.

SMS-SC Short Message Service – Service Center; function unit, which is responsible for the relaying and store-and-forwarding of a short message (SM) between two SM-TEs

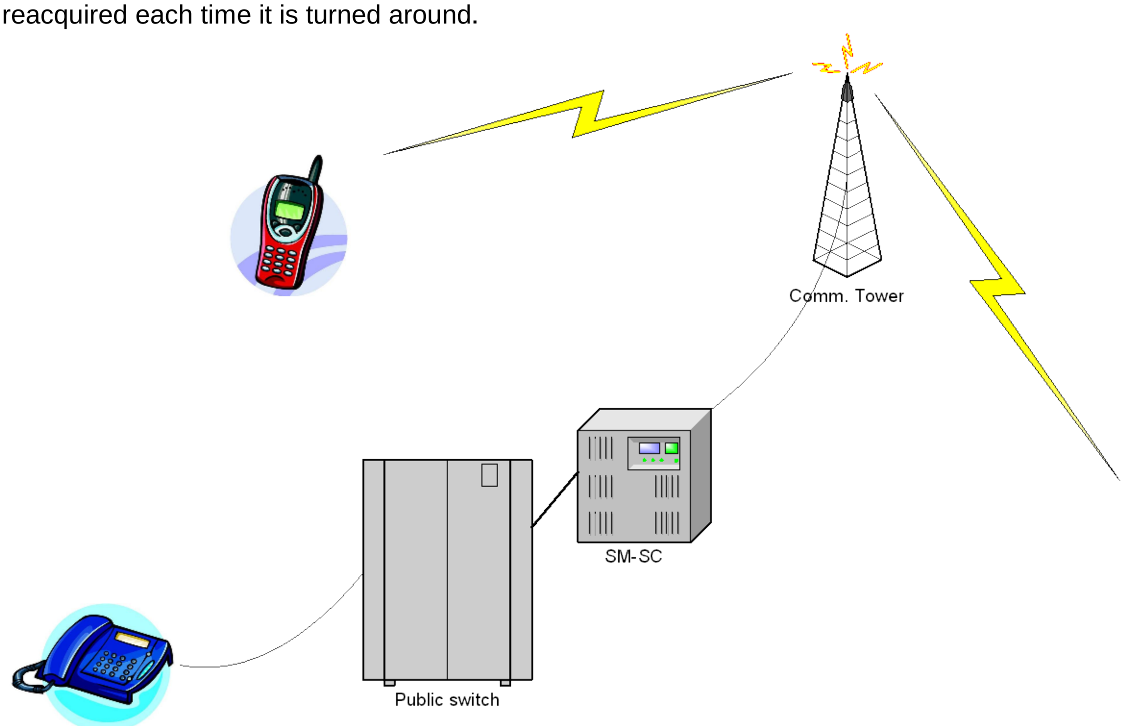
SM-TE Short message – Terminal Equipment; terminal (telephone) that may send or receive short messages.

SM-TL Short Message – Transfer Layer; the link between the Applications Layer and the Data Link Layer (DLL)

SM-DLL	Short Message – Data Link Layer; the DLL is the link that allows the SM-TL to communicate with the SM-TL of the other SMS-SC or SMS-TE. This is the software to format the data for transmission and to receive the data and check for errors, etc. The data format is similar to Caller ID.
DLL	Data Link Layer
PL	The Physical Layer enables the transfer of DLL messages over the voice band, i.e., the modem and network.
SM	Short Message; information that may be sent by means of SMS
CTS	Clear To Send; serial interface signal output from the 73M2901CE that indicates to the host that it is ready to send data.
RTS	Request To Send; serial interface signal input used to control the transmission of carrier from the 73M2901CE. If a modem will initially be used to receive a message, this signal will be de-asserted by the host at the time of the initial connection.
DCD	Data Carrier Detect; serial interface signal output from the 73M2901CE that indicates that a carrier is being received.

Half duplex communication can be accomplished in the same way as SMS. SMS is really only a special case of half duplex that is used for a specific messaging service. The following diagrams show how SMS is accomplished, but the same basic procedures can also be used with half duplex in a more general sense. Non-SMS half duplex can also have other data formats that may be simpler or more complex, depending on the application, but SMS is a good example to see how half duplex works.

There are actually two slightly different SMS protocols defined in ETSI ES 201 912 V.1.1.1 (2002-01). They are SMS Protocol 1 and SMS Protocol 2. They vary in the format of the data frames and the meanings of some of the Message type definitions. We will not go into the differences here and for illustration purposes will discuss only Protocol 2. In SMS the carrier is actually turned around several times during a session. The data packet or frame must be reacquired each time it is turned around.



SMS Network

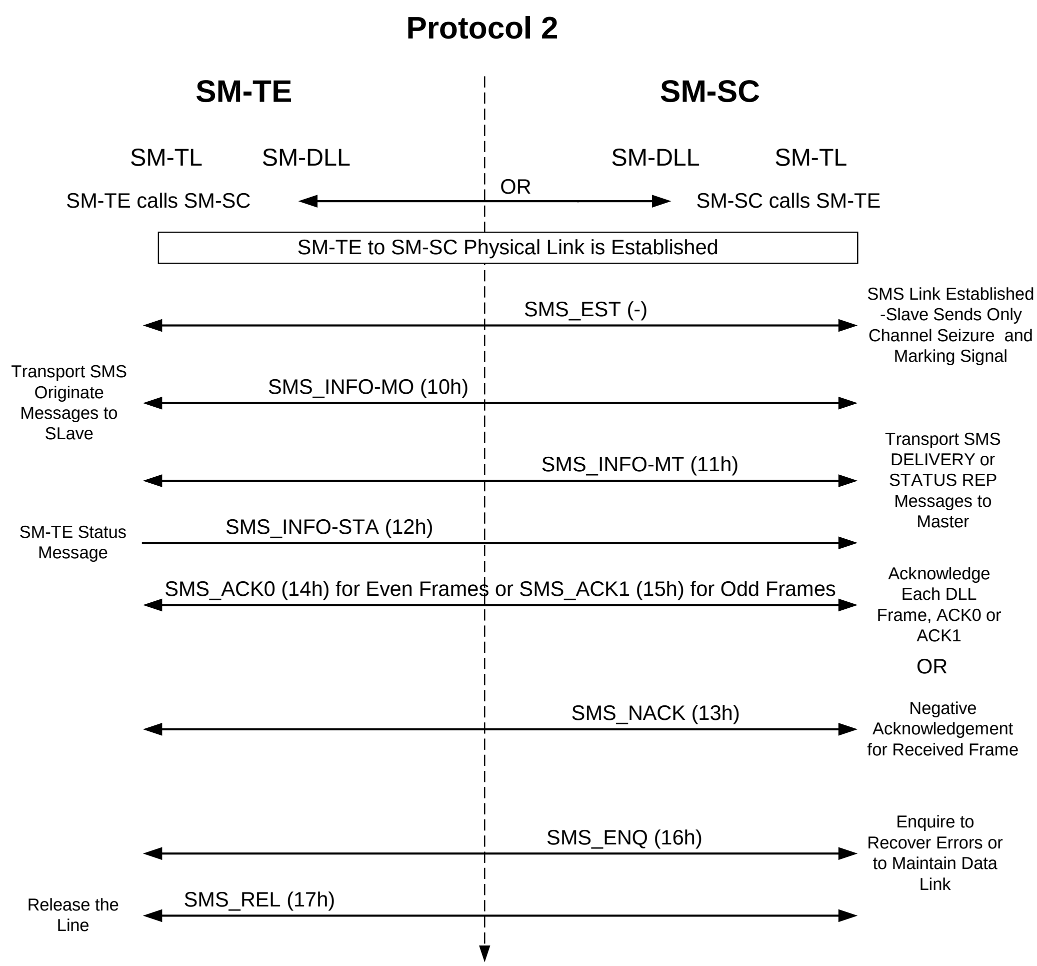
The data frames can be thought of as being similar to a HDLC packet. The data is always preceded by a channel seizure signal consisting of alternating 0's and 1's for 256 ms followed by marks for 70 +/- 20 ms. Similar to HDLC and other packet-based protocols, the Message Type, Message Length (the number of bytes in the Payload only), Payload, and Checksum (calculated from all the information bytes except the checksum) are sent. In the SMS Establishment Phase, only the Channel Seizure and Marking Signal are sent, otherwise all the fields are sent in each direction. Depending on whether the SMS message is originating from a SM-TE or SM-SC, either end can start a communications session. When the SM-TE sending a text message is calling the SM_SC, the SM-TE is the "Master", when the SM-SC is calling the destination SM-TE, the SM-SC is the Master. Put another way, the end that is initiating the call is defined as the Master and the one receiving the Data is the Slave.

As shown in the preceding diagram, SMS can in some cases now be used by PSTN fixed line users as well as mobile users. This PSTN fixed line service is not available as widely as the mobile services, but it is increasing.

Channel Seizure	Mark Signal	Message Type	Message Length	Payload (Transfer Layer Message)	Checksum

Data Link Layer Message Structure

The following diagram shows the different message types that can be sent as defined for the Message Type field in the DLL. Many messages originate in the Transfer Layer or beyond, but messages relating to Call Establishment, ACKs, NACs, and DLL Information are handled at the DLL level. It is highly recommended that the reader consult the ETSI documents referenced in this app note for detailed information on the interworkings of SMS.



Message Types and Code Values

SMS also supports error checking and handling at multiple levels, but data errors are typically caught at the DLL level. Checksum errors are reported to the sending end and retransmission is requested. There are two different Acknowledgement messages sent, ACK0 and ACK1. ACK0 messages are sent for even numbered frames and ACK1 for odd numbered frames. In this way single missing frames can be detected. It is also possible for the TL messages to not get back to the ACKn side DLL in time to be included in the ACKn frame payload. When this happens the ACKn will contain a null payload (no data), in which case the receiving DLL will wait for the next ACKn message, which should be another ACKn with n equal to the previous n, hopefully with the proper TL payload. If this is successful, the next data frame can be sent; otherwise the SMS stations will continue until the retry limit is reached and the session is aborted.

Only 255 bytes maximum can be sent is a frame, but multiple frames can be sent for longer messages. This is accomplished be setting the MSB of the Message Type byte to 1 (0 in Protocol 1). This tells the receiving station the message is segmented and the next frame is also a payload frame. This can be extended so data can be sent as long as the MSB of the preceding frame was a 1. When it is 0, the payload is complete.

Using the 73M2901CE Single Chip Modem in a SMS Application

The 73M2901CE has been optimized for SMS and V.23 half duplex in general. There are several enhancements that have been added to the 73M2901CE to make it more compatible with SMS, including faster turn around and demodulator settling. Normally the modem will be used in the “clear channel” mode (Y0), but this is not mandatory. Speed buffering (Y6) at 4800/9600bps using XON/XOFF (K4) can also be used instead of Y0 and 1200bps. RTS/CTS (K3) flow control cannot be used because these signals are being used to control the V23HD carrier. The 73M2901CE modem is typically initialized with the command string: ATY0B10S73-32C2S10=255 This is broken out as follows:

Y0	clear channel mode (1200 bps)
B10	V.23 HDX gated by RTS
S73-32	no 125ms wait between commands
C2	DCD follows the raw received carrier
S10=255	disable loss of carrier timeout

The following two sequences are typical of how the 73M2901CE should be used in a communications session. An SMS session can be quite complicated as described in the referenced documentation, so this example should not be interpreted to be all that is required. There are various signal times and time-outs that also need to be observed and these all have there own decision trees that need to be accounted for.

Polling of CTS-DCD signals is necessary. CTS indicates that modem is ready to send data. DCD indicate that receive data is valid. CTS, DCD and RTS are all low true signals at the 73M2901 pins.
RTS-ON to CTS-ON response time is controlled by S90 (range 10ms to 2.55s).
RTS-OFF to CTS-OFF is <4ms
Using C2 carrier option, DCD will turn on after receiving carrier for 10-20ms.

Case 1: SM-TE 73M2901CE (Master) to SM-SC (Slave) transmission sequence for a SMS message

1. Set the Local Host serial data rate to 1200bps.
2. The Local Host controls the V23 carrier with RTS signal.
3. Turn off RTS (to start modem as a receiver and prevent sending carrier).
4. Send ATY0B10S73-32C2S10=255 to initialize the 73M2901CE modem.
5. ATDTnnn.. (TE dials SMS-SC).
6. Modem will display "Connect 1200" with CTS off and DCD off.
7. Modem waits for V23 carrier from SM-SC.
8. Wait for DCD on (SM-SC carrier received).
9. Detect channel seizure and mark from V.23 receive data.
10. Wait for DLL_SMS_EST signal and DCD turn off (SM-SC switched to receive mode).
11. Turn on RTS (to switch modem to transmit mode).
12. Wait for CTS on to indicate 73M2901CE is ready to send data.
13. Transmit DLL_SMS_INFO_MO originate message to SM-SC.
14. Turn off RTS (to switch modem to receive mode).

15. Wait for DCD on (SM-SC carrier is being received).
16. Detect ACK1 message from SM-SC or time-out. The slave will include the TL confirmation or rejection message in the payload, or a null message if the timer expires.
17. Wait per SMS timing and DCD turn off (SM-SC switched to receive mode).
18. Turn on RTS (to switch 73M2901CE modem to transmit mode).
19. Wait for CTS on.
20. Transmit DLL_SMS_ENQ message if the ACK1 was a null message or next DLL_SMS_INFO_MO to send another data frame.
21. Turn off RTS (to switch modem to receive mode).
22. Wait for DCD on.
23. Detect DLL_SMS_ACK1 again from SM-SC if the ACK1 was a null last time or DLL_SMS_ACK0 for the SMS_INFO_MO frame just received.
24. (Assuming DLL_SMS_ACK0 was received above) Wait per SMS timing and DCD turn off (SM-SC switched to receive mode).
25. Turn on RTS (to switch 73M2901CE modem to transmit mode).
26. Wait for CTS on.
27. Transmit DLL_SMS_REL message to end session.
28. Turn off RTS (to switch 73M2901CE modem to receive mode).
29. Wait for DCD on.
30. Detect DLL_SMS_ACK1 message from SM-SC acknowledging the end of the session.

END

Case 2: SM-SC to TE transmission of an SMS

1. Set the Local Host serial data rate to 1200bps.
2. The Local Host controls the V23 carrier with RTS signal.
3. Turn off RTS (to prevent sending carrier too early).
4. ATY0B10C2S73-32S10=255S0=2 (Auto answer on 2 rings).
5. Modem auto answer SMS-SC call after S0 rings.
6. Modem will display "Connect 1200" with CTS off and DCD off.
7. Turn on RTS (to switch modem to transmit mode).
8. Wait for CTS on.
9. Prepare to send the DLL_SMS_EST signal from the SM-TE. From the Local Host send the “+++ATS60=3” escape sequence to modem to switch to the on-line command mode along with the ATS60=3 command to set the modem to transmit alternating 0/1s.
10. Wait for 240 ms and then the ATO command to turn off the alternating pattern and start to transmit a MARK signal for 70ms.
11. Turn off RTS (to switch 73M2901CE modem to receive mode).
12. After completion of the Channel Seizure & MARK signal transmission, from the Local Host send ATS60=0O to return to the data mode.
13. Wait for DCD on.
14. Receive DLL_SMS_INFO_MT message from SM-SC (SM message information). There may be multiple messages and ACKn’s if segmented messages are sent.
15. Wait per SMS timing and DCD turn off (SM-SC switched to receive mode).
16. Turn on RTS (to switch modem to transmit mode).
17. Wait for CTS on.
18. Transmit DLL_SMS_ACK1 message to SM-SC.
19. Turn off RTS (to switch modem to receive mode).
20. Wait for DCD on.
21. Receive DLL_SMS_REL message from SM-SC.
22. Wait per SMS timing and DCD turn off (SM-SC switched to receive mode).
23. Turn on RTS (to switch modem to transmit mode).
24. Wait for CTS on.
25. Transmit DLL_SMS_ACK0 message to SM-SC acknowledging the end of the session.

END

A couple of things should be noted in the procedures above. Although detailed only in the SM_SC to SM-TE connection, the 73M2901CE is put into a mode that sends patterns during the handshake to generate the alternating 0/1 and Marks (steps 9 and 10 above). This is also necessary every time the line is turned around and the carrier is sent. The reason for this using the test pattern generator for the alternating pattern is that the modem only sends asynchronous data and to send this by using the equivalent character, “U”, there can be some distortion of the waveform. By using the transmit alternate pattern a symmetrical continuous waveform is guaranteed. The pattern transmission stops automatically when the modem is put back into the data mode. To send the Marking pattern simply do not send data for 70 ms (constant marks are sent when there is no data). If a normal frame were being sent instead of the DLL_SMS_EST signal, the Message Type, Message Length, Payload and Checksum would follow the Marks. This same procedure must be done each time a pattern is sent.

It may take some time to fully comprehend the SMS protocols, but after studying the ETSI documentation it will all start to fall into place. Any robust half duplex protocol should contain a similar structure to SMS, but there is a lot of room for variation. It is important that enough time is allowed for the carriers to turn around and there should be a way to easily recognize the beginning of the data packets. If these functions are missing, the chances for errors increase.

Synchronous FSK operation

It is also advisable to send asynchronous data if FSK is used. There are some applications that use FSK “synchronously”, although to call any FSK synchronous is a bit of a misnomer. By definition synchronous data needs to have a clock that is synchronized to the data. With DPSK and QAM there is an imbedded baud clock in the data carrier. This is extracted in the carrier demodulation process and used by the 73M2901CE modem to generate a phase locked data rate clock to use with the DPSK or QAM receive data to indicate where the data should be sampled. Since FSK does not have an imbedded clock, the modem cannot supply a clock that is accurate over long periods unless it is resynchronized to the data transitions periodically. The 73M2901CE does not support such a mode directly, but there are ways to do this in the host firmware. The Host must be able to generate an accurate clock at the nominal data rate. During periods where there are no transitions the clock can drift out of sync with the data. To overcome this, every time a 0/1 or 1/0 transition is detected the sample clock should be reset to transition one half bit time after the edge to realign it with the data centers. If the 73M2901CE is used with synchronous V.23 FSK, only 1200 bps operation is possible. It is also possible to do this at 300 bps for V.21. Even with these precautions data errors can occur when using FSK with synchronous data, therefore it is not generally recommended.

Conclusion

We hope this document is helpful in understanding SMS and Half duplex operation in general. We have tried to highlight the important aspects of SMS operation and also explain the operation of half duplex in general. The 73M2901CE IC is an important enhancement to the 2901 family of modem integrated circuits. It includes a number of important features that make it the ideal modem to use in any SMS applications.

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