SD-670D & SD-670DE Series
User Manual

SD-671D VHF / SD-674D UHF

SD-671DE VHF / SD-674DE UHF

RF Audio/Data Modem (DMR)

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1. SD-670D & SD-670DE Digital RF Modem Main Functions

The Maxon SD-670 Series Radios are durable, reliable, and designed to meet the needs for a variety of wireless applications in either Digital (DMR) or Analog mode.

SD-670 Series modems incorporate the most requested mechanical footprint in the industry and the most widely used BNC antenna connector. Transmit power can be adjusted via AT Commands from 1 to 5 watts (UHF) and from1 to 10 watts (VHF) to provide the power needed for any job. The LED indicator gives instant on-sight status of the modem's operation and are designed for low current drain but fast transmitter/receiver attack times. Built in AES (256-Bit) encryption in the SD-670DE Series secures both voice and data communications and is compatible with other Maxon radios with AES Encryption.

The die cast aluminum cabinet/lid provides resistance to RF interference and gives exceptional environmental durability in the most extreme conditions.

SD-670 Series Functions

- Frequency band - VHF: 150~174MHz, UHF: 410~470MHz.
- Dual mode (Digital & Analog)
- 1 Zone, 32 channel selections made through internal DIP switches and AT Commands.
- RF Power - VHF: 10/5/1 Watt, UHF: 5/1 Watt
- ETSI Standard DMR Protocol Tier 1 & 2
- Industry Standard AMBE+2 Voice Codec
- AES 256-bit Encryption (AES-CTR)** *(**Encryption available on SD-670DE models or SD-670D models w/encryption factory option only)*
- AT commands provide convenient operation
- 3 wires / 5 wires continuous mode
- Audio Output Power Max rating 0.5 Watt @ 8 ohms. Adjustable from Level 1 – 15.
- Carrier Detect
- RF Communication Data Speed: 9,600bps (Over the Air)
- RS-232C Communication Speed: Standard 115,200bps / 9,600bps (Adjustable w/DIP Switch)
- Convenient PC-based Modem Control GUI Software
- Diecast Lightweight Aluminum Frame/Body
- Service Connector: DE-15 Pin Female Connector
- Power Supply Voltage: DC +12V
- Dimensions: 4.77" (L) x 2.44" (W) x 0.96" (H)

2. Specification

General Specifications

Frequency Range	SD-671: 150~174 MHz
	SD-674: 410 ~470 MHz
Frequency Stability	±1.5ppm (-30 to +60℃)
Numbers of Channel	1 Zone / 32 Channels
Channel Spacing	12.5KHz
Digital Vocoder	AMBE++
Size	110mm(H) x 25mm(W) x 51mm(D)
Weight	280g
Power Source	UHF: 9-24V, VHF: 12-24V.
Current Consumption	Receive Mode @ Maximum audio– 350 mA (Audio Max)
	Transmit Mode @ High Power – VHF: 2,500mA
	UHF: 1,200mA
	Standby ≒110mA (max. 115mA), Standby in
	“Power-Saving” modes via radio programmer
	(50~85mA range)

Receiver Specifications

Reception Sensitivity	0.25uV 12 dB SINAD
Squelch Sensitivity	0.22uV 10dB SINAD
Selectivity	65dB (12.5KHz)
Spurious and Harmonic Rejection	70dB
FM Hum and Noise	40dB (12.5KHz)
Audio Output	1Vrms
Audio Distortion	Less than 3%
Audio Characteristics	+1, -3 dB from 6dB per octave de-emphasis Characteristic
	from 300 ~ 3000Hz

Transmitter Specifications

RF Output	VHF: 10/5/1 Watt, UHF: 5/1 Watt
Spurious and Harmonic	70dB
FM Hum and Noise	40dB (12.5KHz)
Audio Distortion	Less than 3%
Audio Characteristics	+1, -3dB from 6dB per octave pre-emphasis Characteristic
	from 300 ~ 3000Hz
Output Impedance	50 ohms

3.0 Overview

The SD-670 Series modems are digital RF modems that support data and voice communication. Digital uses AMBE3000 vocoder chip with AMBE+2 voice compression algorithm for excellent voice quality. The SD-670 series uses serial interface, are operable with AT commands, and can be applied to work in various fields.

3.1 Functions

- RF Communication Data Speed: 9,600bps
- Serial Interface support (AT Command): 115,200 bps / 9,600bps (Select DIP Switch)
- Frequency band: 1) SD671: 150MHz ~ 174MHz
  2) SD674: 410MHz ~ 470MHz

3.2 External Interface

Picture 3-2) Main Pin Specification

3.3 D-SUB 15-Pin Connector Specification

Pin NO	Pin Name	Pin Description	I/O
1	Not used		
2	Not used		
3	PTT	Low Active	I
4	DC12V	DC+12V	I
5	CTS		I
6	Carrier Detect		O
7	MIC_IN	30mV @ 2KHz Dev	I
8	FLASH_PRO		I
9	SPEAKER_OUT	300mV @ 1KHz dEV	O
10	RX_DATA	3.3V TTL	I
11	TX_DATA	3.3V TTL	O
12	RTS		O
13	GPS_TX_DATA	3.3V TTL	O
14	Ground	Ground	
15	GPS_RX_DATA	3.3V TTL	I

3.4 SD-670D/670DE Drawing

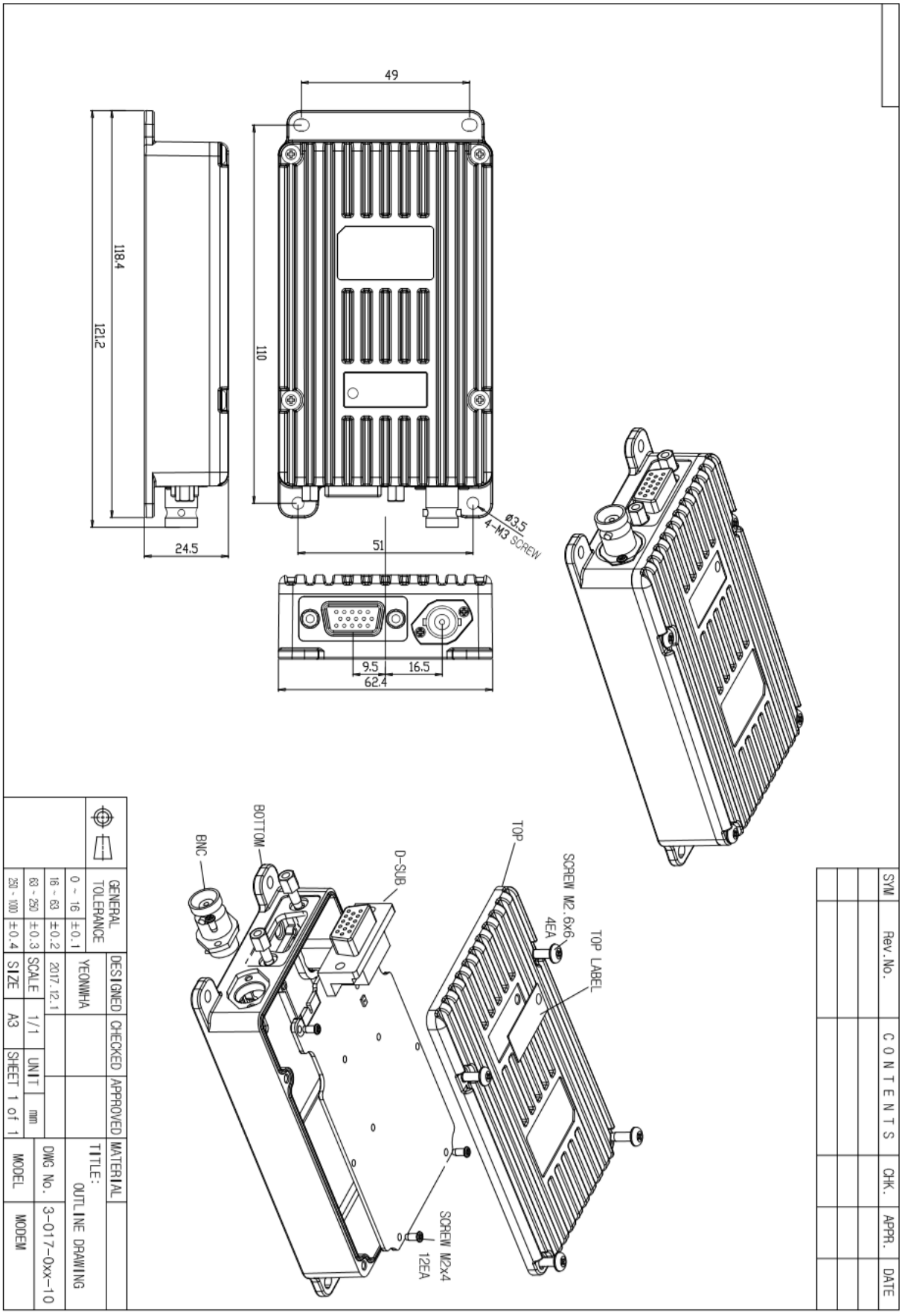
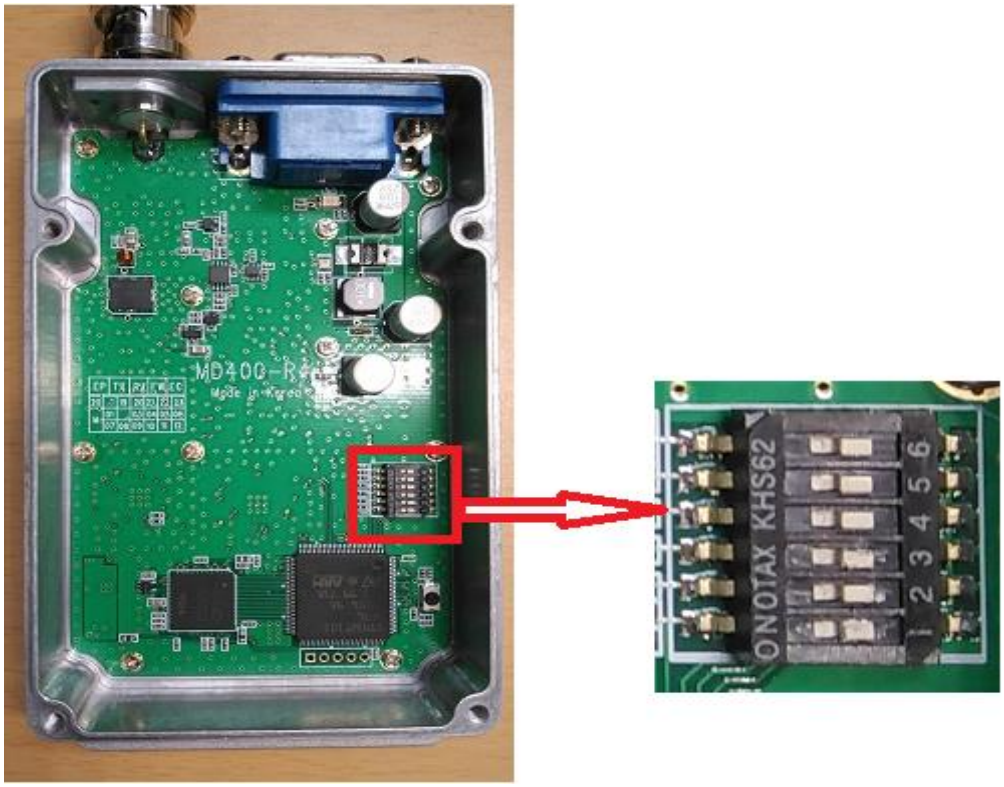


Figure 3-4) SD-670D/670DE Drawing

4. How to set the DIP Switches

4.1. Dip switch setting



Picture 4-1) Dip Switch Baud Rate Setting and Channel Setting

4.2 Baud Rate Setting

The modem's baud rate can be changed by switch No.6

DIP Switch	Baud Rate
	115,200bps
	9600bps

Picture 4-2) DIP Switch Baud Rate Setting

4.3 Channel Setting

There are two ways to set the channel: DIP switch and AT command.

1. DIP switch channel setting method can be set by using DIP switches 1, 2, 3, 4, and 5.

2. Table below shows how to set all 32 channels.

3. AT Command channel setting has the following rules for the priority of the two methods. When the power is turned on, the SD-670D operates as follows.
   1) The channel is set according to the DIP switch when booting.
   2) When changing channel with AT Command, DIP Switch will be ignored and return to DIP Switch setting through AT Command (AT * DIP = 1).

DIP Switch Meaning

1st DIP Switch: 5th digit in binary
2nd DIP Switch:4th digit in binary
3rd DIP Switch: 3rd digit in binary
4th DIP Switch: 2nd digit in binary
5th DIP Switch: 1st digit in binary

Below is the channel table according to DIP Switch status.

DIP Switch	Binary	Channel Value
	00000	1
	00001	2
	00010	3
	00011	4
	00100	5
	00101	6
	00110	7
	00111	8
	01000	9
	01001	10

	01010	11
	01011	12
	01100	13
	01101	14
	01110	15
	01111	16
	10000	17
	10001	18
	10010	19
	10011	20
	10100	21
	10101	22
	10110	23
	10111	24
	11000	25
	11001	26
	11010	27
	11011	28

	11100	29
	11101	30
	11110	31
	11111	32

Picture 4-3) DIP Switch Channel Setting

5. SD-670 Operation Mode

Supports 3 modes: 1) AT Command mode 2) Continuous mode for keyboard input 3) or File Transfer using Tera Term.

1) AT Command mode

2) 3 Wires continuous mode (Operates in 3 Wire Mode (TXD, RXD, GND)).

3) 5 Wires continuous mode (used for many data transmissions). Supports H / W flow control using TXD, RXD, CTS, RTS, GND.

When the SD-670 data modem is booted for the first time, AT Command mode is set.

To change from AT Command mode to Continuous mode, use AT Commands as shown below.

Description	SD-671/674 Operation Mode Setting
Query Answer	AT*CMODE ? “CMODE: OFF “CMODE OK”
Parameters	3WIRES 5WIRES OFF
Example	AT*CMODE=3WIRES AT*CMODE=5WIRES AT*CMODE= OFF Select the required mode from above

6. AT Command interface

Set the modem status or use AT Commands for function operation. Serial speed is 115,200 bps.

6.1 VERSION

Description	**Command to check the modem version**
Query	AT*VERSION?
Answer	*VERSION:<value>
Parameters	
Example	AT*VERSION? *VERSION: Modem v1.0 OK

6.2 RESET

Description	**Command for reset the modem**
Query	AT*RESET?
Answer	RESET
Parameters	
Example	AT*RESET? RESET Going down terminal…

6.3 MSG

Description	**Command for sending a message**
Query	AT*MSG=<value>?
Answer	OK
Parameters	String
Example	AT*MSG=AA? OK

6.4 VOL

Description	Command for the checking or set the modem volume
Query	AT*VOL?
Answer	GET VOLUME(<value>)=(<value>)

	AT*VOL=<value> SET VOLUME(<value>)=(<value>)
Parameters	1 ~ 16
Example	AT*VOL? GET VOLUME(15)=(150) AT*VOL=5 SET VOLUME(5)=(47)

6.5 OID

OWN ID setting is available through programming software; It can only be “checked” via AT Command.

Description	**Command for checking OWN ID**
Query Answer	AT*OID? OID:00000001 OK
Parameters	
Example	AT*OID? OID:00000001 OK

6.6 CHKSTAT

Description	**Status check command**
Query Answer	AT*CHKSTAT? *CHKSTAT:STAT OK OK
Parameters	
Example	AT*CHKSTAT? *CHKSTAT:STAT OK OK

6.7 DIP

Description	DIP switch is ignored when setting the channel with AT Command. If you want to change the channel using the DIP switch again, you can use this command to change the channel so that it can then be changed by DIP Switch operation.
Query Answer	AT*DIP? *DIP=<value> OK AT*DIP=<value> *DIP SET=<value> OK
Parameters	1: Channel setting using DIP Switch 0: Channel setting using AT Command
Example	AT*DIP? *DIP=1 OK AT*DIP=<value> *DIP SET=<value> OK

6.8 CID

Description	Call ID check and setting command Basically, it communicates with Call ID set in radio programmer. You can change the Call ID with this command, and when changing the channel, it will be reset to the Call ID set in the programmer.
Query Answer	AT*CID? CUR-CID:<call id>,CF:<call format> CID[<index>]:<call id>,CF:<call format> [repeat] CALLID OK AT*CID=1 SET CUR-CID:01 CID[01]:00000002,CF:GRP CALLID OK
Parameters	

Example	AT*CID? CID[00]:00000001,CF:GRP CID[01]:00000002,CF:GRP CID[02]:00000003,CF:GRP CID[03]:00000010,CF:GRP CID[04]:********,CF:ALL CALLID OK

6.9 CHSET

Description	Channel setting command (When this command is used, channel value changed by DIP Switch is ignored.)
Query Answer	AT*CHSET=<channel number> CH:<channel number>:<Channel type>,RX:<RX Frequency>,<RX CC>,TX:<TX Frequency>,<TX CC> OK
Parameters	
Example	AT*CHSET=1 CH:01:DMR,RX:41050000,01,TX:41050000,01 OK

6.10 CHLIST

Description	Show channel list command
Query Answer	AT*CHLIST? CUR-CHNUM:<Current channel number> <number>:<Channel type>,RX:<RX Frequency>,<RX CC>,TX:<TX Frequency>,<TX CC> [repeat] OK
Parameters	
Example	AT*CHLIST? CUR-CHNUM:04 00:DMR,RX:40550000,01,TX:40550000,01 01:DMR,RX:41050000,01,TX:41050000,01 02:DMR,RX:41550000,01,TX:41550000,01 03:DMR,RX:42050000,01,TX:42050000,01 04:DMR,RX:42550000,01,TX:42550000,01 OK

6.11 MINFO

Description	Current setting parameter display command
Query Answer	AT*MINFO? *MINFO:<channel index>,<Radio type>,RX:<RX Freq>,<CC>,TX:<TX Frequency>,<TX CC> OID:<Own ID>,CID[<Call ID index>:<Call ID>,CF:<Call format> OK
Parameters	
Example	AT*MINFO? *MINFO:04,DMR,RX:425500000,01,TX:425500000,01 OID:00000001,CID[00]:00000001,CF:GRP OK

6.12 PWRLEVEL (Power Level)

Description	Power Level Setting	Radio defaults at Low Power and can be changed with this command.
Query Answer	AT*PWRLEVEL? GET PWRLEVEL=<value> OK AT*PWRLEVEL=<value> SET PWRLEVEL=<value> OK	
Model Name	AT Command Parameters	RF Power
SD-671D	0: Low Power 2: Medium Power 1: High Power	2W 5W 10W
SD-674D	0: Low Power 1: High Power	2W 5W
Example	AT*PWRLEVEL? GET PWRLEVEL=0 OK AT*PWRLEVEL=1	

	SET PWRLEVEL=1 OK

5.13 TARGET

Description	Commands that specify where to send voice or data
Query **Answer**	AT*TARGET? CUR-TARGET:00000001, CF:GRP
Parameters	Contact format(1byte): 0[group], 1[individual], 2[ALL] ID(8byte)
Example	AT*TARGET=011111111 SET-TARGET:11111111,CF:GRP TARGET OK

5.14 Busy MODE

Description	Commands that specify how Carrier Detector # 6 operates
Query **Answer**	AT*BUSYMODE? Busy MODE: Match or Busy MODE: Carrier Detect
Parameters	0 [Match]: When ID and color code are matched and audio is opened, Carrier Detector pin outputs low 1 [Carrier Detect]: When the frequency is matched Carrier Detector pin outputs low.
Example	AT*BUSYMODE=1 Busy MODE: Carrier Detect Busy MODE OK

5.14 Continuous MODE

Description	Commands that specify how data is transmitted
Query **Answer**	AT*CMODE? CMODE : OFF or CMODE : 3wires or CMODE : 5wires
Parameters	"OFF": AT Command Mode "3WIRES": Continuous without HW flow control "5WIRES": Continuous with HW flow control
Example	AT*CMODE=3WIRES CMODE: 3wires

	CMODE OK

The SD-670 series supports continuous mode for keyboard input or file transfer using Tera Term in addition to the existing AT CMD mode.

The SD-670 series modem has the following three operation modes.

1) AT CMD mode

2) 3wires continuous mode

- HW flow control using CTS and RTS is not supported.

3) 5wires continuous mode

- HW flow control using CTS and RTS is supported.

The modem is AT CMD mode when it is booted at the first time.

To change from AT CMD mode to continuous mode, use AT CMD below.

1. AT * CMODE = 3WIRES (enter)

- changed to 3wires continuous mode

If the command is entered correctly, "CMODE: 3wires", "CMODE OK" will display.

2. AT * CMODE = 5WIRES (enter)

- changed to 5wires continuous mode

If the command is entered correctly, "CMODE: 5wires", "CMODE OK" will display.

To change from continuous mode to AT CMD mode, use AT CMD below.

1. AT * CMODE = OFF (enter)

- Change to AT CMD mode

If the command is entered correctly "CMODE: OFF", "CMODE OK" will display.

1. AT Command Data Configuration

AT*MSG=	ASCII Data (80 byte)	0D0A

2. Send text documents using Tera Term wirelessly

1) RS-232C Serial Buffer of SD-670 has a total of 10 Kbytes.

Each buffer stores 80 bytes of data.

2) Serial transmission Timer transmits maximum 80 bytes after 120msec received buffer check.

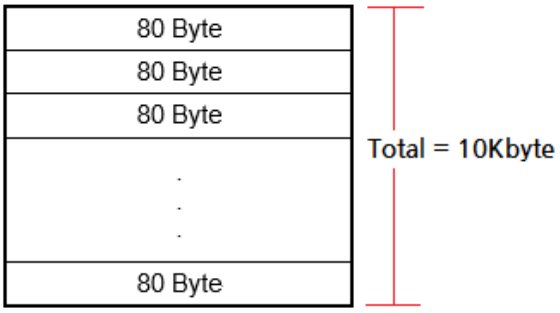
- To improve performance, the Serial Transfer Timer can be reduced by 120msec, and the amount of data transferred can be increased or decreased.

- Currently, the amount of data transferred is fixed at 80 bytes.

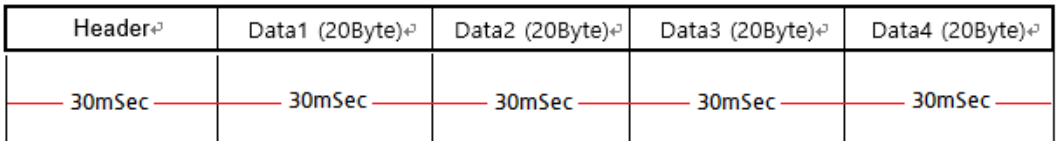
3) It is suggested to use a program like Tera Term to input characters on the keyboard, so it will be sent immediately upon input.

4) You can also transfer files using Tera Term.

SD-670D Serial Buffer Architecture

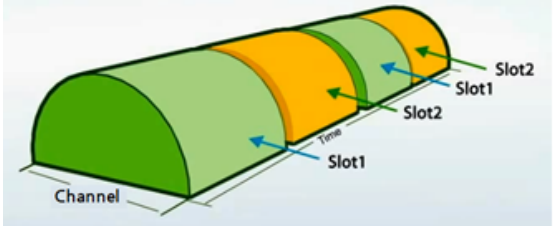


2) AIR data transfer structure



Since the DMR Data Modem operates in 2: 1 mode, the actual transmission is as follows.

2:1 TDMA: There are two slots (slot1, slot2(30m/s) in a single channel so it operates as the below picture.



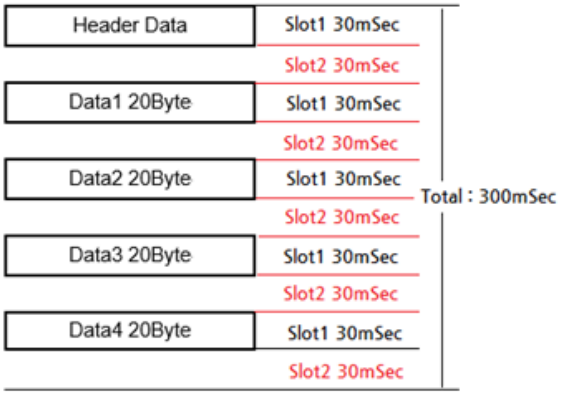
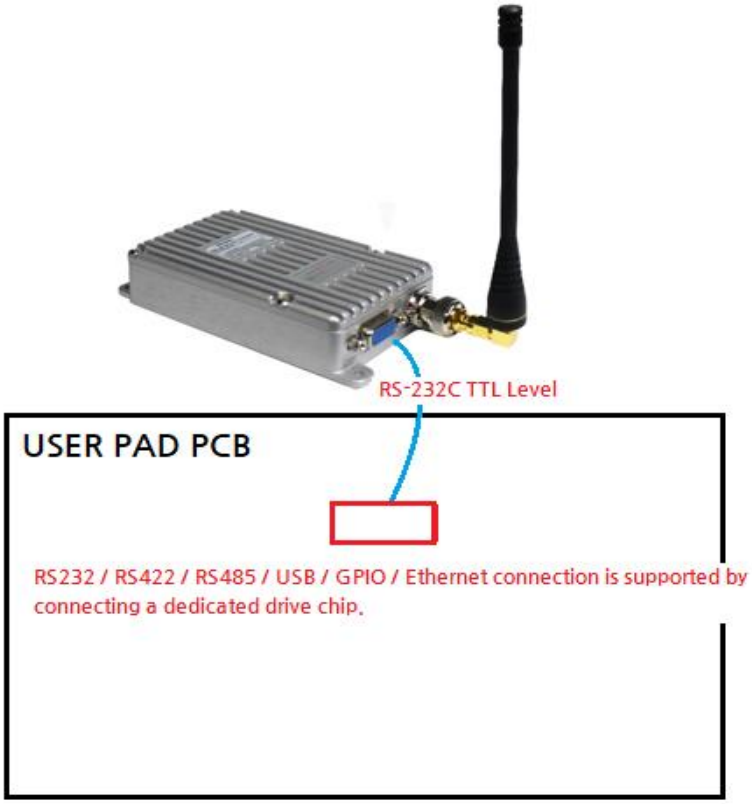


Figure 2: 1 TDMA structure

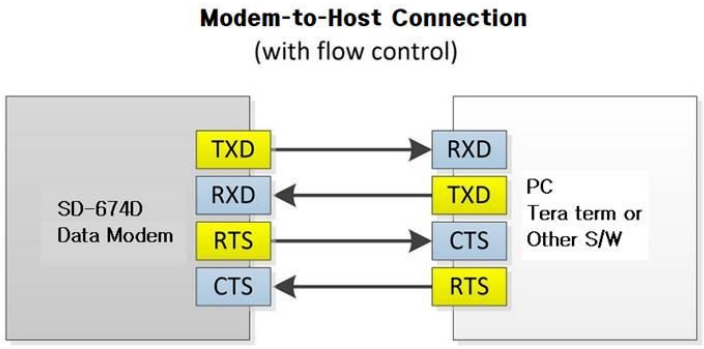
3. How to use RS232 / RS422 / RS485 / USB / GPIO / Ethernet connection



4. When to use CTS and RTS for the cable.

1) The serial buffer of SD-670 is 10Kbytes. If you want to transfer a lot of data (when the amount of data exceeds 10Kbytes), you should use 5-wire serial communication method as below.

Because the RS232 Speed is 115.200bps and the transmission speed of the wireless section is slower at 9,600bps, memory management must be done in the serial buffer.



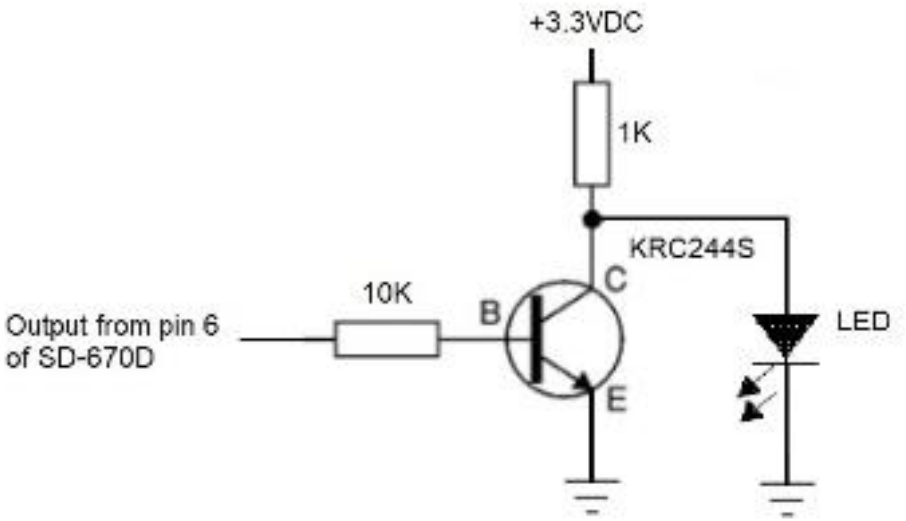
When RTS is "LOW" (when the SD-670 modem's serial buffer has space): The PC or external device sends normal serial data to the modem.

When RTS is "High" (when the serial buffer of the SD-670 modem is full): it stops sending serial data to the external device.

When CTS is "LOW", data received by modem is transmitted to PC or external device. If it is HIGH, data is not transmitted to PC or external device.

5. Diagram of external circuit made to display the status of Carrier Detect.

During receive pin 6 goes low, illuminating the LED.



Appendix for additional AT Commands

8.1 Encryption Enable *(For SD-670DE or SD-670D w/encryption factory option)*

Description	Command to check or set the Encryption status of current channel
Status Setting	AT*ENCENABLE=X <Value : X> 0 : Disable 1 : Enable
Status Check	AT*ENCENABLE?

Example	AT*ENCENABLE=1 => ENC Enable OK // ENC Enable Error AT*ENCENABLE? => CH:00 DMR ENC Enable:X, ENC Index:N

8.2 Encryption Index *(For SD-670DE or SD-670D w/encryption factory option)*

Description	Command to check or set the Encryption Index of current channel
Status Setting	AT*ENCINDEX=N <Value : N> N : Index Range (0 ~ (end -1))=> (The number of Encryption tables set in the radio - 1)
Status Check	AT*ENCINDEX?
Example	AT*ENCINDEX=0 => ENC Index OK // ENC Index Error AT*ENCINDEX? => CH:00 DMR ENC Enable:X, ENC Index:N

FCC RF EXPOSURE COMPLIANCE REQUIREMENTS FOR OCCUPATIONAL USE ONLY

The Federal Communications Commission (FCC), with its action in General Docket 93-62, November 7, 1997, has adopted a safety standard for human exposure to Radio Frequency (RF) electromagnetic energy emitted by FCC regulated equipment. Proper operation of this radio will result in user exposure far below the Occupational Safety and Health Act (OSHA) and Federal Communications Commission limits.

DO NOT transmit for more than 50% of total radio use time (50% duty cycle). Transmitting more than 50% of the time can cause FCC RF exposure compliance requirements to be exceeded.

•This radio is NOT approved for use by the general population in an uncontrolled environment. This radio is restricted to occupational use, work related operations only where radio operator must have the knowledge to control the user's exposure conditions for satisfying the higher exposure limit allowed for occupational use.
•The radio is transmitting when the LED on the cover of the radio is illuminated.
•These are required operating configurations for meeting FCC RF exposure compliance. You will be in violation if you fail to observe these restrictions.

This device complies with part 15, 90 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.