Harman Kardon AVR Series Receivers
RS-232 Port Instructions
# And Code Listing

1.0 Applicable Products

This document contains the technical information needed to connect Harman Kardon AVR series receivers equipped with bi-direction RS-232 control capability to a computer or other compatible specialized control devices with RS-232 communications capability for control and feedback of the receiver. The current Harman Kardon products with this capability are the AVR 635, AVR 630, AVR 435 and AVR 430.

The remote codes listed in this document may be used to control any Harman Kardon AVR or DPR model product equipped with and RS-232 port, but only the models listed above allow for two-way communication. All other products are one-way only.

2.0 Control Capabilities

Applicable Harman Kardon's AVR products listed above are designed for operation in conjunction with remote keypad, computer or other control devices capable of sending compatible hexadecimal data through an RS-232 connection. The commands issued by the computer or control system will mimic the operation of the standard remote control, and the AVR will respond accordingly. This document describes the connections between the devices and their interaction.

The control data is sent from the PC or control device to the AVR using commands issued using either a PC Keyboard or Mouse or a touch screen controller and data from the AVR with its status may be displayed on the PC or interpreted for touch screen display.

PC	AVR Control Data by PC Keyboard or Mouse →	AVR
	← Data for AVR Status Display	
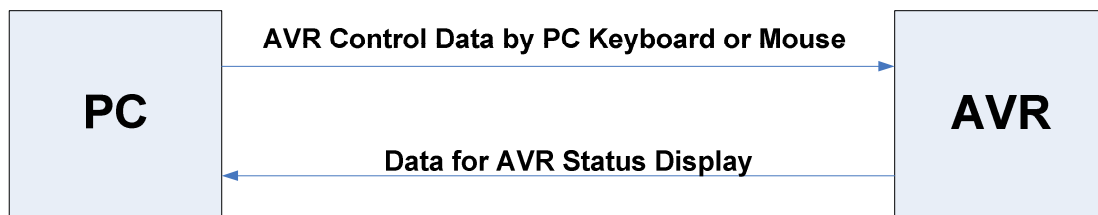
3.0 Connections and Settings

3.1 Connections

The connection between the computer and the AVR is via a two-wire connection using standard DB-9 connections.

The connections should be made directly ("straight through") from pin 3 (TxD) to pin 3, and from pin 5 (GND) to pin 5. No other connections are needed, although a standard serial connection cable with all pins connected may be used.

IMORTANT NOTE: It is essential that a standard "straight through" connection cable be used. DO NOT use a "null modem" cable. Since the AVR cross over the pin connections internally, the use of null modem cable will render RS-232 control system inoperable.

3.2 RS-232 Settings

The following settings should be made on PC or control device:

Baud Rate: 38,400 bps
Data Bits: 8
Parity: No
Stop Bit: 1
Flow Control: No (off)
Command Acceptance Time: 50 ms

4.0 Data Communication Format

4.1. Transmission

Transmission	Data Type	Length	Information Field	Check Sum

Transmission recognition code is 6 bytes long ASCII code and it is used to make a distinction between AVR Control Data being sent from PC to AVR or AVR status Data coming from AVR to be displayed on PC. Following codes are used for this purpose:

"PCSEND"(ASCII) AVR Control Data (PC to AVR) using PC Keyboard or Mouse
"MPSEND"(ASCII) Data for AVR Status Display on PC (AVR to PC)

4.2 Data Type

| Transmission | Data Type | Length | Information Field | Check Sum |

Data Type field is a one byte long and distinguishes between different types of data being used in protocol as explained in the following table:

Purpose	Direction	Value
DSP UPGRADE	PC → AVR	1
PC Remote Controller	PC → AVR	2
CPU UPGRADE	PC → AVR	4
Send Data from AVR	AVR → PC	3

4.3 Data Length

| Transmission | Data Type | Length | Information Field | Check Sum |

Length field is one byte long and represents length of information field. As information field is variable depending on direction of data transfer, this field is necessary. Length field value will be 4 if Remote Control through PC to AVR is used and the value will be 48 if AVR status display on PC is desired.

4.4 Information Field

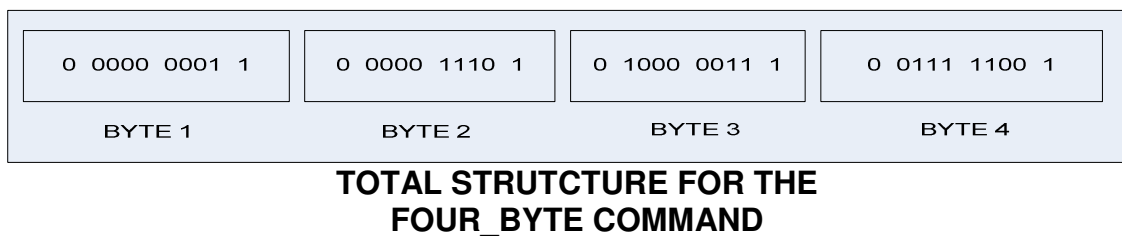| Transmission | Data Type | Length | Information Field | Check Sum |

Information field is hex code data of either four-byte command from PC to AVR or 48-byte hex code for AVR status display on PC. We explain both of them in detail in the following sections:

4.4.1 Information Field Command Sequences

4.4.1.1 Command Transmission Sequence from PC to AVR

Each command consists of a four-byte hex code from the table at the end of this document. To send a command, first find the hex code listed in the chart for the specific function. Convert each byte to binary, and then precede each byte with a start bit (0) and follow it with a stop bit (1). Make certain that the time for the transmission of all four bytes does not exceed 50 ms; the AVR will interpret a time gap greater than 50 ms as the start of a new command.

For example, to send the "80, 70, C1, 3E" hex code sequence to issue a "Mute" command, the sequence would be as follows, including the start and stop bit after each hex code:

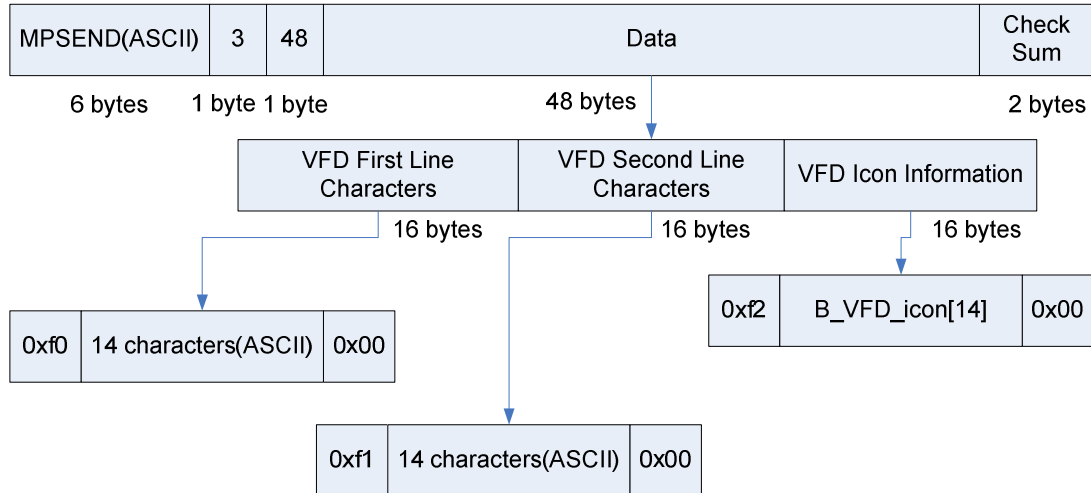| 0 0000 0001 1	0 0000 1110 1	0 1000 0011 1	0 0111 1100 1
BYTE 1	BYTE 2	BYTE 3	BYTE 4

**TOTAL STRUTCTURE FOR THE
FOUR_BYTE COMMAND**

When building a sequence with multiple commands, remember to insert a sufficient time delay so that the total time from the start of one four-byte command to the start of next four byte command is at least 50 ms.

The protocol for code transmission does not allow for "repeat" or continuous code. Thus, for commands (such as "Volume") for which the button would be held down when using the actual remote, the specific command (e. g., "Volume Up" or "Volume Down") must be sent individually as many times as necessary to achieve the desired effect.

The commands being sent through the RS-232 link are direct mirror images of the commands and command sequences that would be used if you were pressing the remote control buttons. In cases where a main command is issued first, followed by up/down or left/right navigation to select a choice, you will need to use the specific directional command codes for the command in use. The up/down and left/right navigation commands are NOT universal for RS-232 link; it is crucial that you use the correct navigation command control.

4.4.4.1 Data Sequence from AVR to PC

The following diagram shows the detail of data being sent from AVR to PC to show status to be displayed:

MPSEND(ASCII)	3	48	Data	Check Sum
6 bytes	1 byte	1 byte	48 bytes	2 bytes

VFD First Line Characters	VFD Second Line Characters	VFD Icon Information
16 bytes	16 bytes	16 bytes

0xf0	14 characters(ASCII)	0x00

0xf1	14 characters(ASCII)	0x00

0xf2	B_VFD_icon[14]	0x00

4.5: Check Sums

Transmission	Data Type	Length	Information Field	Check Sum

Check sum is calculated by splitting the data into even bytes and odd bytes and calculating two checksum bytes using them. Check sum high byte is calculated by Xor sum of even bytes while check sum low byte is calculated by Xor sum of odd bytes.

$$Data[0]\wedge Data[2]\wedge.....Data[2n]= Check\ Sum[0] \leftarrow high\ byte$$
$$Data[1]\wedge Data[3]\wedge.....Data[2n-1]= Check\ Sum[1] \leftarrow low\ byte$$

5.0 Constructing Command Sequences

To construct command set sequences for RS-232 control, you must create a structure that duplicates the button that you would push on remote control to issue the desired command.

Some commands require multiple button presses, regardless of whether the command is being sent from remote, or via RS-232 link. You should make sure that all needed commands for desired functionality is included and the spacing between each commands is at least 50 ms.

The command structure for RS-232 link does not accommodate "repeat" commands. These must be issued by duplicating commands as many times as needed.

In constructing commands for Surround Select, Multi-room, Speaker Configuration, Digital Input and Delay, the direct access setup controls for these options require that you should first send the code that accesses the control sequence. To adjust the settings or scroll through the menus, you must then issue the specific "Up" or "Down" commands that are associated with the item being controlled.

For example, when changing the surround mode using the Dolby, DTS Surround, DTS Neo:6, Logic 7 or Stereo commands, note that first command selects the mode and the next command should select the mode choices.

6.0 Procedures for Switching AVR and PC Modes

In case of AVR Normal Mode and PC Remote Control (REMOCON), normal protocol procedures as mentioned already will be applied. The following sections explain the other switching modes.

6.1 Switching from PC REMOCON Mode to PC CPU Writing Mode

Step 1: User selects CPU button at the screen box of PC REMOCON. As a result, PC sends the following command:

Command: "PCSEND" + 0x04 + 0x02 + 0x00 + 0x00 + 0x00 + 0x00
Response: No response comes from AVR

Step 2: After receiving the command from step 1, AVR will switch from normal mode to AVR CPU writing mode and will stop sending its status information.

Step 3: User clicks the open button at the screen box of PC CPU Writing. User selects and loads CPU HEX DATA (This HEX file has Intel-HEX format) using explorer box.

Step 4: User clicks the Start button at the screen box of PC CPU Writing. This step creates the following protocol behind the scene:

a) **Check Connection** – Following command is used to check connection:

   Command: 0x08 + Sync Data (0x00) X 16 + CRC (2bytes)
   Response: 0x08 + CRC (2bytes)

   Check CRC to make sure the message reached correctly. We have already discussed CRC calculation method.

b) **Erase Earlier Settings –** Unless response is OK, continue to send this command:
   Command: 0x01 + CRC (2bytes)
   Response: if OK, 0x01 + CRC (2bytes)
              if Error, 0x0e + CRC (2bytes)
c) **Program CPU -**   Follow sending the required command, the command is sent
             again till correct response is received:
              Command: 0x03 + address (3bytes: Low, Mid, High byte in order) +
          Hex Data   (256byte) + CRC (2bytes)
              Response: 0x03 + address (3bytes) + CRC (2bytes)
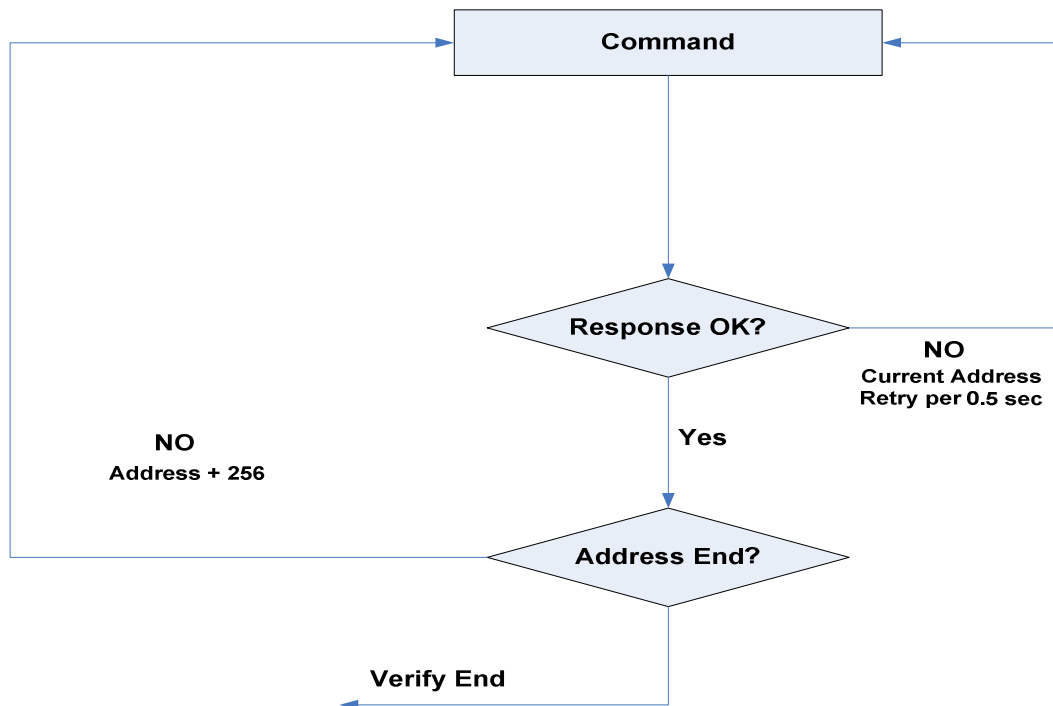
Program Control Flow is as follows:
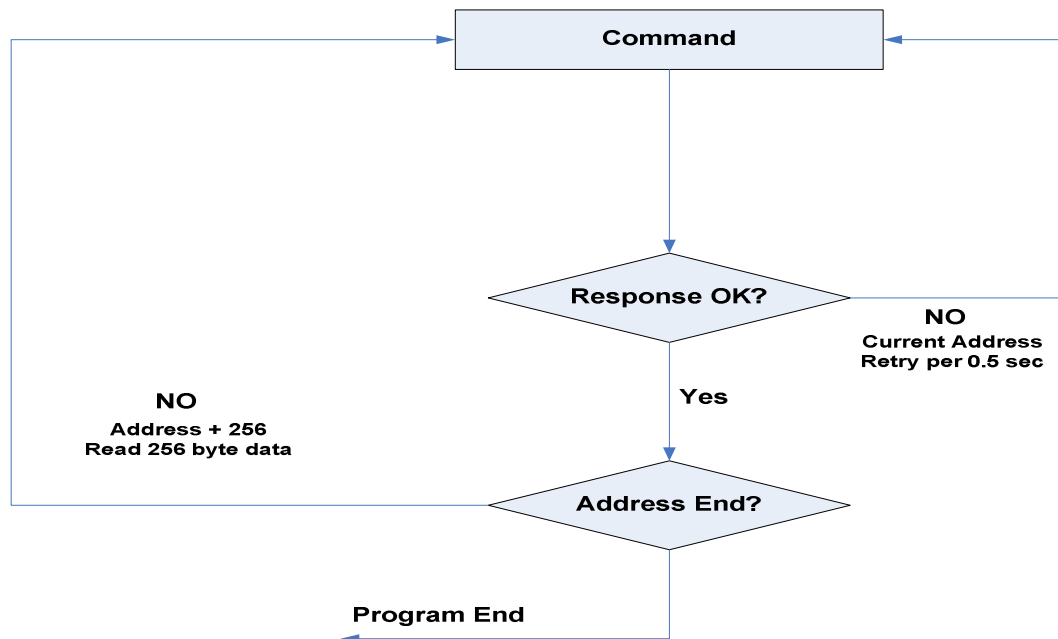
(d) **Verify** that program stored in CPU - Follow sending the required command, the command is sent again till correct response is received:

Command: 0x04 + address (3bytes: Low, Mid, High byte in sequence) + CRC (2 bytes)
Response: 0x04 + address (3bytes) + Hex Data (256) + CRC (2bytes)

Verify Control Flow is as follows:

```
                    ┌──────────────────┐
          ┌────────▶│     Command      │◀────────┐
          │         └──────────────────┘         │
          │                  │                    │
          │                  ▼                    │
          │           ╱────────────╲              │
          │          ╱  Response OK? ╲─────────────┘
          │          ╲              ╱    NO
          │           ╲────────────╱     Current Address
          │                  │           Retry per 0.5 sec
     NO   │                 Yes
 Address + 256               │
          │           ╱────────────╲
          └───────────╲  Address End? ╱
                       ╲              ╱
                        ╲────────────╱
                              │
                         Verify End
                              │
                              ◀─────────
```

(e) **End** CPU Writing/Work End – Following command and response are used:

Command: 0x06 + CRC (2 bytes)
Response: 0x06 + CRC (2 bytes)

(f) **CutOff** – Following command and response are used:

Command: 0x07 + CRC (2 bytes)
Response: 0x07 + CRC (2 bytes)

Step 5: User switches from AVR CPU writing Mode to AVR Normal Mode. User turns the power off and then turns power on again for this purpose.

Step 6: User switches from PC CPU Writing mode to PC REMOCON mode by clicking REMOTE button at the screen box of PC CPU Writing.

7.0 Code Tables

The following table shows four-byte hex codes to be used for Remote Control of applicable products via the RS-232 port. Note that some features are not available on certain models.

	Information Field			
COMMAND -> AVR	1st	2nd	3rd	4th
POWER ON	80	70	C0	3F
POWER OFF	80	70	9F	60
MUTE	80	70	C1	3E
AVR	82	72	35	CA
DVD	80	70	D0	2F
CD	80	70	C4	3B
TAPE	80	70	CC	33
VID1	80	70	CA	35
VID2	80	70	CB	34
VID3	80	70	CE	31
VID4	80	70	D1	2E
VID5	80	70	F0	0F
AM/FM	80	70	81	7E
6CH/8CH	82	72	DB	24
SLEEP	80	70	DB	24
SURR	82	72	58	A7
DOLBY	82	72	50	AF
DTS	82	72	A0	5F
DTS NEO:6	82	72	A1	5E
LOGIC7	82	72	A2	5D
STEREO	82	72	9B	64
TEST TONE	82	72	8C	73
NIGHT	82	72	96	69
1	80	70	87	78
2	80	70	88	77
3	80	70	89	76
4	80	70	8A	75
5	80	70	8B	74
6	80	70	8C	73
7	80	70	8D	72
8	80	70	8E	71

9	80	70	9D	62
0	80	70	9E	61
TUNE UP	80	70	84	7B
TUNE DOWN	80	70	85	7A
VOL UP	80	70	C7	38
VOL DOWN	80	70	C8	37
PRESET UP	82	72	D0	2F
PRESET DOWN	82	72	D1	2E
DIGITAL	82	72	54	AB
DIGITAL UP	82	72	57	A8
DIGITAL DOWN	82	72	56	A9
FMMODE	80	70	93	6C
DELAY	82	72	52	AD
DELAY UP	82	72	8A	75
DELAY DOWN	82	72	8B	74
COM SET	82	72	84	7B
COM UP	82	72	99	66
COM DOWN	82	72	9A	65
SPEAKER	82	72	53	AC
SPEAKER UP	82	72	8E	71
SPEAKER DOWN	82	72	8F	70
CHANNEL	82	72	5D	A2
RDS	82	72	DD	22
DIRECT	80	70	9B	64
CLEAR	82	72	D9	26
MEMORY	80	70	86	79
MULTIROOM	82	72	DF	20
MULTIROOM UP	82	72	5E	A1
MULTIROOM DOWN	82	72	5F	A0
OSD	82	72	5C	A3
OSD LEFT	82	72	C1	3E
OSD RIGHT	82	72	C2	3D
SURR UP	82	72	85	7A
SURR DOWN	82	72	86	79
PRESCAN	80	70	96	69
DIMMER	80	70	DC	23
FAROUDJA	82	72	C6	39
TONE	82	72	C5	3A

8.0 Normal AVR Status Display Mode

Information Field Data Address	AVR MODE -> PC	Information Field Data Value
0	F0 (ID code)	1bytes
1-14	FL UPPER (14byte)	14bytes
15	Reserve	1bytes
16	F1 (ID code)	1bytes
17-30	FL Down (14byte)	14bytes
31	Reserve	1bytes
32	F2 (ID code)	1bytes
33-46	FL ICON (14byte)	14bytes
47	Reserve	1bytes