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Series 4700 Remote Interface Specification and Serial Protocol

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MODEL 4700/4710 REMOTE INTERFACE SPECIFICATION

The Model 4700 and Model 4710 Digitally Controlled Equalizers can be remotely controlled by a computer using either the Model 4702 RS-232 Remote Interface or the Model 4703 EIA-422 Remote Interface. These interfaces consist of factory-installed printed circuit cards. The only difference between these two interfaces is the physical electrical interface used. All protocols and commands are otherwise identical.

The control method used for the 4703 interface is compatible with the PA-422 Communications Interface now under consideration as an AES standard. The PA-422 is described by Bob Rodgers in a paper presented at the 87th Convention of the Audio Engineering Society (AES) in October 1989, and revised May 31, 1990, entitled, *Communicating with Professional Sound Products Using an RS-422 Serial Communications Interface and a Device Control Language*.

1. SERIAL PORT HARDWARE DESCRITPTION

1.1 SERIAL CONNECTOR PIN ASSIGNMENTS

Following are the pin assignments for the 9-pin "D" input connector on the 4702 and 4703 remote interfaces.

Pin	4702 (RS-232)	4703 (EIA-422)
1	Not used	**Data Set Ready (+)**
2	**Receive Data (RXD)**	**Data Set Ready (-)**
3	Transmit Data (TXD)	Signal Ground (GND)
4	Data Terminal Ready (DTR)	**Receive Data (+)**
5	Signal Ground (GND)	**Receive Data (-)**
6	**Data Set Ready (DSR)**	Data Terminal Ready (+)
7	Not used	Data Terminal Ready (-)
8	Not used	Transmit Data (+)
9	Not used	Transmit Data (-)

Note: Outputs are indicated by **bold** type above. 4702 connections are compatible with 9-pin serial ports on IBM type computers when using a straight-through wired cable. 4703 connections conform to the PA-422 standard. DTR and DSR are active low signals. Both TXD and RXD are high when idle, with 1's indicated by highs and 0's by lows. Physical signals are inverted by RS-232 drivers. In this document all level references are logical not physical.

1.2 SERIAL PORT PARAMETERS

The serial interface parameters must be set as follows:

Baud:	19.2k
Parity:	even
No. data bits:	8
No. stop bits:	1

1.3 HARDWARE HANDSHAKE REQUIREMENTS

For both the 4702 and 4703 interfaces, the hardware handshake requirements match those of the PA-422 standard. Namely, the DSR line is used by the slave unit to signal that it has detected its address on the bus. The DTR line is set by the master in acknowledgment of the DSR signal. Both lines are active low.2 DCL PROTOCOL

The **D**evice **C**ontrol **L**anguage (DCL) protocol is specified in the PA-422 standard. Typical operation is as follows:

1. Initially, the DSR output line from the device and the DTR output line from the computer are inactive (high).
2. The computer transmits an eight bit address code.
3. The device whose address matches that sent by the computer acknowledges the computer's call by activating its DSR output line.
4. The computer detects the DSR change at its DSR input and activates its DTR output line in response.

   Note: While the computer's DTR output is active, all devices not involved in the data transaction with the computer will ignore any communications on the bus.
5. The device detects the OTR change at its DTR input and returns two bytes of data to the computer. The first byte is its **D**evice **T**ype (DT) code. The second is its manufacturer's **I**dentification (ID) **C**ode.
6. After verifying validity of the DT and ID codes, the computer transmits its first command byte to the device
7. At this point, a data transfer typically occurs. The type and quantity of device-specific data is determined by the command.
8. Once the action is complete, the device returns a **com**munications **stat**us (COMSTAT) code, resets its DSR output, and resumes an idle state.
9. The computer system verifies that DSR has been reset. It then resets its DTR output and resumes an idle state, thus ending the data transaction. If the returned COMSTAT code indicates an error, the computer must .retransmit the entire command since the device will have ignored the one in error.
10. In the case of a system lock-up, a bus time-out period of typically 250 msec. is specified. If no bus activity occurs for this length of time when the computer is expecting activity, the computer should. reset itself to the idle state. If an equalizer detects a time-out it deactivates its DSR line, ceases processing of bus data and, when the computer deactivates its DTR line, resets to the idle state. In this case, COMSTAT may not be sent before deactivating the DSR line. If the computer sees the DSR line deactivate at an unexpected time, it can assume that the remote device has experienced a bus time-out.

3. COMMAND SET

3.l DCL Protocol Commands

The following commands recognized by the 4702 and 4103 remote interfaces are PA-422 commands and follow the DCL protocol.

3.1.1 Get Device OPSTAT Code - (00 hex)

This command allows the system controller to check the operational status of any device online. Presently, only 00 hex is defined, meaning that the device is operating properly. To read the OPSTAT Code, the controller must do the following:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 00 hex
7. Get OPSTAT code
8. Get CONSTAT (should be 00 hex if successful)
9. Check that DSR is reset
10. Reset DTR

3.1.2 Recall all Data from Device - (01 hex)

This command recalls all device settings from the device channel and memory specified. The data is received in the following byte order- See appendices B and C .for more details.

The Model 4700 presents data in the following order:

BYTE	DATA
1	31.5Hz bandpass filter setting
2 - 27	Bandpass filters between 31.5Hz and 16kHz settings
28	16 kHz bandpass filter setting
29	High- and low-pass filter settings
30	Gain setting
31	EQ IN/OUT status
32	Preset 10's memory assignment
33 - 40	Presets between 10 and 1's memory assignment
41	Preset 1's memory assignment.
42	Firmware version byte #1 (ASCII)
43	Firmware version byte #2 (ASCII)
44	Firmware version byte #3 (ASCII)
45	Firmware version byte #4 (ASCII)

The Model 4710 presents data in this order:

BYTE	DATA
1	25Hz bandpass filter setting
2 - 55	Bandpass filters between 25Hz and 16kHz settings
56	16 kHz bandpass filter setting
51	High- and low-pass filter settings
58	Gain setting
59	EQ IN/OUT status
60	Firmware version byte #1 (ASCII)
61	Firmware version byte #2 (ASCII)
62	Firmware version byte #3 (ASCII)
63	Firmware version byte #4 (ASCII)

To recall this data from the device, the controller must:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Set DT code
5. Get ID code
6. Transmit command 01 hex
7. Transmit CHNUM (ignored by Model 4710)
8. Transmit MEMNUN
9. Get all device-specific data (see above)
10. Get MPTR value
11. Get COMSTAT code (should be 00 hex if successful)
12. Check that DSR is reset
13. Reset DTR

3.1.3 Get Device-type and Company ID Codes - (02 hex)

This command allows the system controller to determine an addressed device's type and manufacturer. No data is sent to the device. The controller must do the following:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 02 hex
7. Get COMSTAT code (should be 00 hex if successful)
8. Check that DSR is reset
9. Reset DTR

3.1.4 Transmit All Data to Device – (01 hex)

This command sends all device-specific data to a specific channel and memory of the addressed device. Note that in both the 4700 and 4710, the EQ IN/OUT status immediately affects the current condition of the equalizer and is not stored in memory.

The Model 4700 receives data in the following byte order:

BYTE	DATA
1	31.5Hz bandpass filter setting
28	16kHz bandpass filter setting
29	High- and low-pass filter settings
30	Gain setting
31	EQ IN/OUT status

The Model 4710 receives data in this byte order:

BYTE	DATA
1	25Hz bandpass filter setting
56	16kHz bandpass filter setting
57	High- and low-pass filter settings
58	Gain setting
59	EQ IN/OUT status

To send this data, the controller must:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 81 hex
7. Transmit CHNUM (ignored by Model 4710)
8. Transmit NEMNUM
9. Transmit all device-specific data (see above)
10. Transmit MPTR value
11. Get COMSTAT code (should be 00 hex if successful)
12. Check that DSR is reset
13. Reset DTR

3.1.5 Reprogram Device from Device Memory - (82 hex)

This command resets the specified device channel with settings previously stored in one of its memory locations. To execute this command, the controller must:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 82 hex
7. Transmit CHNUM (ignored by Model 4710)
8. Transmit MEMNUM
9. Get COMSTAT code (should be 00 hex if successful)
10. Check that DSR is reset
11. Reset DTR

3.1.6 Transmit New Pointer to Device – (83 hex)

This command sends a new memory pointer value to the specified channel of the addressed device. This pointer is set to the memory number which is to be recalled to the specified channel when the Group Execute Command (see below) is received. If set to zero, no active settings will he affected by the Group Execute Command. To execute:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 83 hex
7. Transmit CHNUM (ignored by Model 4710)
8. Transmit MPTR
9. Get COMSTAT code (should be 00 hex if successful)
10. Check that DSR is reset
11. Reset DTR

3.1.7 Reprogram Device from Device Pointer - (84 hex)

If the pointer is enabled (pointer value > 00 hex), the device will reprogram its specified channel with the settings stored in the memory location pointed to by its memory pointer. The controller must:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get ID code
6. Transmit command 84 hex
7. Transmit CHNUM (ignored by Model 4710)
8. Get COMSTAT code (should be 00 hex if successful)
9. Check that DSR is reset
10. Reset DTR

3.1.8 Lock Device - (85 hex) (Model 4710 only)

This command disallows further changes via the PA-422 interface to the programmable settings of the specified device. Attempts to write to any user memory or memory pointer will cause the device to return a 03 hex ("Device Locked") COMSTAT code. However, if the memory pointer is active, the channel can be updated with the Group Execute or Reprogram Device Channel from Pointer commands. Note that the actions of the unit's front panel controls are not affected by this command.

If the device is locked when the power is removed, it will power-up in a locked state. To lock a device:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT
5. Get ID
6. Transmit 85 hex
7. Get COMSTAT (should be 00 hex if successful)
8. Check that DSR is reset
9. Reset DTR

The 03 hex ("Device locked") COMSTAT code will be returned after any attempt to lock or otherwise change programmed settings of an already locked device.

3.1.9 Unlock Device - (86 hex) (Model 47lO only]

This command unlocks the specified device thus allowing changes to its programmable settings via the PA-422 interface. To unlock a device:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT
5. Get ID
6. Transmit 86 hex
7. Get COMSTAT (should be 00 hex if successful)
8. Reset DTR
9. Check that DSR is reset

The 04 hex ("Device not locked") COMSTAT code will be returned after any attempt to unlock an already unlocked device.

3.1.10 Mute All Device Outputs - (89 hex) (Model 47l0 only)

This command causes the addressed device to mute its output. To execute:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT
5. Get ID
6. Transmit 89 hex
7. Get COMSTAT (should be 00 hex if successful)
8. Check that DSR is reset
9. Reset DTR

The 05 hex ("Channel Muted") COMSTAT code is returned after any attempt to mute an already muted output.

3.1.11 Unmute All Device Outputs - (8A hex) (Model 4710 only)

This command causes the addressed device to unmute its output. To execute:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT
5. Get ID
6. Transmit 8A hex
7. Get COMSTAT (should be 00 hex if successful)
8. Check that DSR is reset
9. Reset DTR

The 06 hex ("Channel not muted") COMSTAT code is returned after any attempt to unmute an already restored output.

3.2 Additional Commands

The following commands unique to White Instruments' products, are included in addition to the standard PA-422 commands just listed.

3.2.1 Set Local Address - (19 hex)

This command changes the address of the specified device and enables its output bus driver going to the next device in the chain. The controller must:

1. Transmit current ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT code
5. Get. ID code
6. Transmit command 19 hex
7. Transmit new ADDR
8. Get COMSTAT code (should be 00 hex if successful)
9. Check that DSR is reset
10. Reset DTR

3.2.2 Assign Memory to Preset - (1A hex) (Model 4700 only)

This command assigns a memory number to a Preset in the specified channel of the addressed device. This is similar to the MPTR function except that there are 10 Presets and memory 0 cannot be assigned to a Preset. Since, in the Model 4710, Presets are not implemented, this command will not cause any action to occur if sent there. To assign a Preset, the controller must:

1. Transmit ADDR
2. Check that DSR is set
3. Set DTR
4. Get DT Cole
5. Get ID code
6. Transmit command 1A hex
7. Transmit Preset number (0-9)
8. Transmit CHNUM (ignored by Model 4710)
9. Transmit MEMNUM assignment (1-10 decimal)
10. Get COMSTAT code (should be 00 hex if successful)
11. Check that DSR is reset
12. Reset DTR

3.3 BROADCAST COMMANDS

In addition to the commands listed above, three special commands are defined. These commands are special in that they do not follow the DCL protocol as do those commands just described. These commands are actually special device addresses which have been defined to cause instantaneous execution of certain actions by all devices in, the system. Only the Group Execute Command is. included in the PA-422 specification. The others are unique to White Instruments at this time. These special commands are:

3.3.1 Group Execute Command - (addr=00 hex)

This command triggers all devices with active memory pointers to update their active settings from the memory pointed to by their pointer (MPTR). If the device has multiple channels, each channel will be updated from its own pointer. To execute this command:

1. Transmit ADDR=00 hex

3.3.2 Disconnect Command - (addr=F8 hex)

This command causes all White Instruments' devices currently online to disable their bus drivers going to the next device in the system and to set their local addresses to "1". Once this command is sent, only the first device in the string can receive commends from the controller. To execute this command:

1. Transmit ADDR=F8 hex

3.3.3 Recall Preset Command - (addr=F9 hex)

This command causes all White Instruments' devices in the system to update their active settings from their memory pointed to by their Preset location specified by the number following the command. This is similar to the MPTR function described above except that there can be up to 10 Presets assigned for each channel. In the Model 4700, Preset assignments can be programmed. In the Model 4710, Preset assignments are not programmable and are defined as being equal to the equivalent memory number (e.g. Preset 1 would recall Memory 1, Preset 2 would recall Memory 2, etc.). To execute this command, the controller must:

1. Transmit ADDR=F9 hex
2. Transmit the Preset number (0-9, corresponds to Presets 1-10)

3.3.4 Set Security Codes Command - (addr=FA hex)

This command sets the Security Code and Preset Access Code of each White Instruments' device in the system. These codes consist of values from 00 to 2B hex corresponding to the left to right order of characters chosen from the following character set (note the space character after the dash "-"):

- 0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZ,/# () &

Thus, 00 means "-", 04 means "2", etc. The Security Code is four characters long and the Preset Access Code two. Characters are sent in reverse order from that in which they appear on the device's LCD. To execute:

1. Transmit ADDR=FA hex
2. Transmit Security Code Character 04
3. Transmit Security Code Character 03
4. Transmit Security Code Character 02
5. Transmit Security Code Character 01
6. Transmit Preset Access Code Character 02
7. Transmit Preset Access Code Character 01

APPENDIX A - SUMMARY OF SYSTEM DEFINITIONS

DT (Device-type) Codes

00 hex = Dual channel 1/3rd octave equalizer (4700-2)
03 hex = Single channel 1/3rd octave equalizer (4700)
04 hex = Single channel 1/6th octave equalizer (4710)

ID (Manufacturer's ID) Code

0C hex = White Instruments

COMSTAT (Communications Status) Codes

00 hex = No error
01 hex = Bad data received
02 hex = Bad command received
(The following COMSTAT values are only available in the Model 4710.)
03 hex = Device locked
04 hex = Device not locked
05 hex = Channel muted
06 hex = Channel not muted

OPSTAT (Operational Status) Code

00 hex = No error

DCL (Device Control Language) Commands

00 hex = Get Device OPSTAT Code
01 hex = Recall All Data from Device
02 hex = Get DT and ID Codes
19 hex = Set Local Address
1A hex = Assign Memory to Preset (Model 4700 only)
81 hex = Transmit All, Data to Device
82 hex = Reprogram Device from Device Memory
83 hex = Transmit new Pointer Value to Device
84 hex = Reprogram Device from Device Pointer
85 hex = Lock Device (Model 4710 on1y)
86 hex = Unlock Device (Model 4710 only)
89 hex = Mute Output (Model 4710 only)
8A hex = Unmute Output (Model 4710 only)

Broadcast Commands (address codes)

00 hex = Group Execute Command
F8 hex = Disconnect Command
F9 hex = Recall Preset Command
FA hex = Set Security Codes Command

Device Address Range
01 hex to F7 hex

MEMNUN (Device Memory Number) Codes
00 hex = Default memory (contains current settings)
01 to 0A hex = Memories 1 to 10

MPTR (Memory Pointer) Codes
Same as MEMNUM

Preset Number Codes
00 to 09 hex = Presets 1 to 10

Preset Memory Assignment Codes
01 to 0A hex = Memories 1 to 10

CHNUM (Channel Number) Codes
01 = Device channel A
02 = Device channel B (4700-2 only)

Baud Rate
19.2 kilobaud

Character Frame Bits
1 Start bit
8 Data bits
1 Parity bit. (even parity)
1 Stop bit

Recommended Cable
Belden Part No. 9681 or equivalent

Maximum Cable Length
1.2 kilometers (4,000 feet)

Standard Connector Types
Male 9-pin D-subminiature (Input)
Female 9-pin D-subminiature (Output)

Typical Device Time-out Period
270 milliseconds

APPENDIX B - Model 4700 DATA FORMAT DETAILS

Bandpass Filter and Gain Data Values (decimal)

Level (dB)	Bandpass Filter	Gain Setting
-10.0	0	-
-9.5	1	-
-9.0	2	-
-8.5	3	-
-8.0	4	-
-7.5	5	-
-7.0	6	-
-6.5	7	-
-6.0	8	-
-5.5	9	-
-5.0	10	-
-4.5	11	-
-4.0	12	-
-3.5	13	-
-3.0	14	-
-2.5	15	-
-2.0	16	-
-1.5	17	-
-1.0	18	-
-0.5	19	-
0	20	0
+0.5	21	1
+1.0	22	2
+1.5	23	3
+2.0	24	4
+2.5	25	5
+3.0	26	6
+3.5	27	7
+4.0	28	8
+4.5	29	9
+5.0	30	10
+5.5	31	11
+6.0	32	12
+6.5	33	13
+7.0	34	14
+7.5	35	15
+8.0	36	16
+8.5	37	17
+9.0	38	18
+9.5	39	19
+10.0	40	20
+10.5	41	21
+11.0	42	22
+11.5	43	23
+12.0	44	24

Bandpass Filter Center Frequencies

Filter Number	Frequency (Hz)	Filter Number	Frequency (Hz)
0	31.5	14	800
1	40	15	1000
2	50	16	1250
3	63	17	1600
4	80	18	2000
5	100	19	2500
6	125	20	3150
7	160	21	4000
8	200	22	5000
9	250	23	6300
10	315	24	8000
11	400	25	10.0k
12	500	26	12.5k
13	630	27	16.0k

High- and Low-pass Filter Data Format

These settings are combined into one byte as follows:

MSB **LSB**

--	--	H2	H1	H0	L2	L1	L0
		High-pass			Low-pass		

Note: The values of the upper two bits is indeterminate and should be ignored by the computer. These bits are ignored by the device when received from the computer.

Data Value	HPF (Hz)	LPF (kHz)
0	10	32
1	32	23
2	50	15
3	62	13
4	75	11
5	100	9
6	130	7
7	160	6

EQ IN/OUT Status Format:

EQ IN = 0
EQ OUT = 1

APPENDIX C - Model 4710 DATA FORMAT DETAILS

Bandpass Filter and Gain Data Values

Same as Model 4700. (See Appendix B.)

Bandpass Filter Center Frequencies

Filter Number	Frequency (Hz)	Filter Number	Frequency (Hz)
0	25	28	630
1	28	29	710
2	31.5	30	800
3	35.5	31	900
4	40	32	1000
5	45	33	1120
6	50	34	1250
7	56	35	1400
8	63	36	1600
9	71	37	1800
10	80	38	2000
11	90	39	2240
12	100	40	2500
13	112	41	2800
14	125	42	3150
15	140	43	3550
16	160	44	4000
17	180	45	4500
18	200	46	5000
19	224	47	5600
20	250	48	6300
21	280	49	7100
22.	315	50	8000
23	355	51	9000
24	400	52	10.0k
25	450	53	11.2k
26	500	54	12.5k
27	560	55	16.0k

High- and Low-pass Filter Data Format

These settings are combined into one byte as follows:

MSB **LSB**

RL	--	H2	H1	H0	L2	L1	L0
Relay		High-pass			Low-pass		

The relay bit = 0 when the device output is muted.

Note: The value of bit 6 is indeterminate and should be ignored by the computer.
The upper two bits are ignored by the device when received from the computer.

Data Value	HPF (Hz)	LPF (kHz)
0	10	32
1	32	23
2	51	15
3	62	13
4	75	11
5	100	9
6	130	7
7	160	6

EQ IN/OUT Status Format:

EQ IN = 0

EQ OUT = 1

APPENDIX D - AUTOMATIC ADDRESS ASSIGNMENT PROCEDURE

When a networked system is connected to a controlling computer, each unit's local address can be automatically assigned by the computer. To do this, the following steps are necessary:

1) Issue the broadcast Disconnect Command (addr=F8 hex).

This causes all units to set their address to 1 and disable their output bus driver.

2) Issue the Get DT and ID Codes Command (02 hex) to address 1.

Since all units have now disabled their bus outputs, the computer is only talking to the first device in the chain.

3) Check the resulting values of DT and ID.

This ensures that a White Instruments device is connected to the computer. If no device responds, you have reached the end of the chain, and can end the addressing process.

4) Issue the Set Local Address Command (19 hex) to address 1.

This changes the unit's address and enables its bus output driver. The first address issued should be 247 (the highest available). The next time through, use 246, etc., until all addresses have been assigned. Once done, the unit nearest the computer will have an address of 247, with sequentially descending addresses further along the bus.

5) Repeat the process from Step 2 until done.