The HP 59306A Relay Actuator

The HP 59396A relay actuator is a rather early HP-IB device. In fact its manual from 1973 shows it labeled as “ASCII Programmable Module” and an addendum changes this label to “HP-IB Module”.

The device has six relays which can connect a common contact “C” to either “A” or “B”. The connections can be switched manually by using the push buttons or via the HP-IB bus.

The device implements its HP-IB bus logic with a set of 30 TTL logic chips; no microcontroller was required to handle addressing and command decoding. In order to minimize the part count only a partial decoding scheme was implemented. The “A or B” decoder uses the DIO 2, 6 and, 7 lines for identifying the characters “A” and “B”. This test is ambiguous and also responds to other characters.

Programming

The simple decoding logic lets you also use the following aliases for “A”: `@ADEHILMPQTUXY\]`, and for “B”: `BCFGJKNORSVWZ[^_` . The simple statement

```
OUTPUT 707 ; "A2"
```

or alternatively suppressing the end of line sequence with an `OUTPUT USING` statement like

```
OUTPUT 707 USING "#,2A"; "A2"
```

will connect A↔C on channel 2. The `#` sign in the format string signals the command to suppress the end-of-line sequence.

Instead of the `OUTPUT` statement you can also use the low level `SEND` command to address the device and send the desired commands:

```
SEND 7 ; UNL MTA LISTEN 7 DATA "A135B6"
```

or (see HP-IB and ASCII table and assuming the interface has its default talk address of 21)

```
SEND 7 ; CMD "?U'" DATA "A135B6"
```

to connect A↔C on relays 1, 3 and, 5 and to connect B↔C on relay 6.

Useful Parameters for the `SEND` Command

`UNL`	Removes listener mode from all devices.
`MTA`	Sends My Talk Address – indicates that the HP 85 is the Talker.
`LISTEN 7`	Switches device with address 7 into Listener mode.
`DATA "`*nnn*`"`	Sends *nnn* with ATN disabled (ATN = MRE = high).

`DATA "A`*nnn*`"`	Connects A↔C of the numbered relays (one or multiple, *nnn* are digits in [1…6]).
`DATA "B`*nnn*`"`	Connects B↔C of the numbered relays (one or multiple, *nnn* are digits in [1…6]).
`CMD "`*nnn*`"`	Sends *nnn* with ATN enabled (ATN = MRE = low).

Other useful Commands

`LOCAL LOCKOUT 7`	The controller enables REN and ATN and sends `CMD CHR$(17)` (which is the HP-IB `LLO` command). This deactivates front panel operation of all devices. The 59306A deactivates the "LOCAL RESET" button and the six relay switches.
`REMOTE 707`	The controller enables the REN and ATN lines and sends `UNL MTA LISTEN 7`. The 59306A enters Remote mode.
`REMOTE 7`	The controller enables the REN line. Only listeners will enter Remote mode.
`RESUME 7`	The controller disables the ATN line, i.e. it leaves command mode.
`LOCAL 7`	The controller deactivates the REN line. Cancels `LOCAL LOCKOUT` mode on all listening devices.
`LOCAL 707`	The controller sends `UNL MTA LISTEN 7 CMD CHR$(1)` (which is the HP-IB `GTL` command). Cancels `LOCAL LOCKOUT` mode on the selected device. The 59306A activates the "LOCAL RESET" button and the six relay switches.
`OUTPUT 707 USING`	Note: include a leading `#,` in the IMAGE to suppress the end-of-line sequence.

My Device

My device came with a missing top cover, which I replaced by a new cover made from an 0.5 mm aluminum sheet. The lengthwise edges were bent down and two small angles were riveted to the rear so that the cover slides under the front frame and can be secured to the rear cover. Internally I applied a self-adhesive film cover to insulate the surface – just to be safe. The result looks quite nice.

When I tested the device the relay #1 did not respond. Using the schematics I followed the signal path and discovered that a previous owner had already replaced the dual flip-flop U30. He had removed the chip and inserted individual socket pins to plug in a new SN 7474 chip in. Also some broken traces had been repaired with solder. When I pulled the chip it came off with one of the poorly soldered socket pins. I replaced the pin and after ringing out the connections I added two wires to join broken lines. When testing everything worked but after tightening the screws channel #1 was broken again. Pushing on the PCB sometimes produced a working system. So I dismantled the PCB again and found a cold solder joint on one of the remaining socket pins – re-soldering the pin fixed this problem. At the same time I replaced the SN 7474 by a SN 74LS74 to better match the remaining chips.

Finally I added a missing diode to one of the relays (to safeguard its transistor) and since then the unit worked fine.

HP-IB Signals and Naming

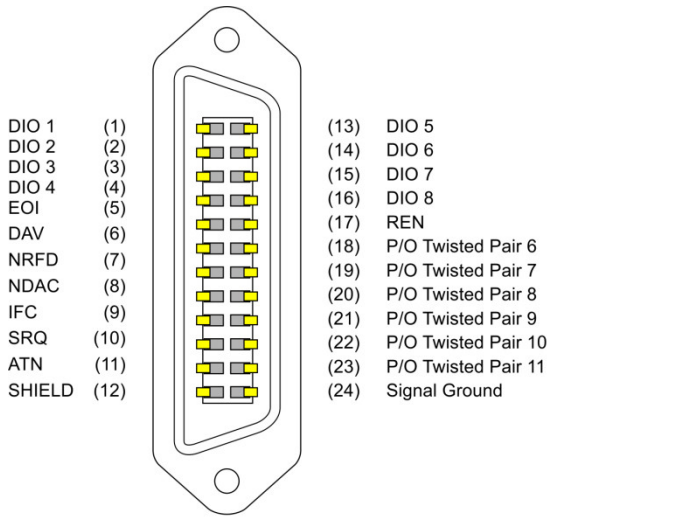
The 59306A uses slightly different Mnemonics for some of the HP-IB signal lines. The following table shows the naming scheme compared with the later standard.

Pins	59306A	HP-IB	Mnemonics	Purpose
1-4	DIO 1–4	DIO1–4	**D**ata **I/O**	data bus, low nibble
5	EOP	EOI	**E**nd **O**r **I**dentify	control (indicate last byte, parallel poll)
6	DAV	DAV	**DA**ta **V**alid	handshake (high: data not valid)
7	RFD	NRFD	**N**ot **R**eady **F**or **D**ata	handshake (high: ready)
8	DAC	NDAC	**N**ot **D**ata **AC**cepted	handshake (high: data has been accepted)
9	IFC	IFC	**I**nter**F**ace **C**lear	control
10	SRQ	SRQ	**S**ervice **R**e**Q**uest	control
11	MRE	ATN	**AT**tentio**N**	control (low: command mode, high: data mode)
12	Shield	Shield		
13-16	DIO 5–8	DIO5–8	**D**ata **I/O**	data bus, high nibble
17	REN	REN	**R**emote **EN**able	control (low: enabled)
18-23	GND	GND		(inverted DAV…ATN, unused)
24	GND	GND		

Note: all HP-IB signals use negative logic, i.e. low == true.

59306A Mnemonics and their IEEE-488 Name

MRE	**M**ultiple **R**esponse **E**nable	→	ATN	**AT**tentio**N**
DAC	**D**ata **AC**epted	→	NDAC	**N**ot **D**ata **AC**cepted
EOP	**E**nd of **O**ut**P**ut	→	EOI	**E**nd **O**r **I**dentify
RFD	**R**eady **F**or **D**ata	→	NRFD	**N**ot **R**eady **F**or **D**ata



HP-IB / IEEE-488
view on male connector side

The following pages contain an HP-IB and ASCII code table. The cells with the binary equivalent are grouped “0.00.00000” to reflect the command groups produced by the bits 5 and 6 and the information part in the lower five bits 0 – 4. The highest bit 7 is unused.

HP-IB		ASCII	Decimal	Binary	Octal	Hexadecimal
		NUL	0	0.00.00000	000	00
	GTL	SOH	1	0.00.00001	001	01
		STX	2	0.00.00010	002	02
		ETX	3	0.00.00011	003	03
	SDC	EOT	4	0.00.00100	004	04
Addressed	PPC	ENQ	5	0.00.00101	005	05
Command		ACK	6	0.00.00110	006	06
Group		BEL	7	0.00.00111	007	07
	GET	BS	8	0.00.01000	010	08
ACG	TCT	HT	9	0.00.01001	011	09
		LF	10	0.00.01010	012	0A
		VT	11	0.00.01011	013	0B
		FF	12	0.00.01100	014	0C
		CR	13	0.00.01101	015	0D
		SOH	14	0.00.01110	016	0E
		SI	15	0.00.01111	017	0F
		DLE	16	0.00.10000	020	10
	LLO	DC1	17	0.00.10001	021	11
		DC2	18	0.00.10010	022	12
		DC3	19	0.00.10011	023	13
	DCL	DC4	20	0.00.10100	024	14
Universal	PPU	NAK	21	0.00.10101	025	15
Command		SYN	22	0.00.10110	026	16
Group		ETB	23	0.00.10111	027	17
	SPE	CAN	24	0.00.11000	030	18
UCG	SPD	EM	25	0.00.11001	031	19
		SUB	26	0.00.11010	032	1A
		ESC	27	0.00.11011	033	1B
		FS	28	0.00.11100	034	1C
		GS	29	0.00.11101	035	1D
		RS	30	0.00.11110	036	1E
		US	31	0.00.11111	037	1F
	L0	SP	32	0.01.00000	040	20
	L1	!	33	0.01.00001	041	21
	L2	"	34	0.01.00010	042	22
	L3	#	35	0.01.00011	043	23
	L4	$	36	0.01.00100	044	24
	L5	%	37	0.01.00101	045	25
	L6	&	38	0.01.00110	046	26
	L7	'	39	0.01.00111	047	27
	L8	(	40	0.01.01000	050	28
	L9	)	41	0.01.01001	051	29
	L10	*	42	0.01.01010	052	2A
	L11	+	43	0.01.01011	053	2B
	L12	,	44	0.01.01100	054	2C
	L13	-	45	0.01.01101	055	2D
Listen	L14	.	46	0.01.01110	056	2E
Address	L15	/	47	0.01.01111	057	2F
Group	L16	0	48	0.01.10000	060	30
	L17	1	49	0.01.10001	061	31
LAG	L18	2	50	0.01.10010	062	32
	L19	3	51	0.01.10011	063	33
	L20	4	52	0.01.10100	064	34
	L21	5	53	0.01.10101	065	35
	L22	6	54	0.01.10110	066	36
	L23	7	55	0.01.10111	067	37
	L24	8	56	0.01.11000	070	38
	L25	9	57	0.01.11001	071	39
	L26	:	58	0.01.11010	072	3A
	L27	;	59	0.01.11011	073	3B
	L28	<	60	0.01.11100	074	3C
	L29	=	61	0.01.11101	075	3D
	L30	>	62	0.01.11110	076	3E
	UNL	?	63	0.01.11111	077	3F

HP-IB		ASCII	Decimal	Binary	Octal	Hexadecimal
	T0	@	64	0.10.00000	100	40
	T1	A	65	0.10.00001	101	41
	T2	B	66	0.10.00010	102	42
	T3	C	67	0.10.00011	103	43
	T4	D	68	0.10.00100	104	44
	T5	E	69	0.10.00101	105	45
	T6	F	70	0.10.00110	106	46
	T7	G	71	0.10.00111	107	47
	T8	H	72	0.10.01000	110	48
	T9	I	73	0.10.01001	111	49
	T10	J	74	0.10.01010	112	4A
	T11	K	75	0.10.01011	113	4B
	T12	L	76	0.10.01100	114	4C
	T13	M	77	0.10.01101	115	4D
Talk	T14	N	78	0.10.01110	116	4E
Address	T15	O	79	0.10.01111	117	4F
Group	T16	P	80	0.10.10000	120	50
	T17	Q	81	0.10.10001	121	51
TAG	T18	R	82	0.10.10010	122	52
	T19	S	83	0.10.10011	123	53
	T20	T	84	0.10.10100	124	54
	T21	U	85	0.10.10101	125	55
	T22	V	86	0.10.10110	126	56
	T23	W	87	0.10.10111	127	57
	T24	X	88	0.10.11000	130	58
	T25	Y	89	0.10.11001	131	59
	T26	Z	90	0.10.11010	132	5A
	T27	[	91	0.10.11011	133	5B
	T28	\	92	0.10.11100	134	5C
	T29	]	93	0.10.11101	135	5D
	T30	^	94	0.10.11110	136	5E
	UNT	_	95	0.10.11111	137	5F
	S0	`	96	0.11.00000	140	60
	S1	a	97	0.11.00001	141	61
	S2	b	98	0.11.00010	142	62
	S3	c	99	0.11.00011	143	63
	S4	d	100	0.11.00100	144	64
	S5	e	101	0.11.00101	145	65
	S6	f	102	0.11.00110	146	66
	S7	g	103	0.11.00111	147	67
	S8	h	104	0.11.01000	150	68
	S9	i	105	0.11.01001	151	69
	S10	j	106	0.11.01010	152	6A
	S11	k	107	0.11.01011	153	6B
	S12	l	108	0.11.01100	154	6C
	S13	m	109	0.11.01101	155	6D
Secondary	S14	n	110	0.11.01110	156	6E
Command	S15	o	111	0.11.01111	157	6F
Group	S16	p	112	0.11.10000	160	70
	S17	q	113	0.11.10001	161	71
SCG	S18	r	114	0.11.10010	162	72
	S19	s	115	0.11.10011	163	73
	S20	t	116	0.11.10100	164	74
	S21	u	117	0.11.10101	165	75
	S22	v	118	0.11.10110	166	76
	S23	w	119	0.11.10111	167	77
	S24	x	120	0.11.11000	170	78
	S25	y	121	0.11.11001	171	79
	S26	z	122	0.11.11010	172	7A
	S27	{	123	0.11.11011	173	7B
	S28	|	124	0.11.11100	174	7C
	S29	}	125	0.11.11101	175	7D
	S30	~	126	0.11.11110	176	7E
	S31	DEL	127	0.11.11111	177	7F