

# Model 5207/5208

## Computer Commands

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### Introduction

This document describes the computer control commands for the obsolete Models 5207 and 5208 lock-in amplifiers that were manufactured by **EG&G PRINCETON APPLIED RESEARCH** and **EG&G BROODEAL ELECTRONICS**. Note that all commands must be terminated by a carriage return <CR> or by a carriage return followed by a line feed <CRLF>, as set via Function 2. In the following descriptions, default parameter values are indicated by: [x], where "x" is the default value.

### Descriptions

**A1 n [0]**: If followed by n, the A1 (AUTORANGE) command turns the AUTORANGE function on and off. If n is omitted, the command requests the function's status. The codes are:

n	STATUS
0	OFF
1	ON

**A2 n [0]**: If followed by n, the A2 (AUTOSET) command turns the AUTOSET function on and off. If n is omitted, the command is a request to report the function's status. The codes are:

n	STATUS
0	OFF
1	ON

**A3**: The A3 (AUTO-OFFSET) command causes the Auto-Offset routine to run. [The sequence O 0 0 (that's OH ZERO ZERO) turns the Offset function off.]

**A4 n [0]**: If followed by n, the A4 (AUTONORMALIZE) command controls the Autonormalize routine. If n is omitted, it is a request to report the function's status. The codes are:

n	STATUS
0	OFF
1	ON

**A5**: If followed by n, the A5 (RATIO) command controls the Ratio routine. If n is omitted, it is a request to report the function's status. The codes are:

n	STATUS
0	OFF
1	ON

Ratio works with X, Y, R, or LOG R. If LOG R is selected, the log of the ratio of R to AUX is displayed. If X, Y, or R is selected, the ratio of X, Y, or R to AUX is

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displayed.

Ratio has a higher priority than Normalized. If Normalization is selected, normally X, Y, and R are displayed as a percent of full scale. However, if Ratio is selected, they are displayed as the ratio of X, Y, and R to AUX.

**A6:** Reserved for future use.

**A7:** In the 5208, the A7 (AUTOPHASE) command invokes a single iteration of the Auto-Range routine and then an Auto-Phase routine. In the 5207, each time an A7 command is applied, one of the three steps required to complete an Auto-Phase routine is invoked. As a result, A7 is not generally a useful command in an actual experiment with a 5207. (For both the Model 5207 and the Model 5208, the AUTO-SET command, A2, is preferred.)

**B n:** This command is the same as the MSK command, discussed further on. It is provided to maintain software compatibility with the 5205/6.

**C n:** This command is the same as the DD command. It is provided to maintain compatibility with the 5205/6.

**CH n [0]:** A read/write command, CH (CRYSTAL HET) allows the crystal-het feature to be turned ON and OFF. If sent without the operand, the command requests the 5207/8 to report the crystal-het status. The codes are:

<b>n</b>	<b>STATUS</b>
0	OFF
1	ON

**D n [0]:** When followed by n, the D (DISPLAY) command sets the parameter displayed by the digital panel meter. If sent without an operand, the command is a request for the display parameter currently selected. The selections are:

<b>n</b>	<b>5207</b>	<b>5208</b>
0	OUTPUT	CH 1
1	PHASE	CH 2
2	PHASE	PHASE
3	OFFSET	CH 1 OFFSET
4	INT. FREQ	INT. FREQ.
5	AUX	AUX

**DD n:** A write-only command, when followed by n, DD (DEFINE DELIMITER) specifies the ASCII character to be sent by the lock-in amplifier as the delimiter between two numbers. The factory set delimiter is the comma (ASCII 44). Any other printing ASCII character could be specified. For example, if n were 59 (decimal), the delimiter would be a semicolon. A DEVICE CLEAR operation does not restore the comma delimiter. Note that this command governs only the delimiter for responses transmitted by the 5207/8. The 5207/8 accepts any non-numeric character as a delimiter. NOTE: The Apple II computer does not accept comma delimiters on INPUT statements.

**E:** This command is exactly the same as the ERR command. It is provided to maintain software compatibility with the 5205/6.

**ERR:** A read-only command, ERR (ERROR) causes the ERROR status of the previous interface command to be sent. Its purpose is to allow the host computer to verify that the previous command and its parameters were valid before proceeding to the next command. ERR is most useful during program development via the RS232C Interface. The error codes are:

<b>ERROR CODE</b>	<b>MEANING</b>
0	NO ERROR
1	OPTION NOT INSTALLED
2	INVALID COMMAND
3	INVALID PARAMETER
4	COMMAND OVERRUN; STILL EXECUTING PREV CMD
5	NOTHING TO SAY
6	NUMERIC ERROR
7	MISSING SEPARATOR

**F n [1]\*:** When followed by n, the F (FREQUENCY BAND) command selects the Frequency Band. If n is omitted, the command requests the 5207/8 to report the selected band. The codes are:

<b>n</b>	<b>BAND</b>
0	BROADBAND
1	AUDIO
2	LOW

If AUDIO card is not present, another card will be selected

**G n [1638]:** If followed by n, the G (GAIN) command sets the gain of the 5207/8 output channel(s). If n is omitted, it is a request to report the gain value. The allowable range for n is 0 to 4095. The default or "normal" value is 1638. With this value, a full-scale input signal gives a full-scale output. The gain adjustment factor then is simply  $n/1638$ . For example, if n were 4095, the gain would be increased by a factor of 2.5. Similarly, if n were 819, the gain would decrease to 0.5 is normal value.

**H n [1]:** If followed by n, the H command controls the front-panel LED's. If n is omitted, the command requests that the LED's status be reported. The codes are:

<b>n</b>	<b>STATUS</b>
0	All LED's OFF
1	NORMAL OPERATION
2	ALL LED's ON (test function)

**ID:** A read-only command, the ID command requests the 5207/8 to report its model number to the host computer.

**J n<sub>1</sub> n<sub>2</sub> [400 6]\*:** When followed by operands, the J command selects the ref. mode and controls the Internal Oscillator Option. If the operands are omitted, the command requests that the Reference Status be reported. If an Int Ref Band is selected, n<sub>1</sub> sets the frequency within the selected band as a percentage of full scale (full scale is the upper limit of the band). The range is 100-to-1000, with each increment being 0.1% of full scale. n<sub>2</sub> selects the reference mode, EXT F, EXT 2F, or, via any of the Internal Frequency bands, INT, as follows.

n <sub>1</sub>	n <sub>2</sub>	BAND
100-1000	0	10 kHz to 100 kHz
100-1000	1	1 kHz to 10 kHz
100-1000	2	100 Hz to 1 kHz
100-1000	3	10 Hz to 100 Hz
100-1000	4	1 Hz to 10 Hz
100-1000	50.	0.1 Hz to 1 Hz
100**	6	EXT. F
100**	7	EXT. 2F

\* Default for n<sub>1</sub> only applies if Oscillator is installed.

\*\* n<sub>1</sub> value must be entered, even if selecting EXT. Mode operation. "100" is a suitable value.

*Note: If the oscillator is not installed and you send the "J" command with the first (frequency band) parameter value in the range of 0 to 5, you get an Error 1 (Option Not Installed).*

**K n:** If followed by n, the K (KEY) command has exactly the same effect as pressing a front-panel key. The value of n designates the key. If n is omitted, the command is invalid. The codes are:

n	SELECTED KEY
0	DISPLAY
1	CH 1 OFFSET (OFFSET IN 5207)
2	MODES
3	REFERENCE
4	PHASE
5	TIME CONSTANT
6	SENSITIVITY
7	SELECT
8	RUN/CLEAR
9	LOCAL
10	OUTPUT MODE (5208)
11	CH 1 EXPAND (EXPAND IN 5207)
12	SET (#)
13	SET (")

There is an ambiguity problem that has to be taken into consideration in using a "K"

command. It is possible that the computer, not knowing which parameter is already addressed at the front panel, will select the parameter that is already addressed. The result would be a different selection than would have occurred if any other parameter were the one addressed prior to issuing the command. For example, assume the computer wanted to "press" the **Modes** key. If any parameter other than **Modes-Reserve** were the one addressed when the K 2 command was sent, **Modes-Reserve** would be selected. However, if **Modes-Reserve** were the one already addressed when the K 2 command was sent, **Modes F Band** would be selected. The action exactly parallels that which occurs when pressing the keys manually. This ambiguity can be averted by always issuing "K" commands in pairs, where the first K command "presses" a key other than the one wanted, and the second activates the key of interest. Applied to the example, this would assure that **Modes Reserve** would be selected.

**L n [20]:** When followed by n, the L (LIMIT) command sets the auto-range sensitivity limit. If n is omitted, it is a request to report the limit. The range for n is 0 to 20, corresponding to a sensitivity range of 5 V to 1 IV in 5-2-1 sequence.

**M n [0]:** When followed by n, the M (METERS) command selects the parameter to be displayed by the analog panel meters in the 5208. If sent without an operand, the command requests the 5208 to report the current meter "selection". The command has no validity for the 5207. The selections are:

n	CH 1 METER	CH 2 METER
0	X	Y
1	R	θ
2	LOG R	θ

**MSK n:** A READ/WRITE command, MSK (SRQ MASK) determines which events must take place to cause a GPIB service request. If n is omitted, MSK is a request for the 5207/8 to report the decimal value of the mask byte. The range is 0 to 255. In setting n, each bit for which a service request is to be generated should be a "1". The other bits should be "0". The factory MSK value is "0". Note that a DEVICE CLEAR operation does not restore this value.

A service request will be generated (SRQ asserted) when both the Status Byte and the Mask Byte have a "1" in the same bit. Digitally speaking, the mask byte and the status byte are AND'ed bit by bit. Anytime the result is a non zero, SRQ is asserted. The codes are the same as for the ST command.

**Example:** If the Mask Byte operand is such as to give a Mask Byte of:

1000001

a service request will be generated any time bit 1 or bit 7 of the STATUS byte is a "1". Service requests will not occur for bits 2, 3, 4, 5, or 6 regardless of the STATUS BYTE status.

**Discussion:** Use of the MSK command to force a **Service Request** is but one of the ways of initiating a serial poll. It is best suited to use in complex systems where there are many devices connected to the GPIB. By having the controller do a serial poll only when necessary, the computer can optimally allocate its time. Alternatively, the computer can periodically poll each device on the bus as part of its basic operating routine. In simpler systems where the computer is dedicated to the 5207/8, it is generally more efficient to have the computer perform repetitive serial polls whenever possible. That way, the computer will detect the 5207/8's need for service as soon as possible. However, MASK byte controlled Service Requests can certainly be made in simple systems too, if desired.

**N:** This command allows the status of the three front-panel overload indicators to be read. The 5207/8 responds with a binary-coded decimal number from 1 to 7. A "1" in bits 0, 1, or 2 indicates an overload condition.

BIT	5208	5207
0	Ch 2 Ovl	
1	Ch 1 Ovl	Output Overload
2	Sig. Ovl	Sig. Ovl

**O n<sub>1</sub> n<sub>2</sub> [0 0]:** When followed by operands, the O (OFFSET) command controls the offset. If the operands are omitted, the command requests the 5207/8 to report the offset status. The magnitude is set by n<sub>1</sub>, where n<sub>1</sub> can range from 0 to 1000. The units are tenths of one percent of full scale. n<sub>2</sub> switches the offset on or off and sets the polarity. The codes for n<sub>2</sub> are:

n	STATUS
0	OFFSET OFF
1	OFFSET ON AND POS.
2	OFFSET ON AND NEG.

**OO n [1]:** When followed by n, the OO (OSCILLATOR OUTPUT) command determines whether the oscillator will be ON or OFF. An operand value of "0" turns the command OFF. An operand value of "1" turns the command ON. If n is omitted, the command requests the 5207/8 to report the Oscillator Output status. **Note:** If this command is applied and the Oscillator Option has not been installed, you get an Error 1 (Option Not Installed).

**OPTION n<sub>1</sub> n<sub>2</sub>:** This is a special read/write command. It allows the computer to inquire whether a specific option is present. The computer sends n<sub>1</sub>, and the 5207/8 responds with n<sub>2</sub>. The codes are:

n <sub>1</sub>	n <sub>1</sub> MEANING
92	NO CRYSTAL HET
93	CRYSTAL HET
94	OSCILLATOR
97	BROAD-BAND
98	AUDIO-BAND
99	LOW-FREQ.

Note that an invalid value for n<sub>1</sub> will result in n<sub>2</sub> response of 0.

<b>n<sub>2</sub></b>	<b>MEANING</b>
0	Option Not Present
1	Option Present

**P n<sub>1</sub>,n<sub>2</sub> [0 200]:** When followed by operands, the P (PHASE) command sets the Phase Shift. If the operands are omitted, the command is a request for the 5207/8 to report the current PHASE setting. n<sub>1</sub> selects the quadrant, 0 (0° to 90°), 1 (90° to 180°), 2 (180° to 270°), or 3 (270° to 360°). #2 specifies the phase shift within the quadrant in increments of 0.025 degrees. The range of n<sub>2</sub> is 100 to 3900. The phase shift contributed by n<sub>2</sub> equals 0.25 \* (n<sub>2</sub>-200). For example, if n<sub>2</sub> were 100, the phase shift contributed by n<sub>2</sub> would be -2.5°. If n<sub>2</sub> were 3900, the phase shifted contributed by n<sub>2</sub> would be 92.5°. The formula relating total phase shift to n<sub>1</sub> and n<sub>2</sub> is:

Total Phase Shift in degrees equals

$$(n_1 * 90) + [0.025(n_2-200)]$$

If you know the desired phase shift, P, and want to find n<sub>1</sub> and n<sub>2</sub>, use:

$$n_1 = \text{INT} (P/90)$$

$$n_2 = (40 * P) - (3600 * n_1) + 200$$

Two convenient reference points are 0° (n<sub>2</sub> = 200) and 90° (n<sub>2</sub> = 3800).

**Q1, Q2, and Q3:** These commands cause the Channel 1 Output, the Channel 2 Output (5208 only), or the Auxiliary Output value respectively to be reported. The number sent is an integer, where -2000=-f.s. and +2000=+f.s. Readings may be up to 20% greater than full scale before data loss occurs.

In the case of the 5207, the output (analog meter reading or AUX potential) is the actual parameter reported. To convert this number to volts, apply the equation:

$$\text{Volts}=(\text{Output}/2000)*\text{Full-Scale Sensitivity}$$

(For AUX, full scale = 10 V)

In the case of a 5208, the quantity reported can be any of several parameters according to the selected OUTPUT MODE.

If X, Y, or R is reported, the voltage can be determined from the equation:

$$\text{Volts}=(\text{Output}/2000)*\text{Full-Scale Sensitivity}$$

To obtain the log of the signal magnitude, select the output mode LOG R,h and use the command Q1. Then Log R can be computed as:

$$\text{Log R}=\text{Output}/20$$

The phase angle  $\theta$  is reported using the output mode R,  $\theta$  and the command Q2. The number reported can be converted to degrees using the equation:

$\theta = \text{Output}/10$

The instrument can execute a Q1 command once in approximately 45 ms. If Q1 and Q2 commands are interleaved, one reading can be taken every 90 ms, and both channels can be read in approximately 180 ms. These intervals do not account for any time required by the host computer to receive the results of one command and transmit the next one.

Some examples of Q1 commands not interleaved with Q2 commands follow.

Q1(CR)  
Q1(CR)

or

Q1;Q1;Q1;Q1

Some examples of Q1 commands interleaved with Q2 commands follow.

Q1;Q2

or

Q1(CR)  
Q2(CR)

**Q5:** This command, OUTPUT CH1,CH2 is a read-only command. It is applied without operands and requests that the 5207/8 respond with the Channel 1 Output level followed by the Channel 2 Output level. The numbers sent are integers, with -2000 = -f.s. and +2000 = +f.s. Readings may be up to 20% greater than full scale before data loss occurs. In the case of a Model 5207, #2 is always reported as "0".

**R n [2]:** When followed by n, the R (RESERVE) command controls the dynamic reserve. If n is omitted, the command requests the 5207/8 to report the reserve setting. The codes are:

<b>n</b>	<b>RESERVE</b>
0	HIGH RES.
1	NORMAL
2	HIGH STAB

**S n [0]:** When followed by n, the S (SENSITIVITY) command sets the sensitivity. If n is omitted, the command requests that the 5207/8 report the set sensitivity. The range for n extends from 0 to 20, corresponding to a Sensitivity Range of 5 V to 1 IV rms full scale in 5-2-1 sequence.

Expressed as a BASIC formula:

$$n = \text{INT}(\text{ABS}(3.0 * \text{LOG}(V) - 2.4))$$

where n = 5207/8 code and



S = sensitivity in volts.

The formula for finding S, given n, is:

$$S=10^{-(\text{INT}(n/3))*n}$$

The following BASIC program uses this formula to find the sensitivity in volts, given n.

```
10 T1=n-(INT(n/3)*3)+1
20 IF T1 = 1 THEN T1 = 5
30 IF T1 = 3 THEN T1 = 1
40 V=(10^-INT(n/3))*T1
```

**ST:** A read-only command, ST (STATUS) requests that the 5207/8 report its status to the host computer. The number reported is the decimal equivalent of the contents of the Serial Poll Status Byte. The significance of each bit is:

#### BIT MEANING

- 0 **Command Complete:** Signifies that the lock-in amplifier is ready for the next command. This bit is set to "1" at power-up and when the lock-in amplifier is ready for the next command. Applying the ST command clears this bit.
- 1 **Invalid Command:** This bit is set if the previous command was invalid. The principle utility of this bit would be in program development.
- 2 **Parameter Error:** This bit is set if a parameter in the previous command was invalid. The principle utility of this bit is in program development.
- 3 **Reference Low:** This bit is set if the reference signal is too low. If this happens, the user should check the applied reference signal and increase its amplitude as required.
- 4 **Overload:** This bit is set if there is an overload in the lock-in amplifier. If this occurs, the user should adjust the Sensitivity as required to end the overload. The OFFSET and EXPAND functions can also cause overload if used improperly.
- 5 **Settled:** This bit is set when the autoranging process has settled on a sensitivity. More specifically, it is set six time constants after the last change of range in an autoranging or autophase sequence. It is also set at powerup and whenever the autoranging is turned off. It is cleared when autoranging is started, and is updated every six time constants when autoranging is active.  
  
*Note: If 12 dB/octave is selected, it is set or updated after twelve time constants. With time constant values of 1us through 100 ms, it is set or updated after 1.2 s (2.4 s with 12 dB/octave).*
- 6 **SRQ Asserted:** This bit is set if a Service Request is currently being generated in the lock-in amplifier.
- 7 **Output Ready:** This bit is set when the lock-in amplifier has output to send to

the host computer.

When the condition in the MEANING column exists, the corresponding bit is set. When the condition in the MEANING column does not exist, the corresponding bit is cleared. The decimal values of the set bit are added and the sum transmitted to the host computer as an ASCII decimal number. For example, if bits 5 (SETTLED) and 7 (OUTPUT READY) were set and ST were applied, the response would be ASCII decimal 160. Note that sending the ST command is not the same as doing a serial poll. A serial poll can be done any time. An ST command, like any other command, cannot be sent if the 5207/8 is busy executing a previously applied command. Another difference is that the response to a serial poll is an eight-bit binary byte, while the response to the ST command is an ASCII coded decimal number. The ST command is provided so that RS232C users will have access to essentially the same information as a serial poll provides in GPIB operation.

**T n<sub>1</sub> n<sub>2</sub> [6 1]:** When followed by operands, the T (TIME CONSTANT) command selects the Time Constant and the dB/octave rolloff rate. If the operands, the command is a request for these parameter settings. The codes are:

n <sub>1</sub>	TIME CONSTANT
0	100 s
1	30 s
2	10 s
3	3 s
4	1 s
5	300 ms
6	100 ms
7	30 ms
8	10 ms
9	3 ms
10	1 ms

**V:** This command is the same as the VER command. It is provided to maintain software compatibility with the 5205/6.

**VER:** This command causes the version number of the firmware in the lock-in amplifier to be sent. This number is provided to facilitate communications between the factory and the user regarding firmware, operating, and service questions about a particular lock-in amplifier.

**X n [0]:** When followed by n, the X (EXPAND) command switches the EXPAND on and off. If n is omitted, the command requests the 5207/8 to report the expand status. The status as a function of n is:

n	STATUS
0	OFF
1	ON

**Z:** This command is exactly the same as the previously defined ST command. It is

provided to maintain software compatibility with the 5205/6.

## Company Names

**SIGNAL RECOVERY** is part of Advanced Measurement Technology, Inc, a division of AMETEK, Inc. It includes the businesses formerly trading as EG&G Princeton Applied Research, EG&G Instruments (Signal Recovery), EG&G Signal Recovery and PerkinElmer Instruments (Signal Recovery)

## **SIGNAL RECOVERY**

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