R.E. SMITH
4311 Tylersville Road
Hamilton, Ohio 45011
Phone (513) 874-4796 www.rs485.com
www.rs485.com and/or www.fiberspace1.com
Phone: 513-874-4796 Fax: 513-874-1236

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PRELIMINARY INFORMATION

COMMAND STRUCTURE & PROTOCOL FOR THE AT1616L RS485/RS232 SERIAL REMOTE I/O BOARD (COMPUTER MODE, Software Version 01.0D, 12-9-99) (COVERS NEW COMMAND STRUCTURE ONLY) October 21, 2000

INTRODUCTION

The AT1616L Remote I/O Board has 16 opto-isolated inputs and 16-Relay (Form C) outputs. The unit can be controlled by our simple/efficient command structure from a host computer (computer mode), such as a PC. Also, with special software, two units can be operated in a standalone mode (master/slave mode) to form a "Relay extension cord," with 16-channels of control in each direction, at distances of up to 4000 ft. or more (order AT1616L-SAL for special software). The unit can communicate using RS485 or RS232, at data rates up to 115.2K bits/second. Up to 256 units (in computer mode & with repeaters) can be connected on a single pair of wires to form a large (4096 I/O points) RS485 multi-drop network.

The AT1616L has an onboard switching regulator for 12VDC operation, LED indicators for all inputs and outputs, 18 jumpers for communications address, Baud rate, mode control, etc., and additional hardware jumpers. Wago terminal connectors (spring loaded) are provided for ease of installation/removal. The RS485 serial port has built in transient

protection and jumper selectable termination. LED indicators monitor the data flow of the serial port.

"Less is more" when using our command structure to control the AT1616L. Only two ASCII commands are needed for full control: 1) The "GXX" command addresses the unit, returns the unit address, and the I/O status of the unit; 2) The "K?DD" command can be used to control any one of the sixteen relays (K1 - K8, with or without an 8-bit timer), or the on/off status of all 8 relays, can be updated with a single execution of this one command (KADD for OL7 thru OL0, and KFDD for OR7 thru OR0).

Other commands are available to check current I/O status ("L," "G," "I"), jumper settings ("J"), unit type ("U"), and software version ("V"). A terminal emulator and a few minutes are all that is necessary to learn our command structure. Quick basic software with source code is also provided to monitor/control the unit. The simplicity of the command structure (depending on commands used) allows for fast control in large multi-drop networks (typically less than 20mSec/unit at 9600,n,8,1 and only about 2mSec/unit at 115.2K,n,8,1). Delays are NOT required and bandwidth utilization is at a maximum.

All commands and hex data are in capital letters. The range 0-9 and A-F are reserved for data. The letters G through Z are available for commands. Command strings are generally 1 to 4 characters in length. Return strings from the AT1616L are generally 4 characters long; however, larger strings (up to 16+ characters) are possible in our "Classic" command mode. The "Classic" command mode is supported to allow for backward compatibility in existing systems (not covered, except "G" & "R").

COMMAND STRUCTURE

(NOTE: I = Installed, R = Removed)

The Locate Command "LXX" (J19 I/R):

This command is used to address the unit and echo back the unit address, along with the status of the first eight inputs (IN1 - IN8). A capital "L" (04Ch) followed by two ASCII-HEX characters (0-9, A-F) is sent to the AT1616L network to enable communications with a specified unit. **All**

other units are disabled by this command and only the specific unit selected is active for subsequent commands.

A typical command string from a host computer and a response string from a selected slave unit are as follows:

Host: L23 (ASCII/ASCII-HEX)
Response from slave unit #23 (023h): 234A (ASCII-HEX)

The first two characters indicate that the correct unit has been selected. The last two characters represent the status of the first Input port (IL). Bit-7 is Input-1 (IL0), and bit-0 is Input-8 (IL7), with J24 installed. 04Ah = 0100 1010 Binary. Inputs IN2, IN5, and IN7 are active (on/closed), while Inputs IN1, IN3, IN4, IN6, and IN8 are inactive (off/open).

L(04Ch) Command Character
2(032h) High nibble of communications address (CA)
3(033h) Low nibble of communications address (CA)

Delay (for response) = 0 to 1mSec. (50uS typical)

2(032h) High nibble of communications address (CA)
3(033h) Low nibble of communications address (CA)
4(034h) High nibble of Input port (IN1 - IN4)
A(041h) Low nibble of Input port (IN5 - IN8)

General Relay (K) Cmd "K?DD" (J19, J15, J24 installed):

This command is used to control all 16 relays on the AT1616L. A capital "K" (04Bh) followed by "X" (where X = relay # in the range 1-8, K1(OL0)-K8(OL7), will use the value "DD" to control the selected relay and/or relay timer (see Relay Subcommand “KX”). If "?" = A, then all relays in the range K1-K8 are controlled by the subsequent data byte "DD" on a bit by bit basis (see Relay Subcommand “KA”). If "?" = F, then all relays in the range K9(OR0)-K16(OR7) are controlled by the subsequent data byte "DD on a bit by bit basis (see Relay Subcommand “KF”).

If "?" = B, then the pre-scale counter (time base, TB) is set by "DD" in 10mS increments. The range of TB is 0.01 to 2.55 seconds. If TB = 0.01 seconds, then the relay timers have a range of 0.01 to 25.3 seconds. If TB = 2.5 seconds, then the relay timers have a range of 2.5 seconds to approximately 10.5 minutes. The value of TB determines the range of all 8 relay timers (K1[OL0] - K8[OL7]). With J18 installed the power on time base is set for 1.0 second. With J18 removed the power on time base is set for 100mS. While a new time base can be loaded using software control from a PC, it should be noted that if a power failure occurs, the default power on time base will be reloaded, and timing will be altered until a new software value is reloaded.

Relay Subcommand "KA" = ("KADD"): (K1 – K8)
Relay Subcommand "KF" = ("KFDD"): (K9 – K16)

If "K" is followed by "A" (all-left), then the data "DD" is used to control the on/off status of all eight relays (K1[OL0]-K8[OL7]), at the same time. Any timers that might be active prior to executing this command will be terminated and the on/off status will be determined by "DD" exclusively (future versions of the software may provide a mechanism to allow selected relays/timers to remain outside of the control of this subcommand). The first nibble controls K1 - K4 (Bit-7 = K1) and the second nibble controls K5 - K8 (Bit-0 = K8). A "1" at any bit position will turn a relay on, and a "0" will turn a relay off. Byte control represents the fastest way to change the status of this relay output port (left).

If "K" is followed by "F" (all-right), then the data "DD" is used to control the on/off status of all eight relays (K9[OR0]-K16[OR7]), at the same time. The first nibble controls K9 – K12 (Bit-7 = K9) and the second nibble controls K13 – K16 (Bit-0 = K13). There are no timers on this port. A "1" at any bit position will turn a relay on, and a "0" will turn a relay off. Byte control represents the fastest way to change the status of this relay output port (right).

A typical command string from a host computer and a response string from a selected slave unit are as follows: (shown for "KA" command)

Host: KAC6 (ASCII/ASCII-HEX)
Response from slave unit: C6XX (ASCII-HEX)

The first two nibbles indicate that the relay port has been changed to the desired value "C6." C6 = 1100 0110 Binary. Relays K1, K2, K6 and K7 are on (closed) and K3, K4, K5 and K8 are off (open). The next two nibbles (XX) have no meaning.

K(04Bh) Command Character
A(041h) Subcommand for All Relays
C(043h) High nibble data for K1 - K4 (K1 and K2 are on)
6(036h) Low nibble data for K5 - K8 (K6 and K7 are on)

Delay (for response) = 0 to 1mSec. (50uS typical)

High nibble data of current status of K1 - K4, C(043h), Low nibble data of current status of K5 - K8, 6(036h). The next two nibbles (XX) have no meaning.

Relay Subcommand "KX" = Relay # (1-8), ("KXDD"):

If "X" is in the range 1-8 K1(OL0)-K8(OL7), then "X" represents the relay selected by this command for control. This subcommand is used to control an individual relay without changing the status of the remaining 7 other relays on the output port, even if previously set by the "KA" command. This method of control can be used to turn an individual relay on, off, or to load a timer that will turn the relay off when the timer value reaches zero (000h). The value of "DD" determines the action that will be taken. If "DD" = 000h, then the selected relay will be turned off. If "DD" = 0FFh, then the selected relay will be turned on. If "DD" = 0FEh no change is made to the relay status; however, the return string from the AT1616L will show the current status of the selected relay (000h = off, 0FFh = on, or ?? = current timer value).

If "DD" is in the range of 001h to 0FDh (1 - 253 decimal) the selected relay will turn on for a time that is determined by the value of "DD" times the value of the time base (TB). The default setting for the time base is 1.0 Sec. on power-up of the unit (1.0 - 255 second range). After the timer reaches 000h the selected relay will turn off. For example, if the command K20A is

sent to the AT1616L, relay K2 will turn on for approximately 10.0 Sec. If the command K601 is sent, relay K6 will turn on for approximately 1.0 Sec. It should be noted that the pre-scale value of the time base (TB) will scale the delay time for all 8 relays.

A typical command string from a host computer and a response string from a selected slave unit are as follows:

Host: K732 (ASCII/ASCII-HEX)
Response from slave unit : 32?? (ASCII-HEX)

Relay K7 is selected for a timed output of 50 seconds. The value for "DD" = 032h (50 decimal). After the time period has expired K7 will turn off. Please note that the "FF" returned in the example below, represents the current status of relay K8 (on). The status of K7 (and K8) can be monitored at any time by using the command K7FE.

K(04Bh) Command Character
7(0437h) Subcommand for relay K7
3(033h) High nibble data for delay timer
2(032h) Low nibble data for delay timer

Delay (for response) = 0 to 1mSec. (50uS typical)

3(033h) High nibble status data for K7
2(032h) Low nibble status data for K7
F(046h) High nibble status data for K8 (on)
F(046h) Low nibble status data for K8 (on)

Relay Subcommand "KB" (Time Base Control), ("KBDD"):

If "K" is followed by "B," then the data "DD" is used to load the pre-scale counter time base (TB) value in 10mS increments. If "DD" = 000h or 001h, then the time base (TB) value = 10mS. The default setting for the time base is 1.0 second on power-up of the unit (TB = 64h). This command takes effect immediately. NOTE: The command, R38 will return the current time base value 64XX (default value, for example), where XX is a random value.

The relay subcommand "K20A" (where "DD" = 10 decimal /0Ah), for the selected relay K2, will turn on for a time that is determined by the value of K2"DD," times the value of the time base (TB). With the default time base (TB = 64h), relay K2 would turn on for 10 second.

Typical values for the time base (TB) would be:

"DD" = 001h = 0.01 second
(Relay KX range = 0.01-2.55 seconds)
"DD" = 00Ah = 0.1 second
(Relay KX range = 0.1-25.5 seconds)
"DD" = 032h = 0.5 second
(Relay KX range = 0.5-127.5 seconds)
"DD" = 064h = 1.0 second (Default at power-up)
(Relay KX range = 1.0-255 seconds)
"DD" = 0C8h = 2.0 seconds
(Relay KX range = 2.0-510 seconds)
"DD" = 0FAh = 2.5 seconds
(Relay KX range = 2.5-637.5 seconds)
"DD" = 0FFh = 2.55 seconds (maximum value)

The I Command "I" (J19 must be installed, no argument):

This command is used to retrieve the input status (16-bits) from the unit. This command is NOT active unless a previous "LXX' or "GXX" command has been executed. If J24 is removed, the return string is 4 ASCII-HEX characters, in the form "INL-INR" where INL = (IL7 IL6 IL5 IL4) (IL3 IL2 IL1 IL0), and ILR = (IR7 IR6 IR5 IR4) (IR3 IR2 IR1 IR0). If J24 is installed (factory default) the input bits are reversed. Inputs are active on "dry" closure or when current (1.0mA) flows through the input, depending on HARDWARE input jumper settings.

The JUMPER Command "J" (J19 installed, no argument):

The jumper command, J will read the current jumper status (J16-J23, 0000 00, J15, J24) of the AT1616L and return the string DDDD (16-bit

value). This command will NOT return the communications address of the unit.

The VERSION Command "V" (J19 installed, no argument):

The version command, V will return the string DDDD showing the current software revision of the controller.

The UNIT Command "U" (J19 installed, no argument):

The unit command, U will return the string DDDD showing the unit identification. At the present time A001 is the SRC88 I/O board (8-in, 8-out), A002 is the AT44R I/O board (4-in, 4-out), A003 is the AT444A, and A004 is the AT1616L.

The REGISTER Command "R" (J19 = I/R):

The register command, RXX will point to a register pair in the AT1616L and return the string DDDD. The register pointed to by the command and the register +1 will be returned. This command is a carryover from our "classic" instruction set and is NOT recommended for general usage (with J19 installed). Register locations can and will often vary from one product to another. Using the RXX command will not generally cause any disruption to normal operation; however, there is no guarantee that register functions will remain stable from software revision to revision, and/or from product to product. This command is provided for test and development purposes only. The command, R38 will return the current time base value 64XX (default value, for example), where XX is a random value.

The GET Command "G" (J19 = I/R):

The "GXX" command is used to select a node (similar to "LXX" command), and return a 16 character string. The returned string is in the format: (CA)(ID)-(OL)(OR)(IL)(IR)(CS)* where CA = the communications address (location), ID = a code indicating the I/O structure of the AT1616L (fixed at 0Fh), an ASCII "-", OL = Output Left relay status, OR = Output Right relay status, IL = Input Left status, IR = Input Right status, CS =

Check Sum Value, and an ASCII "*" to end the string. The "GXX" command will disable all modules except the one addressed by "GXX." **All other units are disabled by this command and only the specific unit selected is active for subsequent commands.**

A typical communications string from a host computer and a response from a slave unit would be as follows:

Host: G0F (ASCII/ASCII-HEX)
Response from slave unit: 0FF0-223301005B* (ASCII-HEX)

G	(048H)	Command character
0	(030H)	High nibble of communications address (CA)
F	(046H)	Low nibble of communications address (CA)

A typical response string is as follows (J15, J24 installed):

DELAY		0 to 1mSEC response delay (50uS typical)
0	(030H)	Communications Address MSN
F	(046H)	Communications Address LSN
F	(046H)	ID code for I/O type (fixed code), MSN
0	(030H)	ID code LSN
-	(2DH)	"-" Separator character (dash)
2	(032H)	K1(OL0) – K4(OL3) status (1 = relay on)
2	(032H)	K5(OL4) – K8(OL7) status
3	(033H)	K9(OR0) – K12(OR3) status
3	(033H)	K13(OR4) – K16(OR7) status
0	(030H)	IN1(IL0) – IN4(IL3) status (1 = input closed/on)
1	(031H)	IN5(IL4) – IN8(IL7) status
0	(030H)	IN9(IR0) – IN12(IR3) status
0	(030H)	IN13(IR4) – IN16(IR7) status

5 (035H) Check Sum
B (042H) Check Sum

* (2AH) "*" End of string (asterisk)

Notes: 1) A total of 16 ASCII characters are returned by the slave for the "GXX" command in approximately 20mS at 9600,N,8,1.
2) The check sum should be checked for data integrity. The check sum is formed by adding the first 14-ASCII characters (in HEX) and inverting the least significant byte and appending this value as the last 2-characters of the response string.

Jumper Tables:

Notes and abbreviations:
I = Install jumper (JX), R = Remove Jumper (JX)
PC = Computer MODE
TX = Transmit, RX = Receive, XX = Don't care
H = Hardware jumper
*** = Factory default setting**

JX	MODE	Function (Hardware)
J1	H	I = P3.5 TO RS232 DSR OUTPUT * R = NO CONNECTION TO DSR
J2	H	I = COMMON TO PIN-1 * R = NO CONNECTION TO COMMON
J3	H	I = COMMON TO PIN-3 * R = NO CONNECTION TO COMMON
J4	H	I = 120 OHM TERMINATION R = NO TERMINATION *
J5	H	I = RESET = HIGH TRUE (8051) * R = RESET = LOW TRUE (AVR)
J6	H	A = GRN RX LED = RX/TX ENABLE B = GRN RX LED = RX DATA *

J25	H TERM LEFT	I = LEFT ISOLATED COMMON TO BOARD COMMON (NON-ISO MODE) * R = DISCONNECT ISOLATED COMMON
J26	H TERM LEFT	A = RAW +12V TO ISOLATED INPUTS B = LOCAL +5V TO ISOLATED INPUTS * REMOVED = ISOLATED TERMINAL V+
J27	H TERM RIGHT	A = RAW +12V TO J30-A * B = LOCAL +5V TO J30-A REMOVED = NO VOLTAGE TO J30-A
J28	H	FIXED ZERO OHM “RESISTOR”
J29	H TERM RIGHT	A = N/C = ISOLATED COMMON B = RIGHT ISOLATED COMMON TO BOARD COMMON (NON-ISO MODE) *
J30	H TERM RIGHT	A = CONNECT TO J27-COMMON-PIN B = = LOCAL +5V TO ISOLATED INPUTS * REMOVED = ISOLATED TERMINAL V+
J25-J30	H TERMS	SEE SCHEMATIC FOR ADDITIONAL INFORMATION ON ISOLATED AND NON-ISOALTED MODES OF OPERATION
JXX	H INPUTS	OTHER JUMPERS ARE AVAILABLE TO ISOLATE INDIVIDUAL INPUTS

Note: Do NOT apply voltage to input terminals unless in ISOLATED mode of operation.

JX	MODE	Function (Range 00h - FFh)
J7	PC	Address MSB (I = 128, R = 0)
J8	PC	Address mid (I = 64, R = 0)
J9	PC	Address mid (I = 32, R = 0)
J10	PC	Address mid (I = 16, R = 0)
J11	PC	Address mid (I = 8, R = 0) *
J12	PC	Address mid (I = 4, R = 0) *
J13	PC	Address mid (I = 2, R = 0) *
J14	PC	Address LSB (I = 1, R = 0) *
*	PC	Factory default Address = 0Fh

JX	MODE	JUMPER FUNCTION AND NOTES
J15	PC	USED TO REVERSE ORDER OF OUTPUTS
J24	PC	USED TO REVERSE ORDER OF INPUTS
J16	PC	Reserved
J17	PC	Reserved
J18	PC	DEFAULT TIME BASE (on power-up) I* = 1.0 Second (253S max. time) R = 0.1 Second (25.3S max. time)
J19	PC	I = New Command Structure (Install to use New CMDs !!) R* = "Classic" Command Structure

Baud Rate Selection in any MODE (J20 - J23) (Jumpers sampled on power-up only)					
HEX	J20	J21	J22	J23	Baud
F	I*	I*	I*	I*	9600
E	I	I	I	R	115.2K
D	I	I	R	I	9600
C	I	I	R	R	57.6K
B	I	R	I	I	38.4K
A	I	R	I	R	28.8K
9	I	R	R	I	19.2K
8	I	R	R	R	14.4K
7	R	I	I	I	9600
6	R	I	I	R	4800
5	R	I	R	I	2400
4	R	I	R	R	1200
3	R	R	I	I	600
2	R	R	I	R	9600
1	R	R	R	I	9600
0	R	R	R	R	9600

SUMMARY OF COMMAND STRUCTURE

HOST	RETURN	COMMENTS
LXX	XXII	Locate unit and return the first eight inputs (8-bit), (IL0 thru IL7)
GXX	CAID-OLORILIRCS*	Locate unit and get all I/O status
KXDD	DDDD	Start a timer (8-bit), (X=1-8)
KADD	DDDD	Change all relay outputs (K1-K8)
KBDD	DDDD	Load time base TB (8-bit)
KFDD	DDDD	Change all relay outputs (K9-K16)
I	IIII	Get inputs (16-bit), (See J24 also)
J	DDDD	Jumper status, aux. (16-bit)
V	DDDD	Get software version (16-bit)
U	DDDD	Get unit identification (16-bit)
RXX	DDDD	Get a register pair - test use only!

Note: The first character (and only the first character) is the ASCII command. All other values X,D,O,I,A,B,F, etc. represent an ASCII hex value in the range 0-9, A-F.

TABLE OF SPECIFICATIONS FOR COMMON COMMUNICATIONS STANDARDS:

SPECIFICATIONS		RS232	RS423	RS422	RS485
Mode of Operation		SINGLE-ENDED	SINGLE-ENDED	DIFFER-ENTIAL	DIFFER-ENTIAL
Total Number of Drivers and Receivers on One Line		1 DRIVER 1 RECVR	1 DRIVER 10 RECVR	1 DRIVER 10 RECVR	32 DRIVR 32 RECVR
Maximum Cable Length		50 FT.	4000 FT.	4000 FT.	4000 FT.
Maximum Data Rate		20kb/s	100kb/s	10Mb/s	10Mb/s
Maximum Driver Output Voltage		+/-25V	+/-6V	-0.25V to +6V	-7V to +12V
Driver Output Signal Level (Loaded Min.), (Unloaded Max.)	Loaded	+/-5V to +/-15V	+/-3.6V	+/-2.0V	+/-1.5V
	Unloaded	+/-25V	+/-6V	+/-6V	+/-6V
Driver Load Impedance (Ohms)		3k to 7k	>=450	100	54
Max. Driver Output Current in High Impedance State	Power On	N/A	N/A	N/A	+/-100uA
	Power Off	+/-6mA @ +/-2v	+/-100uA	+/-100uA	+/-100uA
Slew Rate (Max.)		30V/uS	Adjustable	N/A	N/A
Receiver Input Voltage Range		+/-15V	+/-12V	-10V to +10V	-7V to +12V
Receiver Input Sensitivity		+/-3V	+/-200mV	+/-200mV	+/-200mV
Receiver Input Resistance (Ohms)		3k to 7k	4k min.	4k min.	>=12k