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PRELIMINARY INFORMATION

COMMAND STRUCTURE & PROTOCOL FOR THE AT1616L RS485/RS232 SERIAL REMOTE I/O BOARD (COMPUTER MODE, Software Version 01.0C, 10-1-99)

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. 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. 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 three ASCII commands are needed for full control: 1) The "LXX" command addresses the unit and returns the unit address and the input status of IL7 thru IL0; 2) The "K?DD" command can be used to control any one of the sixteen individual relay (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.

Other commands are available to check current I/O status, jumper settings (J8-J24), unit type, and software version. 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 allows for fast control in large multi-drop networks (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 18+ characters) are possible in our "Classic" command mode. The "Classic" command mode is supported to allow for backward compatibility in existing systems.

COMMAND STRUCTURE

The Locate Command "LXX" (with J19 installed):

This command is used to address the unit and echo back the unit address along with the input status (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 Input port. Bit-7 is Input-1 and bit-0 is Input-8. 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, 50uS typical) = 0 to 1mSec.

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)

The Relay (K) Command "K?DD" (J19 must be installed):

This command is used to control all 16 relays (K1 – K16) on the SRC88. A capital "K" (04Bh) followed by "X" (where X = relay # in the range 1 - 8), will use the value "DD" to control the selected relay and/or relay timer. If "?" = A, then all relays in the range 1 – 8, are controlled by the subsequent data "DD". If "?" = F, then all relays in the range 9 – 16, are controlled by the subsequent data "DD". 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. This command is NOT active unless a previous "LXX" or "GXX" command has been executed. If TB = 0.01 seconds, then the relay timers have a range of 0.01 to 25.3 seconds. With 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. It is anticipated that a "KC" subcommand will be implemented in the future to allow for a 16-bit pre-scale counter with maximum delay times of up to 40 hours.

Relay Subcommand "KA" = ("KADD"):

If "K" is followed by "A" (all relays 1 - 8), then the data "DD" is used to control the on/off status of all eight relays (K1 - K8) 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 the relay output port.

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

Host: KAC6 (ASCII/ASCII-HEX)
Response from slave unit: C60A (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 show the current setting for the pre-scale counter (0Ah = 10 decimal, time base = 10 X 10mSec = 100mSec).

K(04Bh) Command Character
A(041h) Subcommand for All Relays (1 – 8)

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, 50uS typical) = 0 to 1mSec.
C(043h) High nibble data of current status of K1 - K4 6(036h) Low nibble data of current status of K5 - K8 0(030h) High nibble of Time Base Counter (TB) A(041h) Low nibble of Time Base Counter (TB)

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

If "X" is in the range 1 - 8 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. 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 SRC88 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 0.1 Sec. on power-up of the unit (0.01 - 2.55 second range). After the timer reaches 000h the selected relay will turn off. For example, if

the command K264 is sent to the SRC88, relay K2 will turn on for approximately 10.0 Sec. (+0.11/-0.01). If the command K601 is sent, relay K6 will turn on for approximately 0.1 Sec. (+0.11/-0.01). It should be noted that the typical time variation on K6 will range from 0.21 Sec. to 0.9 Sec. in this example. This represents a large percentage error for low values of "DD." This uncertainty (+0.11/-0.01Sec.) will be corrected in future versions of the software. It should also 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 5 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. 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, 50uS typical) = 0 to 1mSec.

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

Relay Subcommand "KF" = ("KFDD"):

If "K" is followed by "F" (all relays 9-16), then the data "DD" is used to control the on/off status of all eight relays (K9 – K16) at the same time. Timers are not available in this range of relays. The first nibble controls K9 – K12 (Bit-7 = K9) and the second nibble controls K13 – K16 (Bit-0 = K16). 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 the relay output port.

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

Host: KFC6 (ASCII/ASCII-HEX)
Response from slave unit: C60A (ASCII-HEX)

The first two nibbles indicate that the relay port has been changed to the desired value "C6." C6 = 1100 0110 Binary. Relays K9, K10, K14 and K15 are on (closed) and K11, K12, K13 and K16 are off (open). The next two nibbles show the current setting for the pre-scale counter (0Ah = 10 decimal, time base = 10 X 10mSec = 100mSec).

K(04Bh) Command Character
F(046h) Subcommand for All Relays(9-16)

C(043h) High nibble data for K9 – K12 (K9 and K10 are on)
6(036h) Low nibble data for K13 – K16 (K14 and K15 are on)

Delay (for response, 50uS typical) = 0 to 1mSec.
C(043h) High nibble data of current status of K9 – K12
6(036h) Low nibble data of current status of K13 – K16
0(030h) High nibble of Time Base Counter (TB) A(041h) Low nibble of Time Base Counter (TB)

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.

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 = 0.01-2.53 seconds)
"DD" = 00Ah = 0.1 second (Default at power-up)
(Relay KX range = 0.1-25.3 seconds)
"DD" = 032h = 0.5 second
(Relay KX range = 0.5-126.5 seconds)

"DD" = 064h = 1.0 second
(Relay KX range = 1.0-253 seconds)
"DD" = 0C8h = 2.0 seconds
(Relay KX range = 2.0-506 seconds)
"DD" = 0FAh = 2.5 seconds
(Relay KX range = 2.5-632.5 seconds)
"DD" = 0FDh = 2.53 seconds (maximum value)

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

This command is used to retrieve the output status (16-bits) from the unit. This command is NOT active unless a previous "LXX' or "GXX" command has been executed. The return string is 4 ASCII-HEX characters, in the form "OUTL-OUTR" where OUTL = (OL7 OL6 OL5 OL4) (OL3 OL2 OL1 OL0), and OUTR = (OR7 OR6 OR5 OR4) (OR3 OR2 OR1 OR0). Outputs are high when normally open relays are closed.

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. 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). Inputs are active on "dry" closure or when current (1.0mA) flows through the input, depending on input jumper settings.

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

The jumper command, J will read the current jumper status (J9-J24) of the SRC88 and return the string DDDD (16-bit value). This command will NOT normally return the communications address of the unit. The data loaded into these registers will vary from unit type to unit type.

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 installed, not used):

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. 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.

Jumper Tables:

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

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 J17	PC	DEFAULT TIME BASE (on power-up only)		
		J9	J10	Default time base setting
		I*	I*	1.0 Second (253S max. time)
		I	R	0.5 Second (126.5S max. time)
		R	I	0.1 Second (25.3S max. time)
		R	R	2.0 Second (506S max. time)
J18	PC	I* = Disable relay drop-out control (no change). R = Enable relay drop-out if no RX (network activity) for 5 seconds.		
J19	PC	I* = New Command Structure 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	NODE	COMMENTS
LXX	XXII	Locate unit and return the first eight inputs (8-bit), (IL7 thru IL0)
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)
H	OOOO	Get outputs (16-bit), (See J15 also)
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!
	DDDD*	Returns ON/OFF status of K1 thru K16 (See J15 also), (OL0-OL7 and OR0-OR7 on the circuit board)

Note: The first character (and only the first character) is the ASCII command. All other values X,D,O,I,A,B 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	1 DRIVER 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