

Logosol Joystick Node LS-731

Doc# 712731001, Rev. 1.2, 05/21/2002

Features

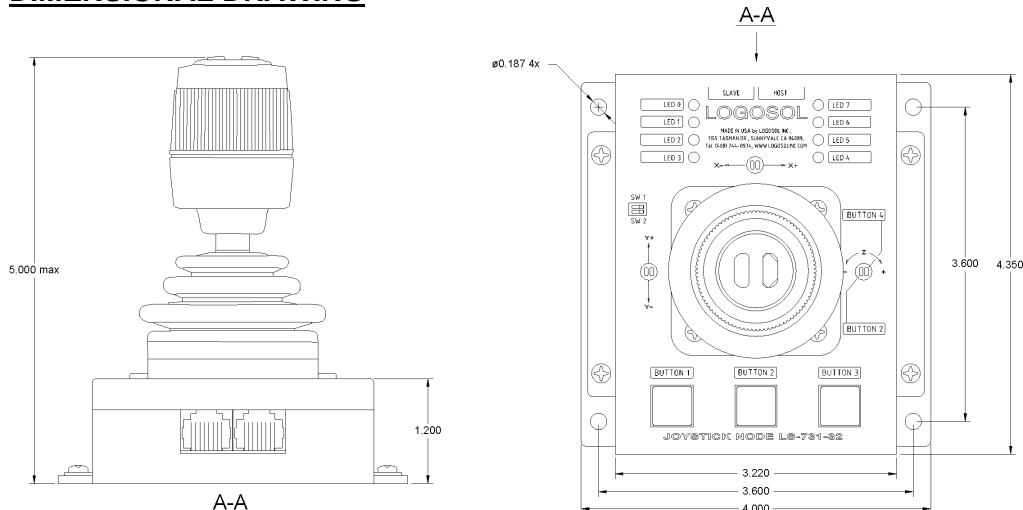
- ❑ 2 and 3 axis models
- ❑ Travel ± 20 deg
- ❑ Non contact hall effect joystick
- ❑ Mechanical MTBF 15,000,000 cycles
- ❑ 3 pushbuttons
- ❑ Up to 2 stick pushbuttons
- ❑ 8 LEDs
- ❑ Member of Logosol's distributed motion control network
- ❑ Communication speed 19.2 ÷ 115.2 Kbps
- ❑ Command rate up to 1000/sec
- ❑ Small footprint (4.35" x 4.00" x 4.90")



Description:

LS-731 is a multifunctional joystick controller designed for a wide range of applications. This controller is a member of Logosol's distributed motion control network (LDCN). Up to 31 LDCN compatible nodes can be controlled over a multi-drop full duplex RS-485 network. Standard RJ-45 connectors and commercially available cables are used to connect modules into a network.

DIMENSIONAL DRAWING



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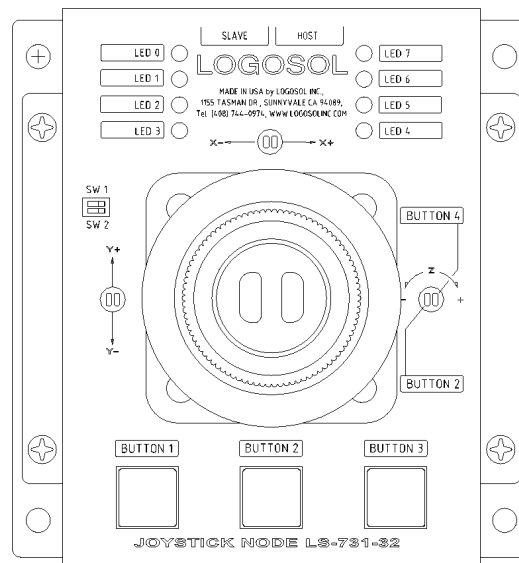
TECHNICAL SPECIFICATIONS rated at 25°C ambient

POWER SUPPLY VOLTAGE	4.75 to 5.25 V DC
POWER CONSUMPTION	<50 mA
NUMBER OF AXIS LS-731-2x LS-731-3x	2 3
AXES RESOLUTION	8 bits
PUSHBUTTONS	3 (Button1, Button2, Button3)
STICK PUSHBUTTONS LS-731-x0 LS-731-x1 LS-731-x2	NA 1 (Button4) 2 (Button2, Button4)
LEDS	8
THERMAL REQUIREMENTS Storage temperature range Operating temperature range	-30 to +85 °C 0 to 45 °C
MECHANICAL Size Weight	L=4.35", H=4.00", D=4.90" 0.6 lb. (0.260 kg)
MATING CONNECTORS Power Supply and communication	8 pin RJ-45

ORDERING GUIDE

PART NUMBER	MODEL	DESCRIPTION
912731001	LS-731-20	Joystick Node 2 axis, no stick pushbuttons
912731002	LS-731-21	Joystick Node 2 axis, 1 stick pushbutton
912731003	LS-731-30	Joystick Node 3 axis, no stick pushbuttons
912731004	LS-731-32	Joystick Node 3 axis, 2 stickpushbuttons

CONNECTORS AND PINOUT



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DIP SWITCH

SW	SIGNAL	DESCRIPTION
1	SW 1	Power supply source select
2	SW 2	Power supply source select

SLAVE

PIN	SIGNAL	DESCRIPTION
1	+5V slave	+5V power supply from slave (SW 1=on), Not connected (SW 1=off)
2	GND	Interface ground
3	+TX	(+) Transmit data
4	-TX	(-) Transmit data
5	-RX	(-) Receive data
6	+RX	(+) Receive data
7	-A out	(-) Address output
8	+A out	(+) Address output

HOST

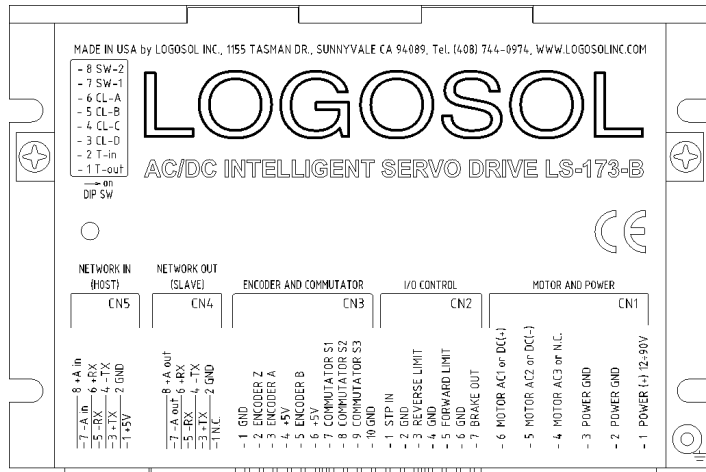
PIN	SIGNAL	DESCRIPTION
1	+5V	+5V when SW 1=on, Not connected when SW 1=off
2	GND	Interface ground
3	+TX	(+) Transmit data
4	-TX	(-) Transmit data
5	-RX	(-) Receive data
6	+RX	(+) Receive data
7	+5V host	+5V Power supply from host (SW 2=on and SW 1=off)
8	+A in	(+) Address input

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SAMPLE APPLICATION for networking with other LDCN nodes.

LS-731 is powered from the network node (LS-173-B as shown) connected to its slave connector.



+
- POWER SUPPLY

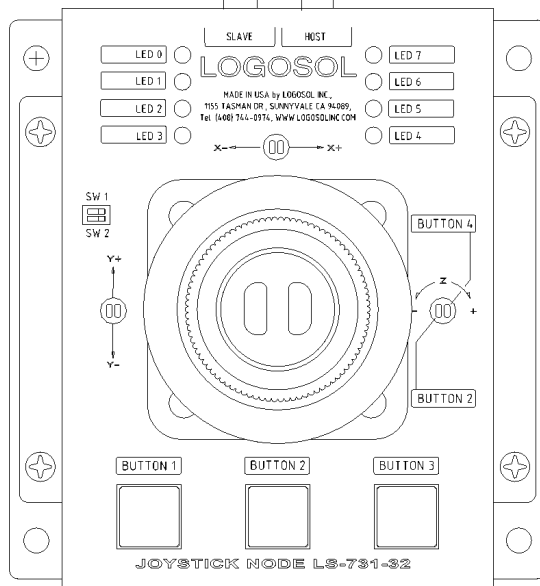
RJ45 to other network device

RJ45

RJ45 to LS-801 ADAPTER or other network device

RJ45

SW 1= on
SW 2= off

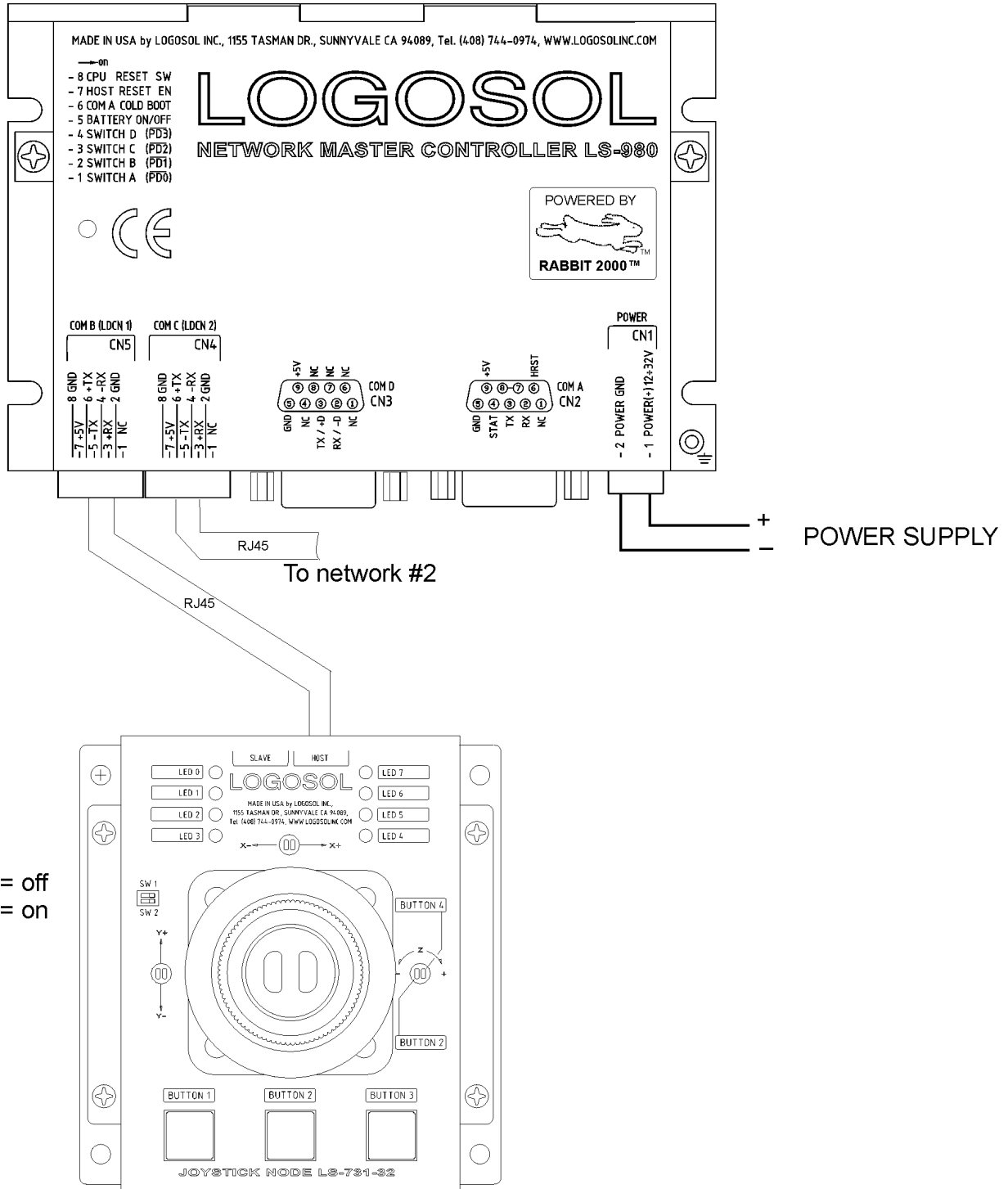


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SAMPLE APPLICATION with Master Controller LS-980

LS-731 is powered from the host (LS-980 as shown).



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LOGOSOL LS-731 QUICK START GUIDE

Hardware Setup

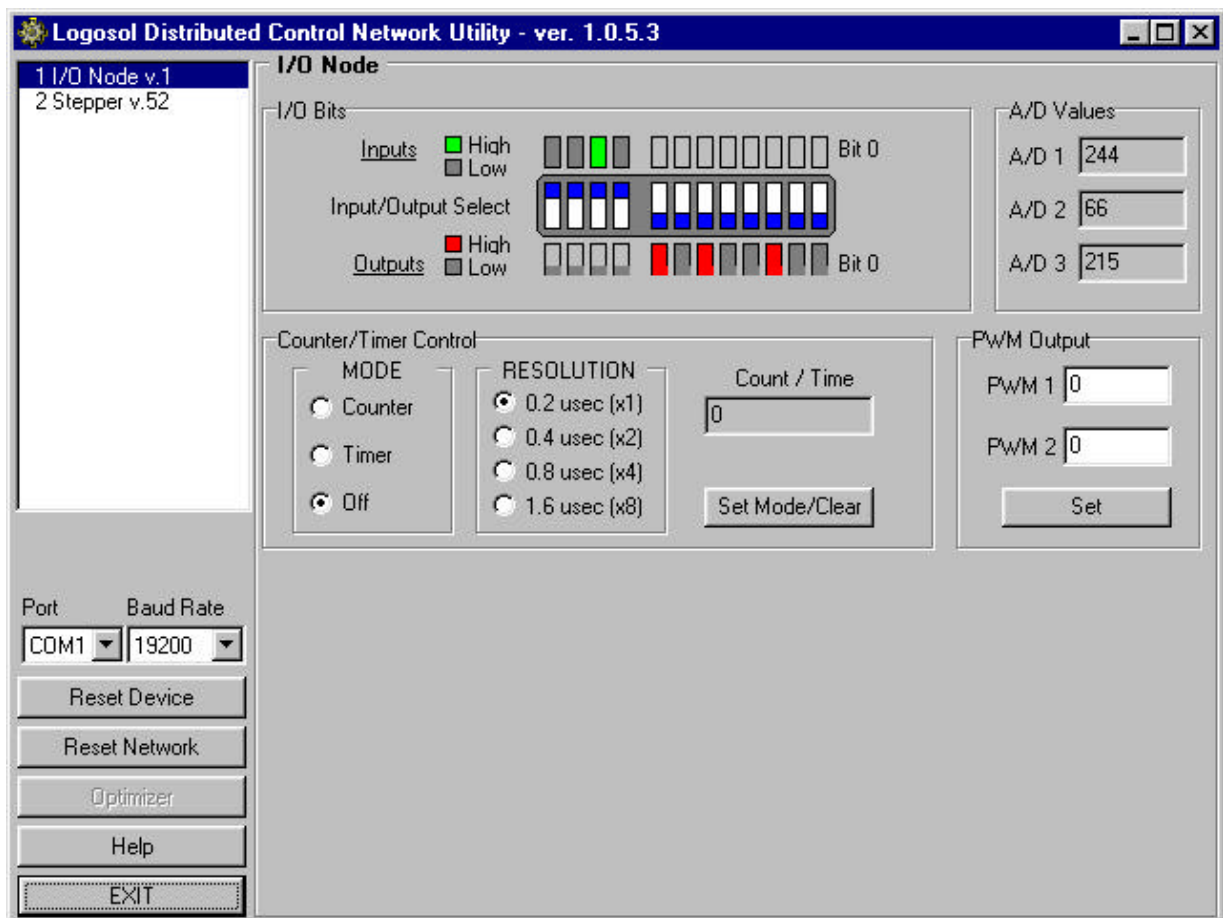
Connect LS-731 to the Network as it is shown in samples above.

Software Installation

1. Installation and using Logosol Distributed Control Network Utility

A. Installation

1. Insert the Logosol Distributed Control Network Utility installation disk into the floppy drive.
2. Select Run from the Windows 95/98/NT Start menu.
3. Type a:\dcnsetup and then click OK (a: represents the drive letter).
4. The installation wizard will guide you through the setup process.



B. Initial Connection to the Host

1. Turn on the power supply.
2. Run the Logosol Distributed Control Network Utility.
3. Choose the proper COM port
4. You will see the IO node specific screen¹.
5. Setup I/O bits bit0 ÷ bit7 as outputs.

¹ Counter Mode and PWM1, PWM2 are not available with Joystick Node LS-731

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2. Installation and using Logosol Motion Control Center

A. Installation

1. Insert the Logosol Motion Control Center installation disk into the floppy drive.
2. Select Run from the Windows 95/98/NT Start menu.
3. Type a:\mccsetup and then click OK (a: represents the drive letter).
4. The installation wizard will guide you through the setup process.

B. Initial Connection to the Host

1. Turn on the power supply.
2. Run the Logosol Motion Control Center software.
3. From the **Connection** menu select **Terminal**. This will open a terminal window. From the **Target** pull-down list select either RS-485-COM1 or RS-485-COM2 corresponding to the one used to communicate with LS-731. Press the Return key to verify that the connection is established and the command prompt (>) appears on the terminal window.
4. Type **INI** at the command prompt followed by Return to initialize the controller. It may take few seconds to complete the process.
6. Type **XST** to check the status of LS-731 Joystick Node and refer to the following MCL Terminal Interpreter Command Set for executing various commands.

MCL TERMINAL INTERPRETER COMMAND SET

The following commands are available from the Terminal prompt:

XST – displays status information:

- 1) **“XST”** displays status info for all modules on the network;
- 2) **“XST A1”** displays status info for module A1.

Status information for module LS-731 includes:

- 1) Address
- 2) Status byte
- 3) Inputs bytes
- 4) Analog In0 (X axis)
- 5) Analog In1 (Y axis)
- 6) Analog In2 (Z axis)
- 7) Counter value
- 8) Device ID
- 9) Version number

VER – returns MCL interpreter version.

IN – returns the state of the pushbuttons.

- 1) **“IN”** returns the state of all 4 pushbuttons of all modules;
- 2) **“IN A1X2”** returns the state of pushbutton 2 of module A1.

OUT – returns or sets the state of the outputs.

- 1) **“OUT”** returns the state of all 8 LEDs of all modules;
- 2) **“OUT A1X1”** returns the state of LED 1 of module A1;
- 3) **“OUT A1X3=0”** turns off the LED 3 of module A1;
- 4) **“OUT A1X1=1”** turns on the LED 1 of module A1.

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INI – resets the network and assigns individual addresses if necessary.

ADC – returns the value of the analog inputs (Joystick axes positions):

- 1) **“ADC”** returns the values of all analog inputs of all modules;
- 2) **“ADC A1X0”** returns the value of the analog input 0 of module A1.

HEX – hex command mode – sends a low-level command written in hexadecimal format. For more information about command format refer to “Command Description” section in this document. Start byte (AA) and checksum byte are generated by the MCL interpreter:

“HEX 01 13 04” - sends “Read Status” command (code 0x13) for module #1 with data byte = 0x04.

BDR – sets different baud rate (19200, 57600 and 115200)

“BDR 115200” - sets baud rate to 115.2 Kbps.

Note: baud rate is set to 19.2 Kbps after power-up.

HIS – shows the history of the last used commands, their hexadecimal codes and the returned status bytes.

EXE – executes a text file containing sequence of MCL commands.

“EXE control.dat” - executes the command sequence from “*control.dat*” file in current directory.

NET – displays number and types of all modules on the network and their addresses.

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COMMUNICATIONS WITH LS-731

Serial Command Interface

The serial communication with the LS-731 nodes adheres to a full-duplex (4 wire) 8 bit asynchronous protocol with one start bit, followed by 8 data bits (lsb first), followed by a single stop bit.

The communication protocol also supports a full-duplex multi-drop RS-485 interface, which allows multiple LDCN nodes to be controlled over a single RS-485 port. In this case, the host sends commands over its RS-485 transmit line and receives all status data back over the shared RS-485 receive line. The command protocol is a strict master/slave protocol in which the host master sends a command packet over the command line to a specific LS-731 slave. The Node sends back a status packet. Typically, the host does not send another command until a status packet has been received to insure that it does not overwrite any previous command data still in use.

Each command packet consists of the following:

Header byte (0xAA)

Address byte - individual or group (0x00 - 0xFF)

Command byte

0 - 15 data bytes

Checksum byte

The command byte is divided into upper and lower nibbles: the lower nibble is the command value; the upper nibble is the number of additional data bytes, which will follow the command byte. The checksum byte is 8-bit sum of the address byte, the command byte and the data bytes. The number of data bytes depends on the particular command chosen. After a command is issued, the corresponding node will send back a status packet consisting of:

Status byte

Optional bytes of status data

Checksum byte

The Status Byte contains basic status data about the LS-731, including a checksum error flag for the command just received. The number and the meaning of Optional Status Data Bytes are programmable by the user and may include any, none or all of data available from the module. The checksum byte is the 8-bit sum of the status byte and the additional optional status data bytes. All 16-bit and 32-bit data is sending with the least significant byte first.

Addressing

Rather than using hard-wired or switch-selected address of each LDCN node, the host dynamically sets the address of each LDCN node with the aid of the daisy-chained "A in" and "A out" lines. This allows additional LDCN nodes to be added to an RS-485 network with no hardware changes. On Power-up, "A in" of the first LDCN node is pulled low, its communication is enabled and the default address is 0x00. When the *Set Address* command is issued to give this node new unique address, it will lower its "A out" line. Connecting "A out" to the "A in" of the next node on the network will enable its communication at default address of 0x00. Repeating this procedure allows a variable number of controllers present to be given an unique addresses.

Group Addresses

In addition to the individual address, each node has a secondary group address. Several LDCN nodes may share a common group address. This address is useful for sending

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commands, which must be performed simultaneously by a number of nodes (e.g. *Set Baud Rate*, etc.). When a LS-731 receives a command sent to its group address, it will execute the command but not send back a status packet. This prevents data collisions on the shared response line. When programming group addresses, however, the host can specify that one member of the group is the "group leader". The group leader will send back a status packet just like it would for a command sent to its individual address. The group address is programmed at the same time as the unique individual address using the *Set Address* command.

Changing Communications Rates

The default baud rate after Power-up is 19.2 Kbps. Baud rates up to 115.2 Kbps may be used. After communication has been established with all nodes on a single network, the baud rate may be changed to a higher value with the *Set Baud Rate* command.

LS-731 I/O BITS MAPPING.

Pushbuttons

BIT	IO11	IO10	IO9	IO8
I/O	INPUT	INPUT	INPUT	INPUT
FUNCTION	BUTTON4	BUTTON3	BUTTON2	BUTTON1

LEDs

BIT	IO7	IO6	IO5	IO4	IO3	IO2	IO1	IO0
I/O	OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT
FUNCTION	LED8	LED7	LED6	LED5	LED4	LED3	LED3	LED1

Axis position inputs²

A/D 1	A/D 2	A/D 3
X axes	Y axes	Z axes

² Axis Position inputs are 8-bit values

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COMMAND SPECIFICATION

The following section describes in detail the commands available for the LS-731.

Command	CMD Code	# Data bytes	Description
Set Direction	0x0	2	Sets the direction (input or output) of the I/O lines
Set Address	0x1	2	Sets the individual and group addresses
Define Status	0x2	1	Defines which data should be sent in every status packet
Read Status	0x3	1	Causes particular status data to be returned just once
---	0x4	0	Not used
Synch Output	0x5	0	Outputs previously stored output bits
Set Outputs	0x6	2	Immediately sets the states of the output bits
Set Synch Output	0x7	4	Stores output bit values to be synchronously set with the <i>Synch Output</i> command
Set Timer Mode	0x8	1	Turns timer mode on or off and sets timer mode prescaler
---	0x9	0	Not used
Set Baud Rate	0xA	1	Sets the baud rate (group command only)
---	0xB	0	Not used
Synch Input	0xC	0	Synchronously stores the input bit values and the timer value
---	0xD	0	Not used
Nop	0xE	0	Simply causes the defined status data to be returned
Hard reset	0xF	0	Resets the controller to its power-up state.

LS-773 Command Description

Set Direction

Command value: 0x0
Number of data bytes: 2
Command byte: **0x20**
Data bytes:

1. Direction bits for I/O bits 1 to 8
Bit 0: Direction bit for I/O bit 1 (0 = output, 1 = input)
Bit 1: Direction bit for I/O bit 2
Bit 2: Direction bit for I/O bit 3
Bit 3: Direction bit for I/O bit 4
Bit 4: Direction bit for I/O bit 5
Bit 5: Direction bit for I/O bit 6
Bit 6: Direction bit for I/O bit 7
Bit 7: Direction bit for I/O bit 8
2. Direction bits for I/O bits 9 to 12
Bit 0: Direction bit for I/O bit 9
Bit 1: Direction bit for I/O bit 10
Bit 2: Direction bit for I/O bit 11
Bit 3: Direction bit for I/O bit 12
Bits 4-7: don't care.

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Description:

Sets the directions of all 12 I/O bits. This command should be executed during initialization of the LS-731 node with data byte 1 = 0x00 and data byte 2 = 0x0f.

Set Address

Command value: 0x1

Number of data bytes: 2

Command byte: **0x21**

Data bytes:

1. Individual address: 0x00-0x7F (initial value 0x00)
2. Group Address: 0x80-0xFF (initial value 0xFF)

Description:

Sets the individual address and group address. Group addresses are always interpreted as being between 0x80 and 0xFF. If a LS-731 is to be a group leader, clear bit 7 of the desired group address in the second data byte. LS-731 will automatically set bit 7 internally after flagging itself as a group leader. (If bit 7 of the second data byte is set, the module will be by default a group member.) The first time this command is issued after power-up or reset, it will also enable communications for the next module on the network chain by lowering the it's "A out" signal.

Define Status

Command value: 0x2

Number of data bytes: 1

Command byte: **0x12**

Data bytes:

1. Status items: (default: 0x00)

- Bit 0: send I/O Byte 0 and Byte 1 (2 bytes)
(pushbutton 1 is bit 0 in I/O byte 1, pushbutton 2 is bit 1 in I/O byte 1, and so on)
- 1: send ANALOG IN 0 value (1 byte) – Joystick X axis
- 2: send ANALOG IN 1 value (1 byte) – Joystick Y axis
- 3: send ANALOG IN 2 value (1 byte) – Joystick Z axis
- 4: send timer value (4 bytes, least significant first)
- 5: send device ID, version number (2 bytes)
(LS-731 device ID = 2, version number = 1)
- 6: send I/O bit values captured with the Synch Input command (2 bytes)
- 7: send timer value captured with the Synch Input command (4 bytes)

Description:

Defines what additional data will be sent in the status packet along with the status byte. Setting bits in the data byte will cause the corresponding additional data to be included in the status packet. The status data will always be sent in the order listed. For example if bits 0 and 3 are set, all subsequent status packets will consist of the status byte followed by two bytes of I/O bit data, followed by the Z axis value, followed by the checksum. The status packet returned in response to this command will include the additional data bytes specified. On power-up or reset, the default status packet will include only the status byte and the checksum byte.

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Read Status

Command value: 0x3
Number of data bytes: 1
Command byte: **0x13**
Data bytes:

1. Status items: (default: 0x00)

- Bit 0: send I/O Byte 0 and Byte 1 (2 bytes)
(pushbutton 1 is bit 0 in I/O byte 1, pushbutton 2 is bit 1 in I/O byte 1, and so on)
- 1: send ANALOG IN 0 value (1 byte) – Joystick X axis
2: send ANALOG IN 1 value (1 byte) – Joystick Y axis
3: send ANALOG IN 2 value (1 byte) – Joystick Z axis
4: send timer value (4 bytes, least significant first)
5: send device ID, version number (2 bytes)
(LS-731 device ID = 2, version number = 1)
6: send input bit values captured with the Synch Input command (2 bytes)
7: send timer value captured with the Synch Input command (4 bytes)

Description:

This is a non-permanent version of the *Define Status* command. The status packet returned in response to this command will incorporate the data bytes specified, but subsequent status packets will include only the data bytes previously specified with the *Define Status* command.

Synch Output

Command value: 0x5
Number of data bytes: 0
Command byte: **0x05**
Data bytes:
None

Description:

Synchronously set the LED values previously stored with the *Set Synch Output* command.

Set Output

Command value: 0x6
Number of data bytes: 2
Command byte: **0x26**
Data bytes:
1. Output Byte 0 – LED 1 to 8 values
2. Output Byte 1 – don't care

Description:

Immediately sets the values for the LEDs.

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Set Synch Output

Command value: 0x7
Number of data bytes: 2
Command byte: **0x27**
Data bytes:
1. Bit values for LEDs 1-8
2. Set this byte to 0x00

Description:

Stores output bit values in internal registers to be set synchronously with the *Synch Output* command.

Set Timer Mode

Command value: 0x8
Number of data bytes: 1
Command byte: **0x18**
Data bytes:
1. Timer mode configuration byte
Bit 0: 0 = Timer disabled, 1 = Timer enabled
Bit 1: Should be 0
Bits 5,4: 00 = No prescaler (5 MHz)
01 = 2:1 prescaler (2.5 MHz)
10 = 4:1 prescaler (1.25 MHz)
11 = 8:1 prescaler (0.625 MHz)
Bits 2,3,6,7: are not used

Description:

Sets the operating mode of the timer. In timer mode, the LS-731 counts its 5.0 MHz internal clock. The prescaler can be used to slow down the clock.

Set Baud Rate

Command value: 0xA
Number of data bytes: 1
Command byte: **0x1A**
Data bytes:
1. Baud rate divisor, BRD
sample values:
9600 BRD = 0x81
19200 BRD = 0x3F
57600 BRD = 0x14
115200 BRD = 0x0A

Description:

Sets the communications baud rate. All modules on the network must have their baud rates changed at the same time, therefore this command should only be issued to a group including all of the modules on the network. A status packet returned from this command would be at the new baud rate, so typically, there should be no group leader when this command is issued. (Note that the host's baud rate must also be changed for subsequent communication.)

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Synch Input

Command value: 0xC
Number of data bytes: 0
Command byte: 0x0C
Data bytes:
None

Description:

Causes the current input bit values and the timer value to be synchronously stored in the LS-731's internal registers. These values can be read using the *Read Status* or the *Define Status* commands.

No Operation

Command value: 0xE
Number of data bytes: 0
Command byte: 0x0E

Description:

Does nothing except that causes a status packet with the currently defined status data to be returned.

Hard Reset

Command value: 0xF
Number of data bytes: 0
Command byte: 0x0F

Description:

Resets modules to their power-up state. No status will be returned. Typically, this command is issued to all modules on the network, although if the baud rate is set to the default value, it is possible to reset and re-initialize the addresses of a contiguous sub-chain of modules.

Status Byte

The first byte of each status packet is the status byte. The LS-731 has only one bit defined: *if bit 1 of the Status Byte is set*, the LS-731 detected a *checksum error* in most recently command packet. Bits 0, 2, 3, 4, 5, 6 and 7 are undefined and can be ignored.

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Initializing Procedure and Programming Examples for LS-731

To ensure a proper operation of LS-731 joystick node connected to the network, the addresses for all connected units must be set.

Understanding the Serial Communication with LS-731

The Serial Communication with LS-731 is strictly master-slave and includes repeatedly two elements:

- Sending a command to the specified node's address;
- Receiving answer to the sent command – Status Byte(s).

Note: During the communication all bytes are sent with LSB first.

Commands

There are 12 commands controlling LS-731 nodes (refer to LS -731 Command Description). Each command as shown in the following two tables includes header, address, command, data bytes and one checksum byte. Checksum does not include the header byte.

Structure of *Read Status* command

Byte 1	Byte 2	Byte 3		Byte 4	Byte 5
Header	Address (Individual or Group)	Command Code		Data Byte	Checksum = Byte 2 + Byte 3 + Data Byte
		High 4 bits number of data bytes	Low 4 bits command code		
AA	01	1	3	01	15

Examples

Cmd. Bytes	Byte 1	Byte 2	Byte 3	Byte 4 – N	Byte N+1
Command	Header	Address	Cmd. Code	Data Byte(s)	Checksum
No operation	AA	01	0 E		0F
Define Status	AA	01	1 2	05	18
Set Address	AA	01	2 1	07 FF	28
Set Outputs	AA	01	2 6	01 00	28

Status Data

The structure of the returned status information depends on *Define Status* or *Read Status* commands (refer to LS-731 Command Description). By default only the Status byte and Checksum are returned to the host. Normally the returned Status Byte is 00h.

Examples

Byte 1	Optional Bytes 0-16	Checksum
Status Byte	Additional Status Bytes as inputs, A/Ds, timer, version, etc.	Checksum = Byte 1 + Optional Bytes
00	no additional status bytes requested	00
00	01 23 05 10 – four additional status bytes	39

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Addressing

Each node on the daisy-chained network has two addresses:

- Individual - for individual control of each node. It is from 01h to 7Fh.
- Group - for simultaneous control of all group members by sending a single command to their group address. It is between of 80h to FFh.

Both individual and group addresses have to be set during the initialization process.

The group may have Group leader responsible to send status data. Its address is:

Group leader address = Group address - 80h.

If there is no group leader - no status data will be send after a group command.

Set Baud Rate command must be sent only as a group command with no group leader, otherwise communication problems may occur.

Set Address Command:

Next table presents the structure of *Set Address* command. The preset address 00h is set by the firmware after power-up.

Example of *Set Address* command

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Header	Preset Address	Command code	Individual Address	Group Address	Checksum
AA	00	21	01	FF	21

Setting the Addresses

After power-up and *Hard Reset* command all nodes have their address set to 00h and only the first node (starting from the host) has its communication enabled. Consecutive *Set Address* commands are sent to address 00h until all nodes are addressed. This procedure can be executed once after *Hard Reset*. The table below shows the steps to address 3-nodes network.

Example of sequential addressing for three LDCN nodes

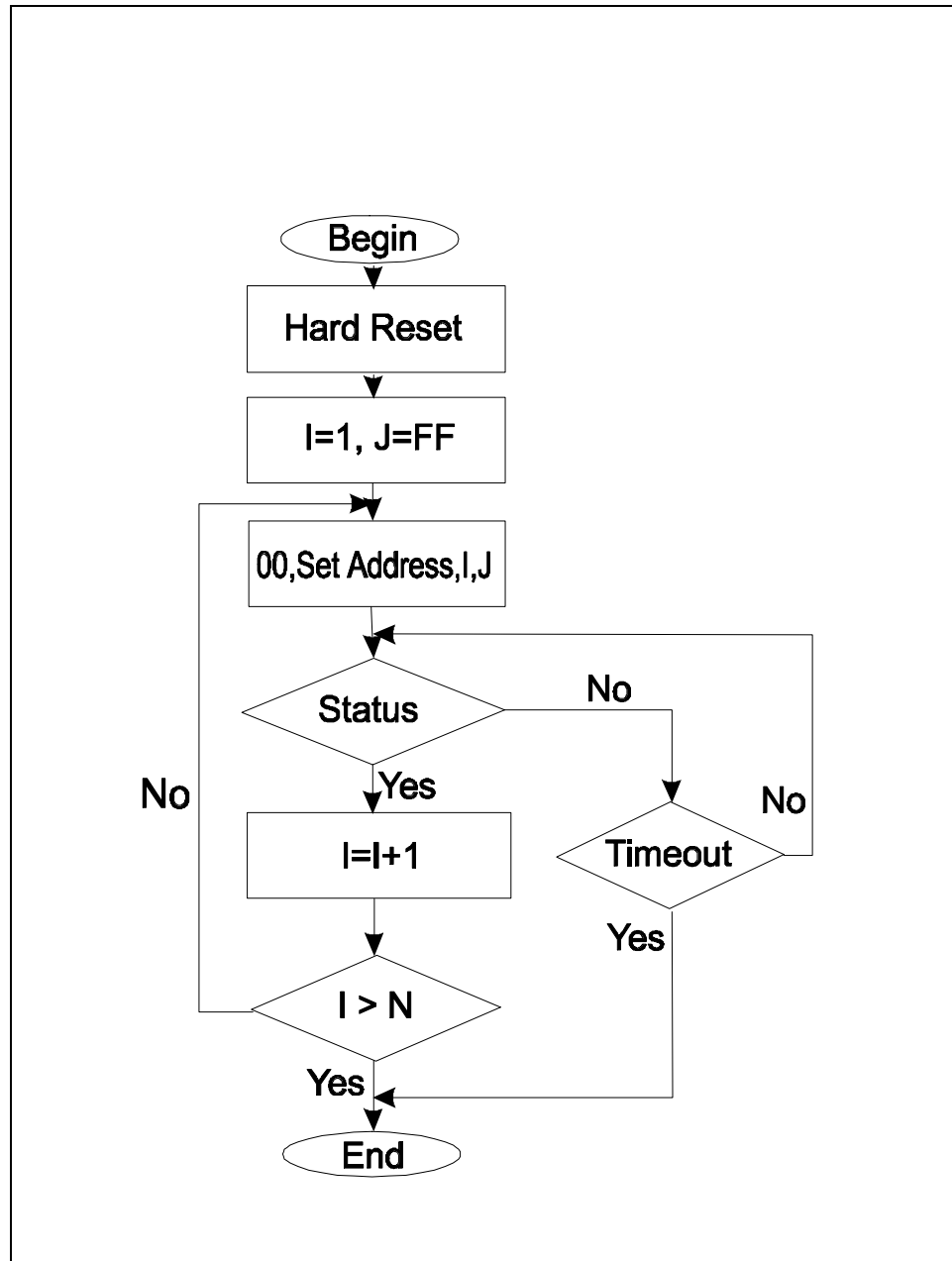
Step	Command	Set address Hexadecimal Code	Node 1		Node 2		Node 3	
			Individual address	Group address	Individual address	Group address	Individual address	Group address
0	Power-up							
1	Hard Reset	AA FF 0F 0E	address=00 communication <i>enabled</i>		address=00 communication <i>disabled</i>		address=00 communication <i>disabled</i>	
2	Set Address Node1 = 01	AA 00 21 01 FF 21	01	FF	address=00 communication <i>enabled</i>		address=00 communication <i>disabled</i>	
3	Set Address Node2 = 02	AA 00 21 02 FF 22	01	FF	02	FF	address=00 communication <i>enabled</i>	
4	Set Address Node3 = 03	AA 00 21 03 FF 23	01	FF	02	FF	03	FF

Note: Before start addressing *Hard Reset* command must be issued.

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The flowchart shows the addressing procedure of N drives network. There is no group leader and the group address is FF.



I - Individual Address; *J* - Group Address = FF;
Status - Status Data sent to the Host; *Timeout* - Greater than one servo circle.

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Examples of Managing LS-731 Node

- # 1 - Resets network with group command.
- # 2 - Sets the address of LS-731.
- # 3 - Checks if there are more LDCN nodes, connected to the network.
- # 4 - Reads the pushbuttons states.
- # 5 - Reads analog inputs (axes positions).
- # 6 - Sets the LED values.

Examples

#	Hexadecimal code of command	Comments
1	AA FF 0F 0E	<i>Hard Reset</i>
2	AA 00 21 01 FF 21	Sets address 01h for node 1. Group address is FFh.
3	AA 00 21 02 FF 22	Sets address 02h for node 2. Group address is FFh.
4	AA 01 13 01 15	Reads pushbuttons states of node 1. Use <i>Read Status</i> command. Set Data Byte to 01h to read the inputs.
5	AA 01 13 0E 22	Reads axes positions. Use <i>Read Status</i> command. Set Command Byte to 0Eh. When Command Bits 1, 2 and 3 are set to 1 the axes positions are requested.
6	AA 01 26 07 00 2E	Sets LEDs 0, 1 and 2 of node 1. Second output byte is 00h.