

# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

Doc # 712173038 / Rev. B, 01/27/2005

## Features

- ❑ **Motors supported:**
  - Brushless 60/120° commutated
  - Brush-commutated (DC)
- ❑ **14-bit Servo Feedback Input**
- ❑ **Output current**
  - 12A peak, 8A continuous
  - 20A peak, 12A continuous
- ❑ **9 to 90V single power supply**
- ❑ **14-bit position, 24-bit velocity and acceleration, 16-bit PID filter gain values**
- ❑ **Backlash compensation**
- ❑ **Hardware stop input**
- ❑ **Over-travel protection**
- ❑ **Comprehensive motor output short-circuit protection:**
  - Output to output
  - Output to ground
- ❑ **Adjustable motor current limit**
- ❑ **Over/under voltage shutdown**
- ❑ **Overheating protection**
- ❑ **Forward and reverse over travel inputs**
- ❑ **Communication speed 19.2 - 115.2 KBps**
- ❑ **Servo rate 2 kHz**
- ❑ **PWM frequency 20 kHz**
- ❑ **Command rate up to 1000/sec**
- ❑ **Small footprint (5" x 3.3" x 0.85")**



## Description

LS-173AF is a single-axis 14-bit analog feedback motion controller with integrated servo amplifier designed for applications using brushless or brush-commutated motors up to 1 HP. Trapezoidal brushless motor commutation is performed. Up to 31 intelligent servo drives can be controlled over a multi-drop full duplex RS-485 network in a distributed motion control environment. Standard RJ-45 connectors and commercially available cables are used for daisy chaining of the modules. LS-173AF is equipped with various safety features for the motor and amplifier such as short circuit protection, over travel limit, hardware stop input, over and under voltage shutdown. The maximum motor output current can be limited by setting of dipswitches or by software.

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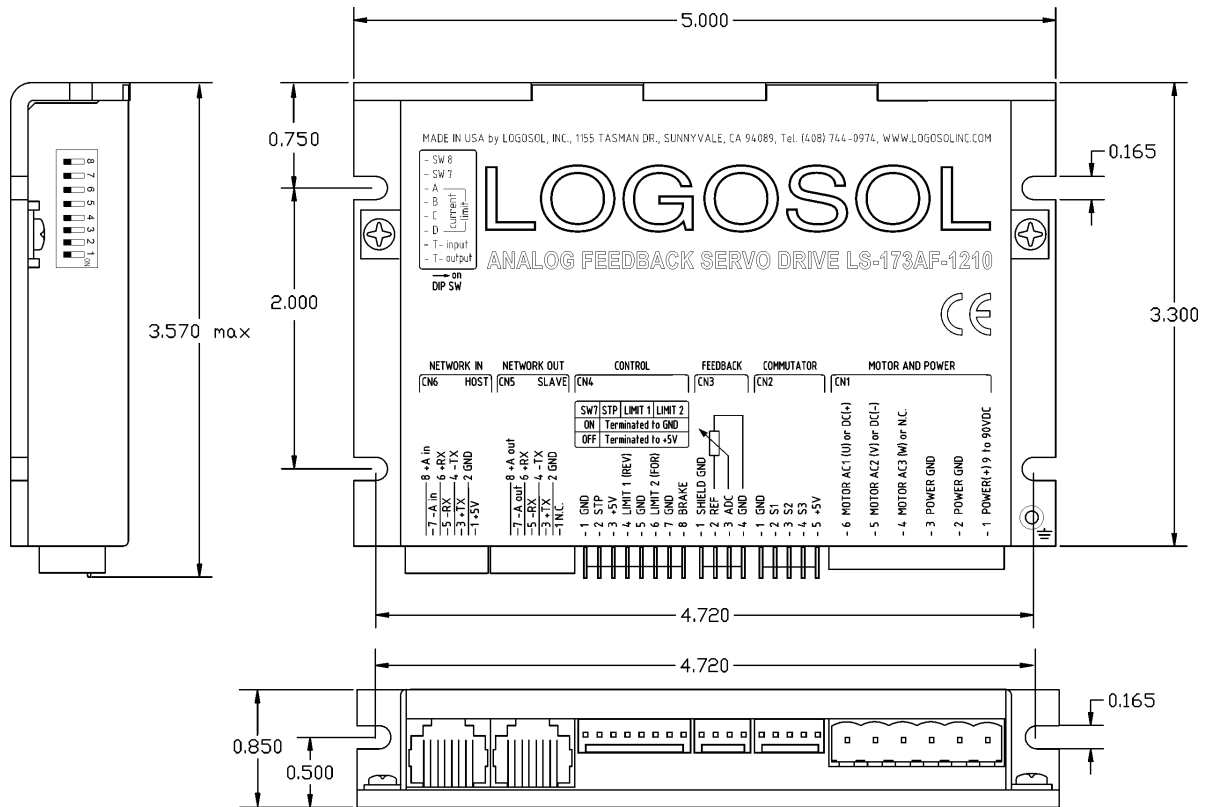
## **TECHNICAL SPECIFICATIONS** rated at 25°C ambient, POWER (+)=60VDC, Load=250μH motor

POWER SUPPLY VOLTAGE	9 to 90 V DC, 100V Absolute Maximum
MAX MOTOR OUTPUT CURRENT LS-173AF-1210 LS-173AF-2010	Peak / Continuous 12A / 8A 20A / 12A
MAX MOTOR OUTPUT VOLTAGE	$V_{out} = 0.96(\text{POWER (+)}) - 0.17(I_{out})$
MIN LOAD INDUCTANCE	200μH
PWM SWITCHING FREQUENCY LS-173AF-1210, LS-173AF-2010	19,531 KHz
SERVO RATE	0.512 msec
POSITION FEEDBACK	14-bit Ratiometric Analog to Digital Converter. 0 to +5V / 2.2MOhm input impedance.
SERIAL BAUD RATE	19.2 – 115.2 Kbps (faster communication rates are possible at lower servo rates)
OPEN COLLECTOR BRAKE OUTPUT Max voltage applied to output Max current load	48V 0.3A
INPUTS Commutation Digital Inputs	TTL with 2K2 pull-up terminators to +5V LOmin=-1V, HImax=35V SW 7 selectable 3K3 pull-up to +5V OR 3K3 pull-down to GND
COMMUTATION	Hall sensors 60/120°
LEDS ORANGE GREEN	Power 'ok' (ORANGE and GREEN LEDES are ON when the Power Servo 'on' is 'OK' and the device is not initialized)
SHORT CIRCUIT PROTECTION	Motor output to motor output, Motor output to POWER GND
OVERHEATING PROTECTION	Activated at 80°C
FIRE-SAFETY	Internal fuse
POWER DISSIPATION (max)	30W
THERMAL REQUIREMENTS Storage temperature range Operating temperature range	-30 to +85°C 0 to 45°C
MECHANICAL Size Weight	L=5.00", H=3.30", D=0.85" 0.55lb. (250gr.)
MATING CONNECTORS Power & Motor Commutator Feedback Control Communication	Magnum EM2565-06-VL or Phoenix MSTB 2.5/6-ST-5.08 Molex 22-01-3057 housing with 08-50-0114 pins (5 pcs.) Molex 22-01-3047 housing with 08-50-0114 pins (4 pcs.) Molex 22-01-3087 housing with 08-50-0114 pins (8 pcs.) 8 pin RJ-45

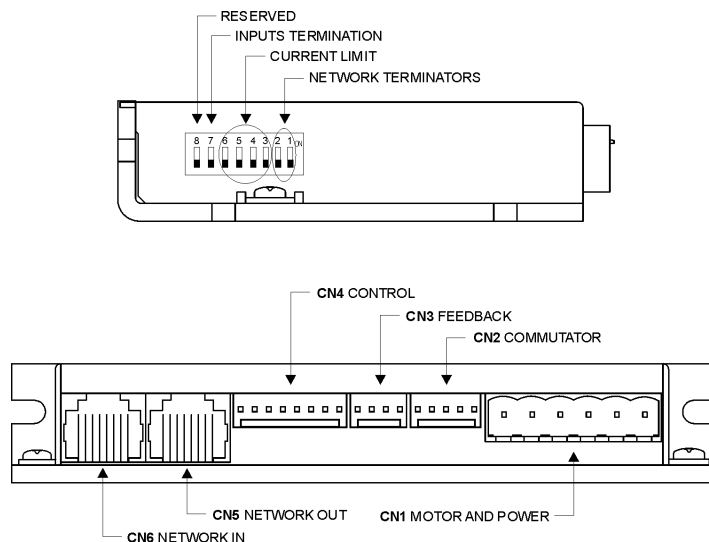
# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

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## DIMENSIONAL DRAWING



## SERVO DRIVE LAYOUT



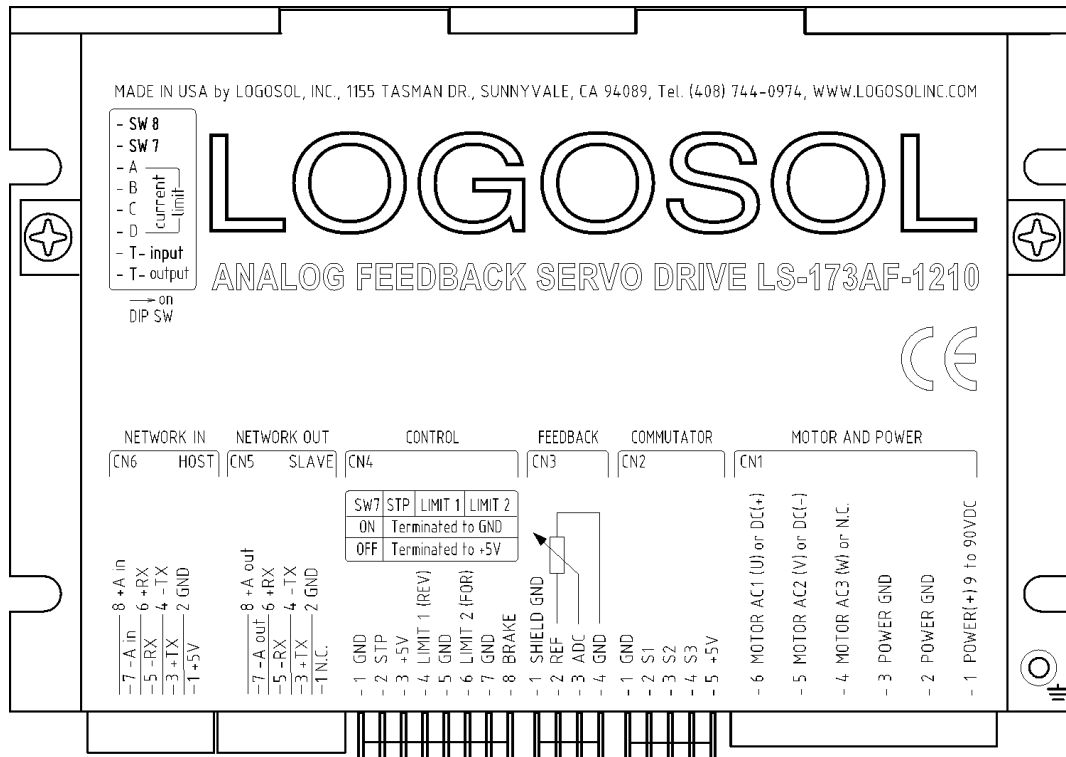
## ORDERING GUIDE

PART NUMBER	MODEL	DESCRIPTION
912173037	LS-173AF-1210	Intelligent Servo Drive with Analog Feedback LS-173AF 12A / 8A / 100V 20KHz PWM
912173038	LS-173AF-2010	Intelligent Servo Drive with Analog Feedback LS-173AF 20A / 12A / 100V 20KHz PWM
230601042	LS-173AF-CN	Mating connector kit

# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

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## CONNECTORS AND PINOUT



### DIP SW – DIP SWITCH

SW	SIGNAL	DESCRIPTION	FACTORY SETTING
1	T-output	Transmit line terminator	OFF
2	T-input	Receive line terminator	OFF
3	CL-D	Current limit	OFF
4	CL-C	Current limit	ON
5	CL-B	Current limit	ON
6	CL-A	Current limit	ON
7	SW 7	Control inputs termination ON – Inputs terminated with 3K3 to GND OFF – Inputs terminated with 3K3 to +5V	OFF
9	SW 8	RESERVED – Must be ON	ON

### CN1 – POWER AND MOTOR CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	POWER (+) 9 to 90VDC	9 to 90VDC power supply, positive terminal
2	POWER GND*	Power supply ground
3	POWER GND*	Power supply ground
4	MOTOR AC3 (W) or NC	Output to motor Phase #3 terminal for brushless motors Not connected for brush motors
5	MOTOR AC2 (V) or DC (-)	Output to motor Phase #2 terminal for brushless motors Negative terminal for brush motors
6	MOTOR AC1 (U) or DC (+)	Output to motor Phase #1 terminal for brushless motors Positive terminal for brush motors

\* POWER GND and GND are electrically connected. Drive Case is isolated from Drive circuitry and can be grounded externally.

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## CN2 – COMMUTATOR

1	GND*	Commutator ground
2	S1	Hall sensor input #1 for brushless motors
3	S2	Hall sensor input #2 for brushless motors
4	S3	Hall sensor input #3 for brushless motors
5	+5V**	Commutator power supply

## CN3 – FEEDBACK

PIN	SIGNAL	DESCRIPTION
1	SHIELD GND*	Servo potentiometer shield
2	REF	Reference output +5V/10mA Max.
3	ADC	Feedback input. 0 to +5V / 2MΩ input impedance
4	GND*	Feedback GND

## CN4 – CONTROL

PIN	SIGNAL	DESCRIPTION
1	GND*	Signal ground
2	STP IN	Stop input (disable Power Driver)
3	+5V**	Control inputs power supply output +5V
4	LIMIT 1 (REV)	Reverse limit input
5	GND*	Signal ground
6	LIMIT 2 (FOR)	Forward limit input
7	GND*	Signal ground
	BRAKE OUT	Brake output. Open collector output 48V/0.3A

## CN5 – NETWORK OUT (SLAVE)

PIN	SIGNAL	DESCRIPTION
1	N.C.	Not connected
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

## CN6 – NETWORK IN (HOST)

PIN	SIGNAL	DESCRIPTION
1	+5V**	RS-232 adapter power supply
2	GND*	Interface ground
3	+TX	(+) Transmit data
4	-TX	(-) Transmit data
5	-RX	(-) Receive data
6	+RX	(+) Receive data
7	-A in	(-) Address input
8	+A in	(+) Address input

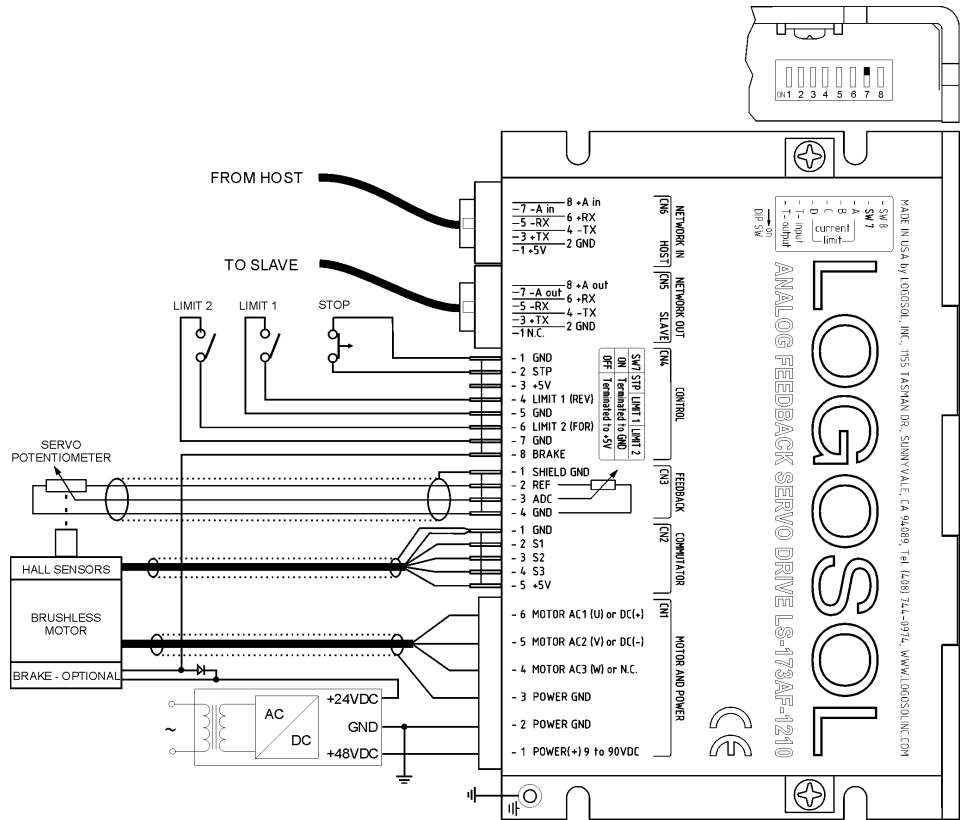
\* POWER GND and GND are electrically connected. Drive Case is isolated from Drive circuitry and can be grounded externally.

\*\* 200mA Max current for all three outputs combined.

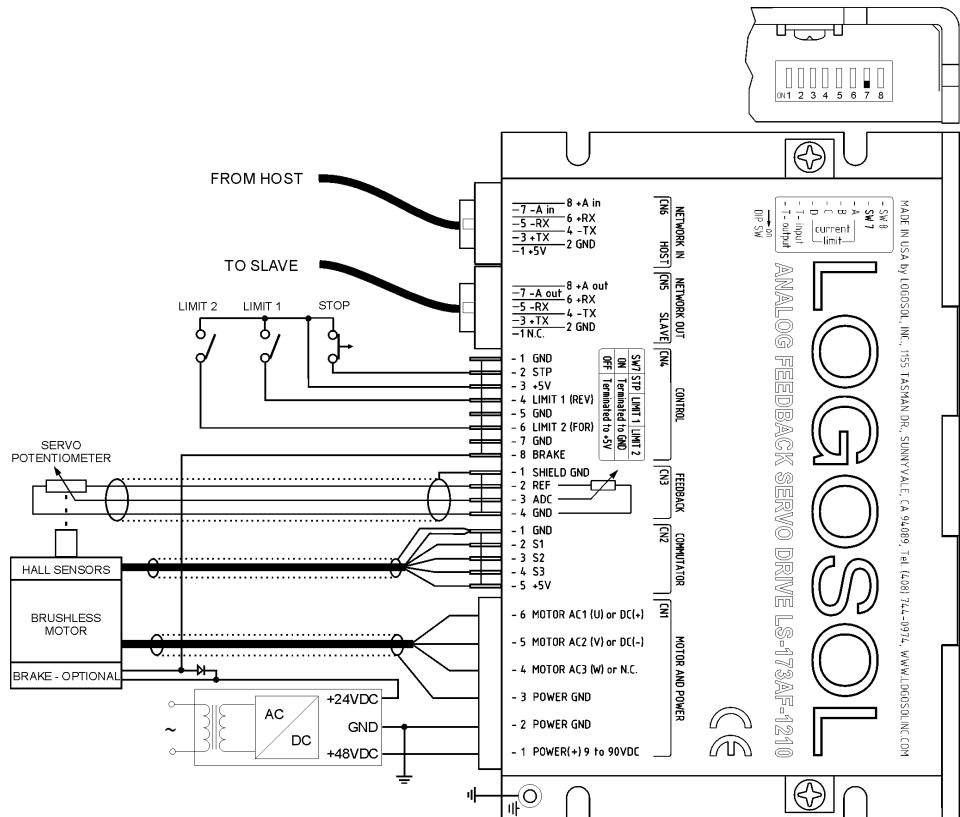
# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

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## SAMPLE APPLICATION using Brushless motor and pull-up terminated inputs



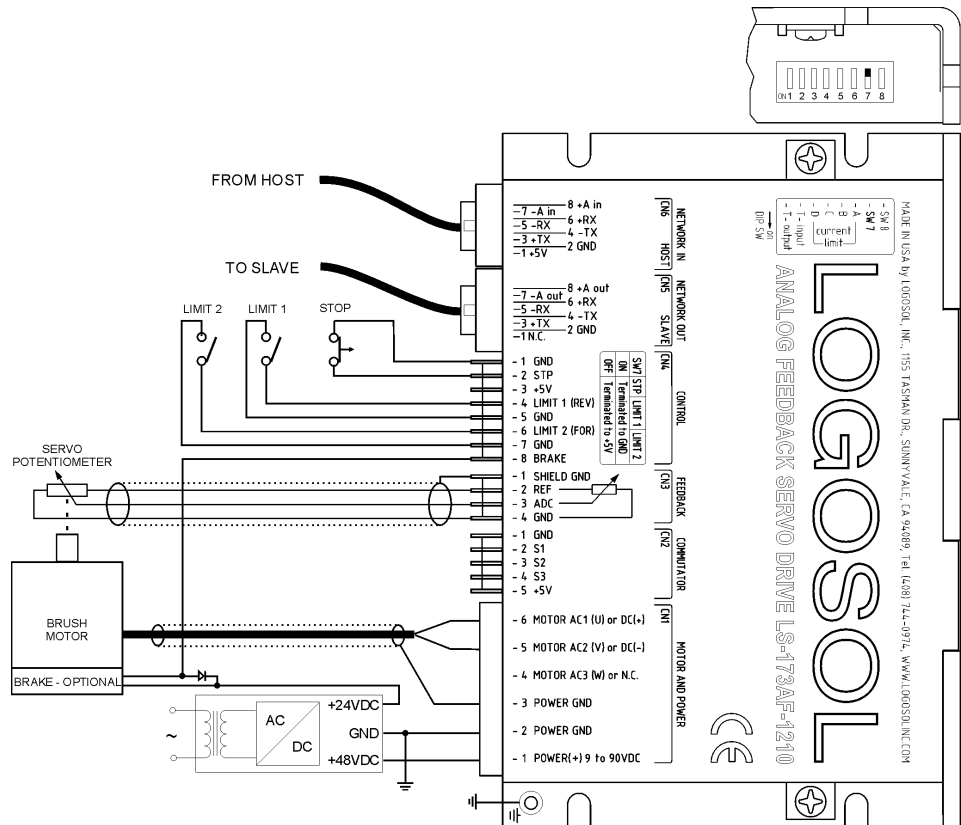
## SAMPLE APPLICATION using Brushless motor and pull-down terminated inputs



# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

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## SAMPLE APPLICATION using DC (brush) motor and pull-up terminated inputs



## LOGOSOL LS-173AF QUICK START GUIDE

### Hardware Setup

1. Connect power supply (9 to 90 V DC) to LS-173AF.
2. Connect your motor, servo potentiometer and any other I/O you may have.
3. Connect RS-232 adapter and RJ-45 network cable between LS-173AF and your host computer.

### Software Installation

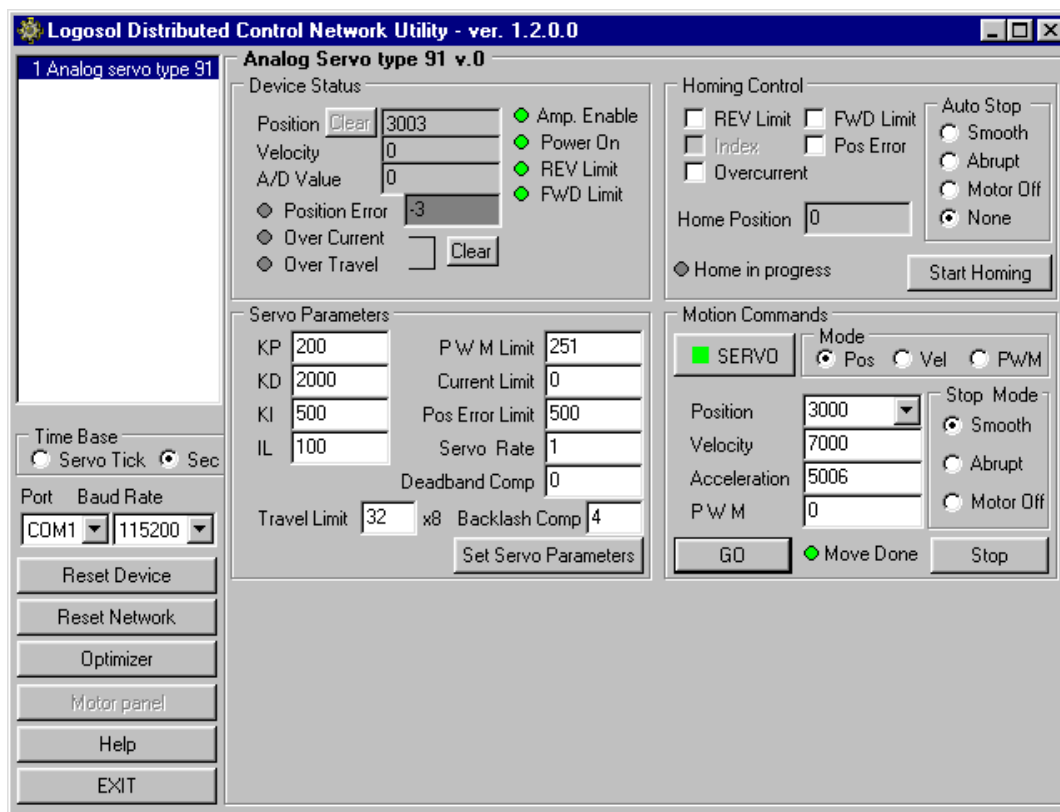
#### 1. Installation and using Logosol Distributed Control Network Utility

##### 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/XP 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. Click "SERVO" button.
5. Click "GO" button. The motor should rotate slowly in positive direction. Click "Stop" to interrupt the motion. More information about using LDCN utility is available in LDCN Help.





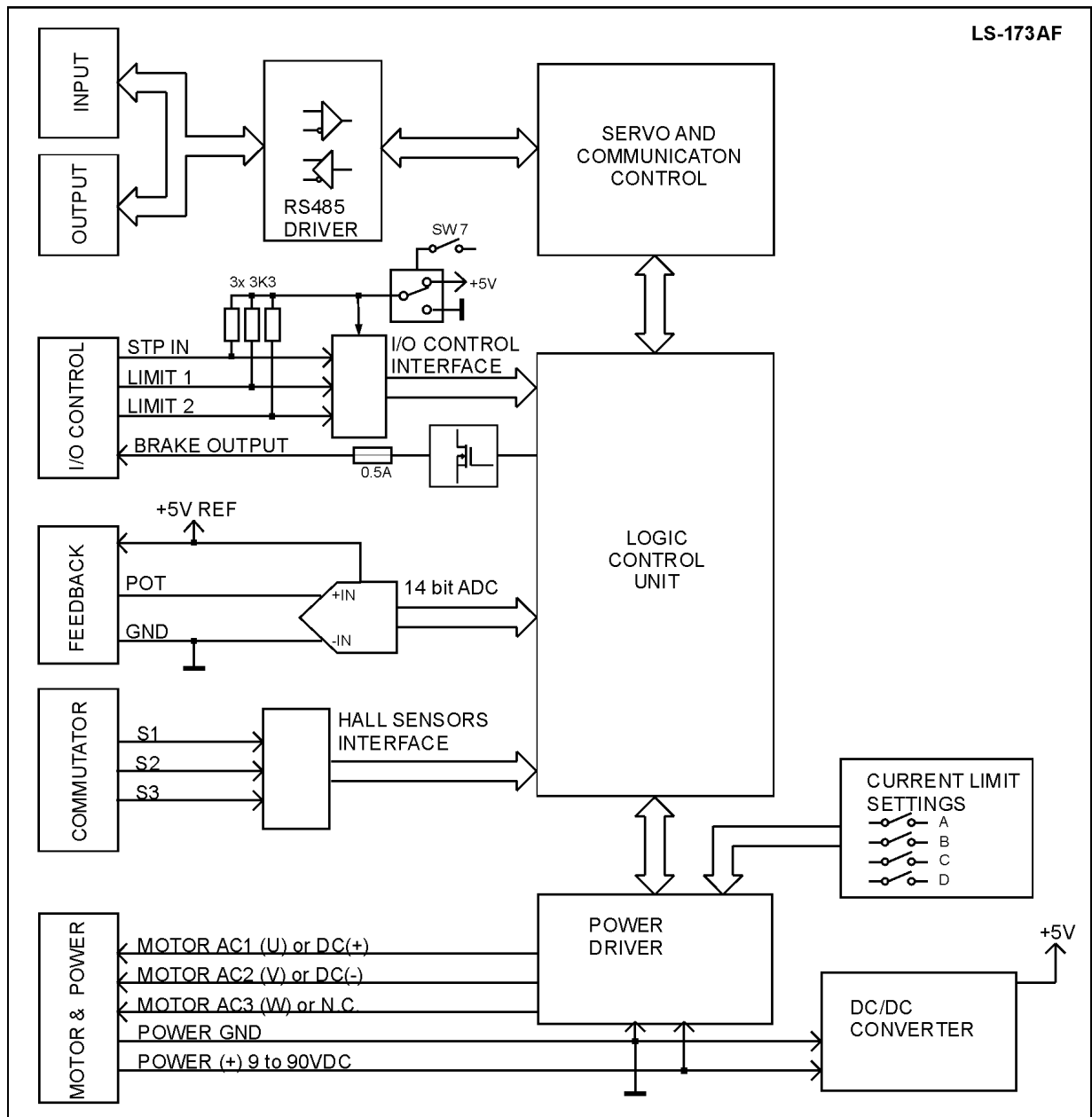
# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

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## LS-173AF ARCHITECTURE

### Overview

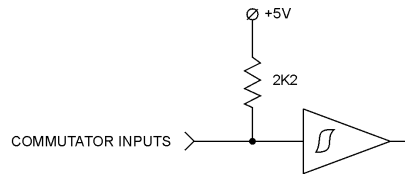
The LS-173AF Analog Feedback Servo Drive is a highly integrated servo control module incorporating a 14-bit Analog to digital converter, motion controller, servo amplifier, serial communication interface, limit switch inputs, and protection circuit (short circuit, under and overvoltage, current limit, travel limit and software controlled current limit). The Servo Drive is designed so that up to 31 controllers can be daisy-chained and connected directly to a single standard serial port (RS-232 adapter may be necessary).



Functional Diagram

## Commutator Inputs

The commutator (hall) inputs are TTL compatible inputs with pull-up resistors 2K2 to +5V.



## Digital Inputs

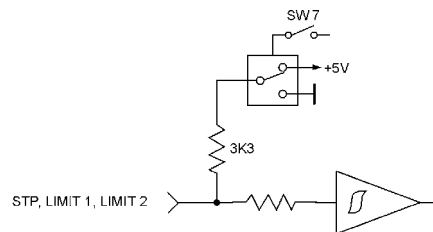
There are 3 digital inputs - STP, LIMIT 1 (REV) and LIMIT 2 (FOR).

They can be configured with SW 7 as pull-up or pull-down terminated inputs.

Regardless of SW 7 setting LIMIT 1 (REV) and LIMIT 2 (FOR) bits read from Status byte will return "1" when the corresponding switch is closed. (See the *Status byte and Auxiliary status byte definition* section in this document and the *Sample Application notes*).

The STP input will require normally closed switch. When this switch is open the motor will stop.

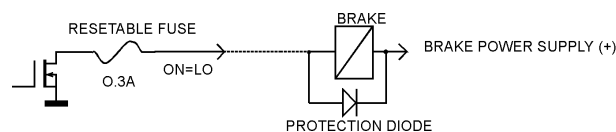
Limit inputs may be used as "HOME" switches, limit switches or as general-purpose inputs. (Refer to *I/O Control* and *Set Homing Mode* commands in the *Command Description* section in this document)



Limit Switches and Stop Input

## Brake Output

Brake is released (brake output is "on") when Power\_on (bit3 of Status byte) and Pic\_ae (bit0 of Stop command control byte) are set to 1.



Brake Output

Brake is engaged (Brake output is "off") if:

- STP is open;
- Overvoltage;
- Overcurrent;
- Motor output short;
- Overheat;
- Position error exceeds the position error limit;
- Over-travel limit;
- Pic\_ae (bit0 of Stop command control byte) is cleared

*Note: For additional information refer to Status bits and LED, Status byte and Auxiliary status byte and Stop command description, sections of this document. If Power Driver is OK, brake will be released after Pic\_ae 0 to 1 transition.*

## Dip Switches

DIP switches are used for current limit setting, digital inputs and network terminator control.

Two of the switches, T-input and T-output, are used for connecting terminators to the network receive and transmit lines.

The current limit can be set using A, B, C, and D switches (refer to *Overcurrent DIP Switch Settings...* of *Safety Features* section in this document).

LS-173AF digital inputs STP, LIMIT 1 (REV), and LIMIT 2 (FOR) can be configured altogether as pull-up or pull-down inputs using SW 7.

## Serial Command Interface

The serial communication with the LDCN 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 LDCN Node. 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 following:

*Header byte (0xAA)*

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

*Command byte*

*0 - 15 data bytes*

*Checksum byte*

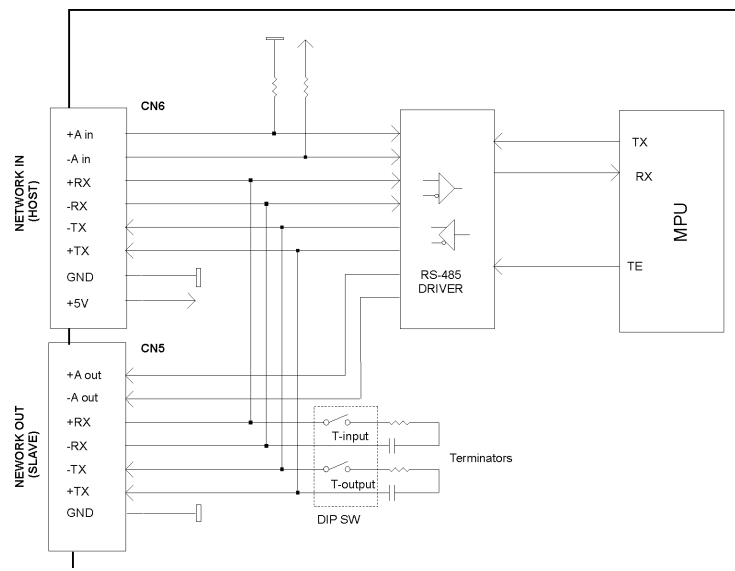
The command byte is divided into upper and lower nibbles: the lower nibble is the command value; the upper nibble is the number of additional data bytes, which will follow the command byte. The checksum byte is 8-bit sum of the address byte, the command byte and the data bytes. The number of data bytes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

*Status byte*

*0-16 optional bytes of status data*

*Checksum byte*

The Status Byte contains basic status data about the LDCN Node, 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.



Servo Drive Serial Interface

## Terminators

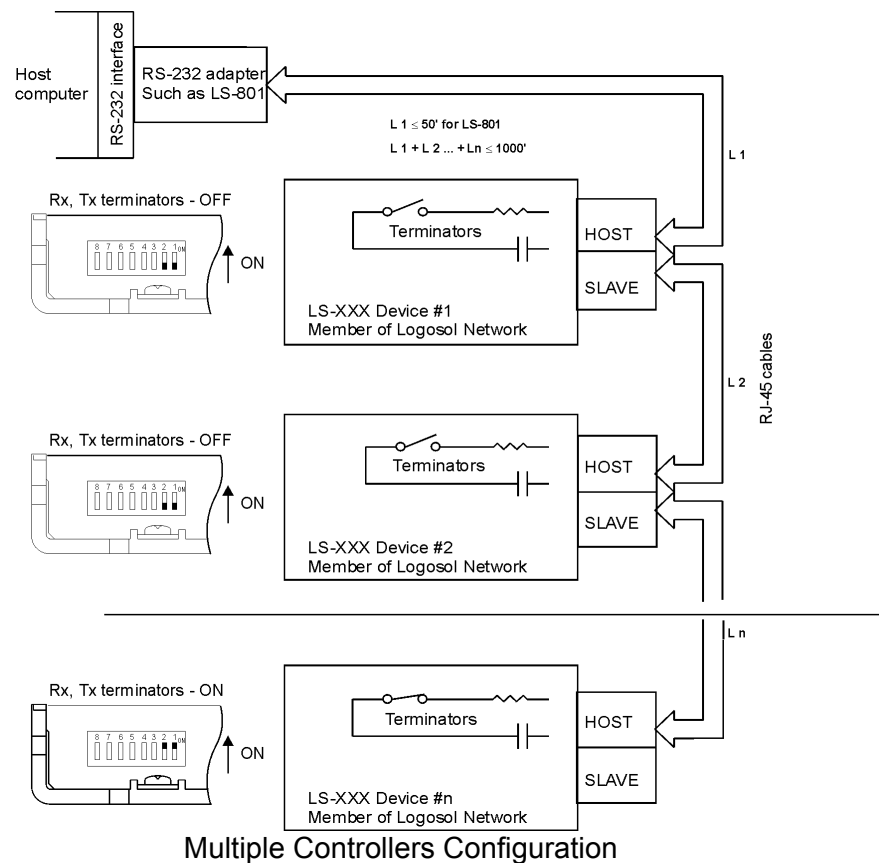
DIP switches T-input and T-output, are used to turn ON/OFF receive and transmit lines terminators. In a network of Logosol devices only the last one (at the remote end) is supposed to have its line terminators ON. All other devices located between this device and the host must have their terminators set to OFF. The maximum network cable length is limited to 1000 feet.

## Addressing

Rather than using hard-wired or switch-selected address of each LDCN Node, the host dynamically sets the address of each 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 a 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 nodes present to be given unique addresses.

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## 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 commands, which must be performed simultaneously by a number of nodes (e.g. *Set Baud Rate*, etc.). When a node 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 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 the controllers on a single network, the baud rate may be changed to a higher value with the *Set Baud Rate* command.

## Servo Control

LS-173AF uses a "proportional-integral-derivative", or PID filter. For position feedback a servo potentiometer is used to read the actual motor position. The absolute motor position is read as 14-bit value between 0 and 16383. The velocity and acceleration are programmed as 32-bit quantities (range 0 to 0x00FFFFFF) in units of position counts per servo ticks. For example, a velocity of 2000 position counts per second at a tick time of 0.512 msec. would correspond to a velocity of 1.0240 position counts/tick. Velocities and accelerations use the lower 16 bits as a fractional component so the actual programmed velocity would be  $1.024 \times 2^{16}$  or 67,109. An acceleration of 8000 position counts/sec/sec (which would bring us up to the desired speed in  $\frac{1}{4}$  sec) would be 0.0021 counts/tick/tick; with the lower 16 bits the fractional component, this would

be programmed as  $0.0021 \times 2^{16}$  or 137. Target position is programmed as a straight 32-bit quantity in the range from 0 to 16383 with no fractional component. Note that if the servo rate divisor is modified, the time dependent velocity and acceleration parameters will also have to be modified.

The PWM output signal is a square wave with 51.2µsec period and varying duty cycle. A PWM value of 255 corresponds to 100% and a value of 0 corresponds to 0%. Usually, PWM value greater than 251 is not recommended.

When the drive is in position or velocity modes and motion is completed, the *Backlash Compensation* parameter defines a window around the target position, where only the proportional term of PID filter is calculated. This parameter can be used to stop system oscillations, when a gearbox with backlash is installed between the motor and servo potentiometer. The *Backlash Compensation* is programmed in position units using the *I/O control* command.

## PWM Mode Operation

If the position servo is disabled, the motor is operated in a raw PWM output mode and no trapezoidal or velocity profiling is performed. In this mode, a user specified PWM value is outputted directly to the amplifier. A PWM value of 255 corresponds to 100% power supply voltage, applied to motor in positive direction and a value of 0 corresponds to 0%.

To set the drive in position or velocity mode, the motor should be stopped first.

## Connecting Brushless or Brush Type Motor

LS-173AF is capable of driving brushless commutated (AC) and brush (DC) type motors. No jumpers or other setting are required. If there are no Hall sensors connected to "COMMUTATOR" connector, LS-173AF drives the motor as brush (DC) type. The positive motor lead should be connected to "MOTOR AC1 (U) or DC+" terminal and negative to "MOTOR AC2 (V) or DC-" terminal of "MOTOR AND POWER" connector. If Hall sensors are detected, LS-173AF performs commutation according to their state.

Often, connecting the brushless motor phases is difficult because of the different terms and signal names, which motor / encoder manufactures are using. Here is a simple procedure that may be used.

To check the motor and feedback directions:

1. Connect the hall sensors to "COMMUTATOR" connector if brushless motor is used.

LS-173AF Commutator signal	Motor manufacture signal name			
S1	R	U	A	S1
S2	S	V	B	S2
S3	T	W	C	S3

2. Connect servo potentiometer.
3. Connect motor.
4. Power on the LS-173AF, start the LDCN utility and initialize the drive.
5. Set the drive in PWM mode and start motion with small PWM value (+5 to +10). Increase the value if the motor is not moving. If a brushless motor is used, try different motor leads connection. There are only six combinations and it is recommended to try all of them. Usually only one works fine. If you find more than one, try to run the motor at higher speed with higher PWM value. If the phasing is correct the motor shaft should rotate smoothly without any jerks in both directions (positive and negative PWM values).
6. Check if the position reading is increasing when PWM is positive. If the position is decreasing exchange the servo potentiometer wires to REF (CN3 pin2) and GND (CN3 pin4) or exchange the motor leads for brush motors.

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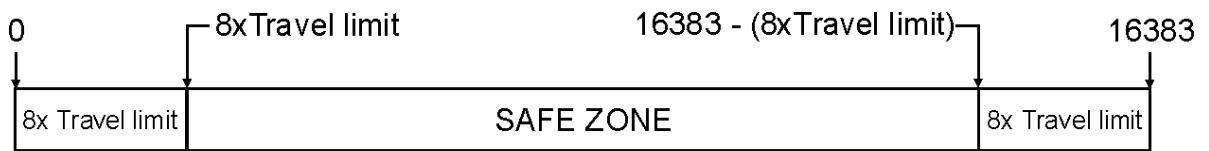
For reversing a brushless motors exchange S1 (CN2 pin2) with S3 (CN2 pin4) and MOTOR AC1 (CN!1 pin6) with MOTOR AC2 (CN1 pin5).

## Safety Features

To protect both the user device and the drive, LS-173AF is equipped with various safety features.

### Travel limit

The Power Driver will be disabled and the status byte bit 3 (Power\_on) will be set to zero when the position is outside off a predefined safe zone. This safety feature will stop the motor if any of the servo potentiometer wires is disconnected or shorted. The *Travel limit* parameter can be programmed with *I/O control* command.



### STP – Stop Input

For normal operation STP switch must be closed. If it is open it will disable the Power Driver and set status byte bit 3 (Power\_on) to zero. For more details see the *Digital Inputs* and the sample application diagrams.

### Undervoltage / Overvoltage Protection

LS-173AF is protected against power supply under / overvoltage. In case the power supply is below 9V the Power Driver will be disabled and hardware reset is generated. More then 91V will disable the Power Driver and set status byte bit 3 (Power\_on) to zero.

### Overcurrent Protection

A protection circuit monitors the output current to the motor and limits it to a value set by dipswitches.

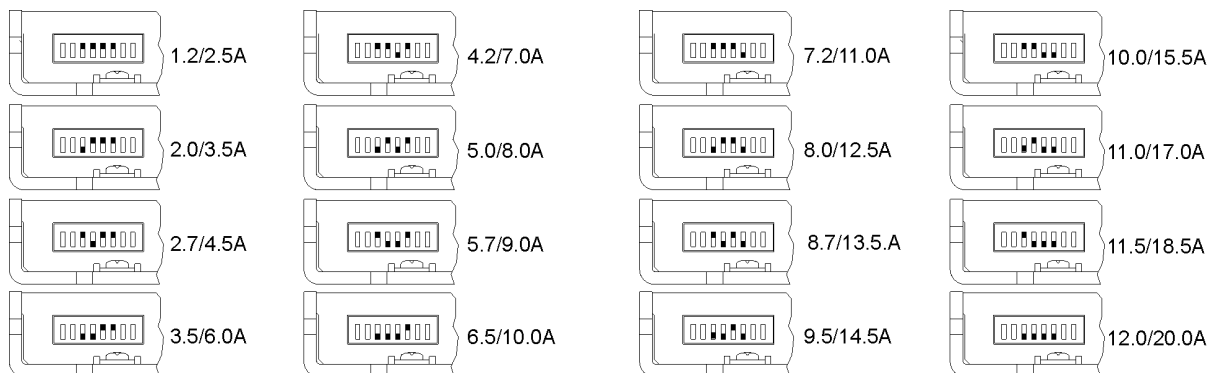
If the motor is overloaded for less than 1.5 sec, the output current will be limited.

If the motor is overloaded for more then 1.5 sec Power Driver will be disabled.

To set the current limit use the table:

### Overcurrent DIP Switch Settings for:

#### LS-173AF-1210 / LS-173AF-2010



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## Motor current monitoring

Motor current can be monitored using *Read Status* command (refer to Command Description section of this document). A/D value is proportional to the motor current according to the following table:

### A/D values as function of motor current

	A/D Value				
	25	50	100	150	200
LS-173AF-1210	1.0A	2.0A	4.0A	6.0A	8.0A
LS-173AF-2010	1.7A	3.4A	6.7A	10.0A	13.5A

A/D value and CL (*Current Limit* parameter of *Set Gain* command) may be used for current limit control. CL is compared each servo tick with A/D value (proportional to the motor current).

The actual PWM output value is:

$$PWM = PWM_{calc} - PWM_{adj}$$

Where: PWM is output value; PWMcalc is motion command calculated value; PWMadj (0 < PWMadj ≤ PWMcalc) is internal parameter. If CL < A/D PWMadj is incremented by 1 each servo tick. If CL > A/D PWMadj is decremented by 1 to 0. Bit 2 (Current\_Limit) of status byte will be set. CL is in the range of 0 ÷ 255 and only odd values must be used.

If A/D > CL for more than 200ms the Power Driver will be disabled (refer to Status Bits and LED section of this document).

## Status Bits and LED

Bit 3 (Power\_on), bit 5 (Limit 1 (REV)) and bit 6 (Limit 2 (FOR)) of Status Byte and bit 0 (Index) of Auxiliary Status byte are used for reading input signals and driver diagnostics as shown in the tables below.

### Power Driver OFF condition (Stop motor command Pic\_ae=0)

Diagnostic bits

Status byte			Condition	LEDS
Bit 6 (FOR Limit)	Bit 5 (REV Limit)	Bit 3 (Power_on)		
1	0	1	STP IN ACTIVATED	Orange
0	1	0	OVERVOLTAGE or OVERHEAT	Orange
1	1	1	OK CONDITION	Orange

Diagnostic codes

Status byte		Index	Fault code description
Pos_error =1	Pos_error =0		
59h	49h	1	STP IN ACTIVATED
31h	21h	1	OVERVOLTAGE or OVERHEAT
79h	69h	1	NO Fault



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## Power Driver ON condition (*Stop motor* command Pic\_ae=1)

Status byte			Drive inputs CN2 (Control)	LEDS
Bit 6 FOR Limit)	Bit 5 REV Limit)	Bit 3 Power_on)		
0	1	1	FORWARD LIMIT=HIGH REVERSE LIMIT=LOW	Green
1	0	1	FORWARD LIMIT=LOW REVERSE LIMIT=HIGH	Green
0	0	1	FORWARD LIMIT=HIGH REVERSE LIMIT=HIGH	Green
1	1	1	FORWARD LIMIT=LOW REVERSE LIMIT=LOW	Green

## Power Driver Fault condition (*Stop motor* command Pic\_ae=1)

Diagnostic bits

Status byte			Condition	LEDS
Bit 6 (FOR Limit)	Bit 5 (REV Limit)	Bit 3 (Power_on)		
1	0	0	STP IN (LATCHED) ENCODER ERROR	Orange
0	1	0	MOTOR SHORT* or OVERVOLTAGE	Orange
0	0	0	OVERCURRENT	Orange
1	1	0	OVERHEAT	Orange

Diagnostic codes

Status byte	Index	Fault code description
51h	1	STP IN
	0	RESERVED
31h	1	MOTOR SHORT* OR OVERVOLTAGE
11h	1	HARDWARE CURRENT LIMIT
71h	1	OVERHEAT

\* MOTOR SHORT – output to output or output to POWER GND.

Brake follows the LEDES status:

- Orange <-> brake is engaged;
- Green <-> brake is released.

To restore the normal operation (if bit 3 (Power\_on) is set to 0) Pic\_ae must be cycled to “0” and “1”. If there are no more fault conditions Power\_on bit will be set to “1”

## Power-up and Reset Conditions

On Power-up or after *Hard reset* command, the following state is established:

- Velocity and acceleration values are set to zero;*
- All servo gain parameters are set to zero;*
- The servo rate divisor is set to 1 (0.512msec servo rate);*
- The PWM value is set to zero;*
- The PWM limit is set to 251;*
- The Backlash\_Comp is set to zero;*
- The Over\_Travel limit is set to 32 (256 position units);*
- The controller is set in PWM mode;*
- The default status data is the status byte only;*
- The individual address is set to 0x00 and the group address to 0xFF (group leader not set);*
- Communications are disabled pending a low value of “A in”;*
- The baud rate is set to 19.2 KBPS;*

In the *status byte*, the *move\_done* and *pos\_error* flags will be set and the *current\_limit* and *home\_in\_progress* flags will be clear;  
 In the *auxiliary status byte*, the *over\_travel*, *servo\_on*, *accel\_done*, *slew\_done* and *servo\_overnrun* flags will be cleared.

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## COMMAND SPECIFICATION

### List of Commands

Command	CMD Code	# Data bytes	Description	While Moving?
Nop	0x0	0	Simply causes the defined status data to be returned	Yes
Set address	0x1	2	Sets the individual and group addresses	Yes
Define status	0x2	1	Defines which data should be sent in every status packet	Yes
Read status	0x3	1	Causes particular status data to be returned just once	Yes
Load trajectory	0x4	1-14	Loads motion trajectory parameters	Maybe*
Start motion	0x5	0	Executes the previously loaded trajectory	Maybe**
Set gain	0x6	14	Sets the PID gains and operating limits	Yes
Stop motor	0x7	1	Stops the motor in one of three manners	Yes
I/O control	0x8	1-3	Sets the direction and values of the LIMIT pins, Travel limit and Backlash compensation	Yes
Set home mode	0x9	1	Sets conditions for capturing the home position	Yes
Set baud rate	0xA	1	Sets the baud rate (group command only)	Yes
Clear bits	0xB	0	Clears the sticky status bits	Yes
Save as home	0xC	0	Saves the current position in the home position register	Yes
Nop	0xD	0	Simply causes the defined status data to be returned	Yes
Nop	0xE	0	Simply causes the defined status data to be returned	Yes
Hard reset	0xF	0	Resets the controller to its power-up state.	Yes

\*Only allowed while moving if the "start motion now" bit of the trajectory control word is not set or if the "profile mode" bit is set for velocity mode.

\*\*Only allowed while moving if the previously loaded trajectory has the "profile mode" bit set for velocity mode.

## Command Description

### **Set Address**

*Command value:* 0x1

*Number of data bytes:* 2

*Command byte:* **0x21**

*Data bytes:*

1. *Individual address: 0x01-0x7F (initial address 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 Drive is to be a group leader, clear bit 7 of the desired group address in the second data byte. The module will automatically set bit 7 internally after flagging the Drive as a group leader. (If bit 7 of the second data byte is set, the module will default to being a group member.) The first time this command is issued after power-up or reset, it will also enable communications for the next Drive in 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:	<i>send position (4 bytes)</i>
1:	<i>send A/D value (1 byte)</i>
2:	<i>send actual velocity (2 bytes - no fractional component)</i>
3:	<i>send auxiliary status byte (1 byte)</i>
4:	<i>send home position (4 bytes)</i>
5:	<i>send device ID and version number (2 bytes)</i> <i>(motor controller device ID = 91, version number =0 to 9)</i>
6:	<i>send current position error (2 bytes)</i>
7:	<i>don't care</i>

### Description:

Defines what additional data will be sent in the status packet along with the status byte. Setting bits in the command's data byte will cause the corresponding additional data bytes to be sent after the status byte. The status data will always be sent in the order listed. For example if bits 0 and 3 are set, the status packet will consist of the status byte followed by four bytes of position data, followed by the aux. status byte, 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.

Note: The actual velocity is a positive number when moving in reverse direction and a negative number when moving in forward direction.

## Read Status

Command value: 0x3

Number of data bytes: 1

Command byte: 0x13

Data bytes:

1. Status items:

- |     |    |  |
|-----|----|--|
| Bit | 0: | send position (4 bytes)  |
|     | 1: | send A/D value (1 byte)  |
|     | 2: | send actual velocity (2 bytes - no fractional component)   |
|     | 3: | send auxiliary status byte (1 byte)  |
|     | 4: | send home position (4 bytes)   |
|     | 5: | send device ID, version number (2 bytes)<br>(motor controller device ID = 91, version number = 0 to 9) |
|     | 6: | send current position error (2 bytes)  |
|     | 7: | don't care   |

### 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.

Note: The actual velocity is a positive number when moving in reverse direction and a negative number when moving in forward direction.

## Load Trajectory

Command value: 0x4

Number of data bytes:  $n = 1-14$

Command byte: 0xn4

Data bytes:

1. Control byte:

- |     |    |  |
|-----|----|--|
| Bit | 0: | load position data ( $n = n + 4$ bytes)                      |
|     | 1: | load velocity data ( $n = n + 4$ bytes)                      |
|     | 2: | load acceleration data ( $n = n + 4$ bytes)                  |
|     | 3: | load PWM value ( $n = n + 1$ bytes)                          |
|     | 4: | servo mode - 0 = PWM mode, 1 = position servo                |
|     | 5: | profile mode - 0 = trapezoidal profile, 1 = velocity profile |
|     | 6: | velocity/PWM direction - 0 = FWD, 1 = REV                    |
|     | 7: | start motion now   |

### Description:

All motion parameters are set with this command. Setting one of the first four bits in the control byte will require additional data bytes to be sent (as indicated) in the order listed. The position data (range 0x00000000 to 0x00003FFF) is only used as the goal position in trapezoidal profile mode. The velocity data (range 0x00000000 to 0x00FFFFFF) is used as the goal velocity in velocity profile mode or as the maximum velocity in trapezoidal profile mode. Velocity is given in position units per servo tick, multiplied by 65536. The acceleration data (range 0x00000000 to 0x00FFFFFF) is used in both trapezoidal and velocity profile mode. Acceleration is given in position units per servo tick per servo tick, multiplied by 65536. The PWM value (range 0x00 - 0xFF), used only when the position servo is not operating, sends a raw PWM value directly to the amplifier. The PWM value is reset to 0 internally on any condition, which automatically disables the position servo.

Bit 4 of the control byte specifies whether the position servo should be used or if the PWM mode should be entered. Bit 5 specifies whether a trapezoidal profile motion should be initiated or if the velocity profiler is used. Trapezoidal profile motions should only be initialized when the motor velocity is 0. (Bit 0 of the status byte indicates when a trapezoidal profile motion has been

completed, or in velocity mode, when the command velocity has been reached.) Bit 6 indicates the velocity or PWM direction and is ignored in trapezoidal profile mode. If bit 7 is set, the command will be executed immediately. If bit 7 is clear, the command data will be buffered and it will be executed when the *Start Motion* command is issued. For example to load only new position data and acceleration data but not to start the motion yet, the command byte would be 0x94, the control byte would be 0x15, followed by 4 bytes of position data (least significant byte first), followed by 4 bytes of acceleration data.

If in the middle of a trapezoidal position move, a new *Load Trajectory* command is issued with new position data downloaded, new position data will be used as a relative offset to modify the goal position. For example, if in the middle of a move to position 50,000, a new *Load Trajectory* command with new position data of 10,000 is loaded, the motor will stop at final position of 60,000. The relative offset can be either positive or negative. The new *Load Trajectory* command must be issued while the motor is running at a constant velocity – issuing the command while accelerating or decelerating will cause a position error to occur. If more than one *Load Trajectory* is issued before the end of move, the goal position will be modified by the sum of relative offsets.

## Start Motion

Command value: 0x5  
Number of data bytes: 0  
Command byte: 0x05

### Description:

Causes the trajectory information loaded with the most recent Load Trajectory command to execute. This is useful for loading several Drives with trajectory information and then starting them simultaneously with a group command.

## Set Gain

Command value: 0x6  
Number of data bytes: 14  
Command byte: 0xE6  
Data bytes:  
1,2. Position gain KP (0 - 0x7FFF)  
3,4. Velocity gain KD (0 - 0x7FFF)  
5,6. Integral gain KI (0 - 0x7FFF)  
7,8. Integration limit IL (0 - 0x7FFF)  
9. Output limit OL (0 - 0xFF) (typically recommended 0xFA)  
10. Current limit CL (0 - 0xFF) (only odd values)  
11,12. Position error limit EL (0 - 0x3FFF)  
13. Servo rate divisor SR (1 - 0xFF)  
14. Amplifier deadband compensation (0 - 0xFF) (typical value is between 0x03 and 0x05)

### Description:

Sets all parameters and limits governing the behavior of the position servo. KP, KD, KI and IL are PID filter parameters. OL limits the maximal PWM output value to  $0 < \text{PWM} \leq \text{OL}$  in position servo modes. In PWM mode OL is ignored. CL is used for motor current limitation (refer to *Motor current monitoring* in *Safety Features* for detailed information). Setting CL=0 effectively disables current limiting. The position error limit (EL) will cause the position servo to be disabled should the position error grow beyond the limit. The servo rate divisor sets the servo tick time to be a multiple of 0.512 msec (1.953 KHz). For example SR=3 gives a servo rate of 651 Hz. The servo tick rate is also used as the profiling timebase, although command processing and current limiting are always performed at the maximum tick rate. Sometimes it is necessary to compensate the deadband region around zero PWM output exhibited by some amplifier/motor combinations. The

deadband compensation value will be added to the magnitude of the PWM output to force the amplifier into its active region.

## Stop Motor

Command value: 0x7  
Number of data bytes: 1 or 5  
Command byte: **0x17 or 0x57**

Data bytes:

### 1. Stop control byte

Bit 0: Pic\_ae (Power Driver enable)  
1: Turn motor off  
2: Stop abruptly  
3: Stop smoothly  
4: Stop here  
5-7: Clear all to 0

2-5. Stopping position (only required if bit 4 above is set)

## Description:

Stops the motor in the specified manner. If bit 0 of the Stop Control Byte is set, Power Driver will be enabled. If bit 0 is cleared Power Driver will be disabled, regardless of the state of the other bits. Pic\_ae also controls the meaning of bit 3 (Power\_on), bit 5 (Limit 1 (REV)), and bit 6 (Limit 2 (FOR)) of status byte (refer to *Status Bits* section of *Safety Features* in this document). If bit 1 is set, the position servo will be disabled, the PWM output value will be set to 0, and bits 2, 3 and 4 are ignored. If bit 2 is set, the current command velocity and the goal velocity will be set to 0, the position servo will be enabled, and velocity mode will be entered. If the velocity servo was previously disabled, the motor will simply start servoing to its current position. If the motor was previously moving in one of the profiling modes, it will stop moving abruptly and servo to its current position. This stopping mode should only be used as an emergency stop where the motor position needs to be maintained. Setting bit 3 enters a more graceful stop mode - this sets the goal velocity to 0 and enters velocity mode, causing the motor to decelerate to a stop at the current acceleration rate. If bit 4 is set, the motor will move to the specified stopping position abruptly with no profiling. This mode can be used to cause the motor to track a continuous string of command positions. Note that if the stopping position is too far from the current position, a position error will be generated. Only one of the bits 1, 2, 3 or 4 should be set at the same time. The *Stop Motor* command must be issued initially to set Pic\_ae before other motion commands are issued.

## I/O Control

Command value: 0x8

Number of data bytes: n = 1-3

Command byte: 0xn8

Data bytes:

1. I/O control byte

- |     |      |   |
|-----|------|---|
| Bit | 0:   | Output value of Limit 1 (not used)                        |
|     | 1:   | Output value of Limit 2 (not used)                        |
|     | 2:   | Direction of Limit 1 (Reverse) (must be set to 1 = input) |
|     | 3:   | Direction of Limit 2 (Forward) (must be set to 1 = input) |
|     | 4:   | Load Travel limit (n = n + 1 bytes)                       |
|     | 5:   | Load Backlash compensation (n = n + 1 bytes)              |
|     | 6-7: | Don't care  |

## Description:

The programmed *Travel limit* parameter is internally multiplied by 8 and the result defines two stop zones in position units on both ends of servo potentiometer. When the position feedback reaches either of those two stop zones the Power Driver will be disabled, Status Byte bit 3 (Power\_on) bit will be cleared and the Auxiliary Status Byte bit 1 (Over\_travel) will be set. Programming the Travel limit = 0 will disable this safety feature. *Travel limit* = 255 will give two 2040 stop zones on both ends. The safe zone will be between 2041 and 14342 position units. On Power-up or *Hard reset* command the *Travel limit* is set to 32 (256 position units).

When the drive is in position or velocity modes and motion is completed, the *Backlash Compensation* parameter defines a window around the target position, where only the proportional term of PID filter is calculated. On Power-up or *Hard reset* command the *Backlash Compensation* parameter is set to 0.

On Power-up or *Hard reset* command *Limit 1 (REV)* and *Limit 2 (FOR)* are programmed as inputs.

## Set Homing Mode

Command value: 0x9

Number of data bytes: 1

Command byte: 0x19

Data bytes:

1. Homing control byte

- |     |    |  |
|-----|----|--|
| Bit | 0: | Capture home position on change of Limit 1 (REV)           |
|     | 1: | Capture home position on change of Limit 2 (FOR)           |
|     | 2: | Turn motor off on home                                     |
|     | 3: | Reserved – always set to “0”.                              |
|     | 4: | Stop abruptly on home                                      |
|     | 5: | Stop smoothly on home                                      |
|     | 6: | Capture home position when an excess position error occurs |
|     | 7: | Capture home position when current limiting occurs         |

## Description:

Causes the Drive to monitor the specified conditions and capture the home position when any of the flagged conditions occur. The home\_in\_progress bit in the status byte is set when this command is issued and it is then lowered when the home position has been found. Setting one (and only one) of bits 2, 4 or 5 will cause the motor to stop automatically in the specified manner once the home condition has been triggered. This feature can also be used as a safety shutoff.

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## Set Baud Rate

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

### Description:

Sets the communication baud rate. All drives 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 controllers on the network. A status packet returned from this command would be at the new baud rate, so typically (unless the host's baud rate can be accurately synchronized) there should be no group leader when this command is issued.

## Clear Sticky Bits

<i>Command value:</i>	<i>0xB</i>
<i>Number of data bytes:</i>	<i>0</i>
<i>Command byte:</i>	<b><i>0x0B</i></b>

### Description:

The overcurrent and position error bits in the status byte and the Over\_travel and servo timer overrun bits in the auxiliary status byte will stay set unless cleared explicitly with this command.

## Save Current Position as Home

<i>Command value:</i>	<i>0xC</i>
<i>Number of data bytes:</i>	<i>0</i>
<i>Command byte:</i>	<b><i>0x0C</i></b>

### Description:

Causes the current position to be saved as the home position. This command is typically issued to a group of controllers to cause their current positions to be stored synchronously. The stored positions can then be read individually by reading the home position

## No Operation

<i>Command value:</i>	<i>0x0 or 0xD or 0xE</i>
<i>Number of data bytes:</i>	<i>0</i>
<i>Command byte:</i>	<b><i>0x00 or 0x0D or 0x0E</i></b>

### Description:

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

## Hard Reset

<i>Command value:</i>	<i>0xF</i>
<i>Number of data bytes:</i>	<i>0</i>
<i>Command byte:</i>	<b><i>0x0F</i></b>

### Description:

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



## STATUS BYTE AND AUXILIARY STATUS BYTE DEFINITIONS

### Status Byte

<u>Bit</u>	<u>Name</u>	<u>Definition</u>
0	Move_done	Clear when in the middle of a trapezoidal profile move or in velocity mode, when accelerating from one velocity to the next. This bit is set otherwise, including while the position servo is disabled
1	Cksum_error	Set if there was a checksum error in the just received command packet
2	Current_limit	Set if current limiting has exceeded (refer to <i>Motor Current Monitoring</i> section in this document). Must be cleared by user with <i>Clear Sticky Bits</i> command
3	Power_on/diag. bit	Refer to <i>Status Bits and LED</i> section in this document
4	Pos_error	Set if the position error has exceeded the position error limit. It is also set whenever the position servo is disabled. Must be cleared by user with <i>Clear Sticky Bits</i> command
5	Limit 1 (REV) /Reverse Limit or diagnostic bit	Refer to <i>Status Bits and LED</i> section in this document). diag.
6	Limit 2 (FOR) /diag. bit	Forward Limit or diagnostic bit (refer to <i>Status Bits and LED</i> section in this document).
7	Home_in_progress	Set while searching for a home position. Reset to zero once the home position has been captured

### Auxiliary Status Byte

<u>Bit</u>	<u>Name</u>	<u>Definition</u>
0	Index/diag. bit	Compliment of the value of the index input or diagnostic bit (refer to <i>Status Bits and LED</i> section in this document).
1	Over_Travel	Set if the position is outside off the predefined safe zone. Cleared with the <i>Clear Sticky Bits</i> command.
2	Servo_on	Set if the position servo is enabled, clear otherwise
3	Accel_done	Set when the initial acceleration phase of a trapezoidal profile move is completed. Cleared when the next move is started
4	Slew_done	Set when the slew portion of a trapezoidal profile move is complete. Cleared when the next move is started
5	Servo_overnun	At the highest baud rate and servo rate, certain combinations of calculations may cause the servo, profiling, and command processing to take longer than 0.512 msec, in which case, this bit will be set. This is typically not serious, only periodically introducing a small fraction of a millisecond delay to the servo tick time. Cleared with the <i>Clear Sticky Bits</i> command

## INITIALIZING PROCEDURE AND PROGRAMMING EXAMPLES FOR SERVO DRIVES

To ensure a proper operation of all Servo drives connected to the network, the following initializing steps should be executed:

1. Reset all modules with *Hard Reset* command.
2. Set the addresses for all connected drives.
3. Set the individual gains (KP, KD, KI, IL, OL, CL, EL, SR and DB). Minimal requirements are:  $KP \neq 0$ ,  $EL \neq 0$  and  $SR \neq 0$ .
4. Use *Load trajectory* command to set the target position, velocity acceleration with start motion now in trapezoidal mode. Minimal requirements are acceleration  $\neq 0$  and target position = 0. This command does not start any motion. It is necessary to initialize internal registers of the module.
5. Close the servo loop by using *Stop Motor* command (Pic\_ae=1 and Stop abruptly=1).

### Understanding the Serial Communication with Servo drives

The Serial Communication with Servo drives is strictly master-slave and matches repeatedly two elements:

- Sending a command to the specified drive'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 16 commands managing Servo drives (refer to 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 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 No. 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
Define status	AA	05	1 2	05	1C
Set address	AA	01	2 1	07 FF	21
Load trajectory	AA	01	5 4	91 00 28 00 00	0E
Set gain	AA	01	E 6	64 00 00 04 00 00 00 00 FF 00 00 08 01 00	57

### Status Data

The structure of the returned status information depends on *Define Status* or *Read Status* commands (refer to Command Description). By default only the Status byte and Checksum are returned to the host.

#### Examples

Byte 1	Optional Bytes 0-16	CheckSum
Status Byte	Additional Status Bytes as position, velocity, home position, A/D auxiliary byte, version and position error.	CheckSum = Byte 1+ Optional Bytes
09	no additional status bytes requested	09
09	00 28 00 00 – four additional status bytes	31

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## Addressing

Each drive in the daisy-chained network has two addresses:

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

Both these 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 format

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

## Example of sequential addressing for three Servo drives

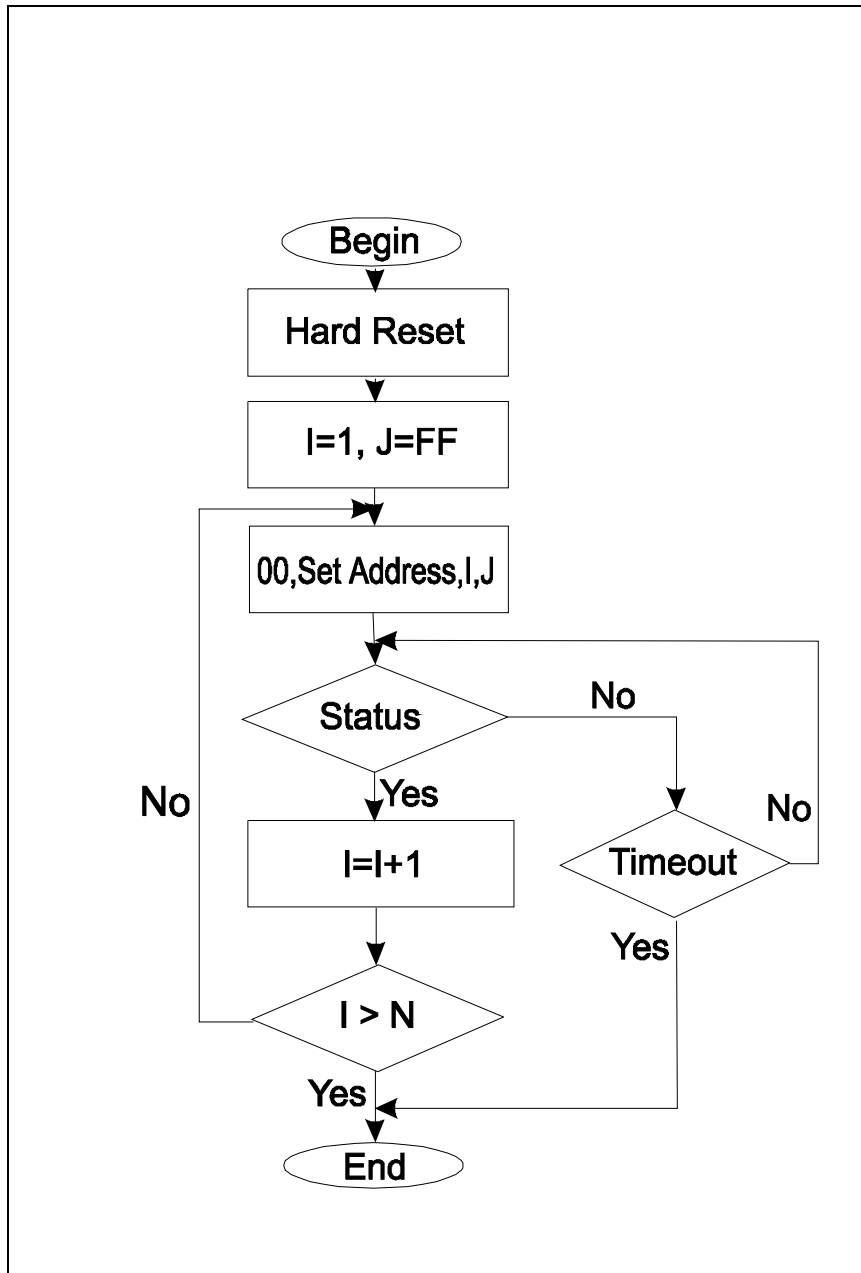
Step	Command	Set address Hexadecimal Code	Drive 1		Drive 2		Drive 3	
			Individual address	Group address	Individual address	Group address	Individual address	Group address
0	Power-up							
1	Hard Reset	AA FF 0F 0E	address=00 communication <i>enabled</i>		address=00 communication <i>disabled</i>		address=00 communication <i>disabled</i>	
2	Set Address Drive1 = 01	AA 00 21 01 FF 21	01	FF	address=00 communication <i>enabled</i>		address=00 communication <i>disabled</i>	
3	Set Address Drive2 = 02	AA 00 21 02 FF 22	01	FF	02	FF	address=00 communication <i>enabled</i>	
4	Set Address Drive3 = 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 Two Servo-Drives

- # 1 – Resets all modules with group command.
- # 2 and # 3 - Set the addresses of drives 1 and 2.
- # 4 and # 6 - Set PID parameters of drives 1 and 2.
- # 6 and # 7 - Starts motion in trapezoidal mode with target position=0, velocity=0, acceleration=1 and PWM=0.
- # 8 and # 9 - Close servo loops of drives 1 and 2. Initialization is complete at this point.
- # 10 and # 10 - Load trajectories (positions, velocities and accelerations) for drives 1 and 2.
- # 12 and # 13 - Load and execute new trajectory for drive 1.
- # 14 and # 15 - Read additional status bytes from drives 1 and 2.
- # 16, # 17 and #18 - Load new trajectories for drives 1 and 2 and execute them with one command sent to the drives' group address.

## Examples

#	Hexadecimal code of command	Comments
1	AA FF 0F 0E	<i>Hard Reset</i>
2	AA 00 21 01 FF 21	<i>Set Address 01h for drive 1. Group address=FFh.</i>
3	AA 00 21 02 FF 22	<i>Set Address 02h for drive 2. Group address=FFh.</i>
4	AA 01 E6 64 00 00 04 00 00 00 00 FF 00 00 08 01 00 57	<i>Set Gains of drive 1 – defines PID parameters: KP=64h, KI=400h, KI=00h, IL=00h, OL=FFh, CL=00h, EL=800h, SR=01h, DC=00h.</i>
5	AA 02 E6 64 00 00 04 00 00 00 00 FF 00 00 08 01 00 58	<i>Set Gains of drive 2 – defines PID parameters: KP=64h, KI=400h, KI=00h, IL=00h, OL=FFh, CL=00h, EL=800h, SR=01h, DC=00h.</i>
6	AA 01 E4 9F 00 10 00 00 00 00 00 00 01 00 00 00 00 95	<i>Load trajectory for drive 1 – target position=1000h, velocity=0, acceleration=1, PWM=0 and start motion now</i>
7	AA 02 E4 9F 00 10 00 00 00 00 00 00 01 00 00 00 00 96	<i>Load trajectory for drive 2 – target position=1000h, velocity=0, acceleration=1, PWM=0 and start motion now</i>
8	AA 01 17 05 1D	<i>Stop Motor - closes servo loop of drive 1 with Power Driver enable and Stop Abruptly in Command byte.</i>
9	AA 02 17 05 1E	<i>Stop Motor - closes servo loop of drive 2 with Power Driver enable and Stop Abruptly in Command byte.</i>
10	AA 01 E4 9F 00 20 00 00 00 80 01 00 64 00 00 00 00 89	<i>Load Trajectory of drive 1 with Pos=2000h, Vel=18000h, Acc=6400h, PWM=00h, servo mode=1.</i>
11	AA 02 E4 9F 00 20 00 00 00 80 01 00 64 00 00 00 00 8A	<i>Load Trajectory of drive 2 with Pos=2000h, Vel=18000h, Acc=6400h, PWM=00h, servo mode=1.</i>
12	AA 01 54 11 00 28 00 00 8E	<i>Load Trajectory of drive 1 with new position=2800h.</i>
13	AA 01 05 06	<i>Start Motion - executes previously loaded trajectory.</i>
14	AA 01 13 05 19	<i>Read Status from drive 1 (plus position and velocity).</i>
15	AA 02 13 05 1A	<i>Read Status from drive 2 (plus position and velocity).</i>
16	AA 01 54 11 20 3D 00 00 C3	<i>Load Trajectory of drive 1 with new position=3D20h.</i>
17	AA 02 54 11 20 3D 00 00 C4	<i>Load Trajectory of drive 1 with new position=3D20h.</i>
18	AA FF 05 04	<i>Start Motion – executes previously loaded trajectories. The command is sent to the drives' group address FFh.</i>

# Logosol Intelligent Servo Drive with Analog Feedback LS-173AF

Doc # 712173038 / Rev. B, 01/27/2005

## Procedure Initialize

AA FF 0F 0E	Hard reset
AA 00 21 01 FF 21	Set address
AA 00 21 02 FF 22	Search for more modules until no response received
AA 01 13 20 34	Read Device ID and Version number
AA 01 13 FF 13	Read all status data
AA 01 E6 64 00 00 04 00 00 00 00 FF 00 00 08 01 00 57	Set Gain parameters
AA 01 E4 9F 00 00 00 00 00 00 00 00 01 00 00 00 00 85	Set Trajectory parameters
AA 01 17 05 1D	Close servo loop

## Procedure FindHomePosition

AA 01 E6 C8 00 20 03 46 00 28 00 FF 00 40 1F 01 00 9F	Set gain parameters: KP=200, KD=800, KI=70, IL=40, Output limit=255, current limit =0, Position error limit=8000, Servo rate divisor=1 amplifier deadband compensation=0
AA 01 17 09 21	Close the servo loop (Stop smoothly and amplifier enable)
AA 01 94 37 25 06 01 00 58 01 00 00 51	Load trajectory: Velocity mode, Forward direction, Velocity=00010625h, Acceleration = 00000158h
AA 01 19 12 2C	Set home mode - capture home position on change of Forward Limit and stop abruptly
AA 01 05 06	Start motion
wait while home_in_progress bit=1	Home position is found on change of Forward Limit

Calculation of programmed velocity and acceleration for servo rate divisor = 1:

Vel = (position units per second) x 33.554432

Acc = (position units per second<sup>2</sup>) x 0.017179869184