Linkam Scientific Instruments Ltd

Serial Communications Manual for T92, T93, T94 Series Programmers, MDS 600 Motorised Stage and DSC 600

User's Guide

Contents

Range of Instruments

The following information about RS232 commands only applies to the following range of instruments :

T92 Series with firmware version V2.4 + onwards.
T93 Series with firmware version V1.8 + onwards.
T94 Series with any version of firmware.
CO 102 with firmware version 3.3 and onwards (comms option must be fitted).
PE 60 with firmware version V3.3 and onwards.

Before trying to use any of the commands on a TMS 92 or a TP 92 it is essential that the optional PT91 printer mode has been set to off, details of how to do this can be found in the manuals shipped with these units. On these units an instrument calibrate should also be carried out.

Cable Connections

RS 232 Interface Cables can be supplied by Linkam and are connected as follows :

9 way 'D' type on the computer

Linkam			Computer	
TX	pin 3	------ RX	pin 2	
RX	pin 2	------ TX	pin 3	
RTS	pin 7	------ CTS	pin 8	
CTS	pin 8	------ RTS	pin 7	
GND	pin 5	------ GND	pin 5	
		------ DSR	pin 6	
		------ DTR	pin 4	

25 way 'D' type on the computer

Linkam			Computer	
TX	pin 3	------ RX	pin 3	
RX	pin 2	------ TX	pin 2	
RTS	pin 7	------ CTS	pin 5	
CTS	pin 8	------ RTS	pin 4	
GND	pin 5	------ GND	pin 7	
		------ DSR	pin 6	
		------- DTR	pin 20	

The serial computer port follows a DTE pinout and uses a RTS/CTS handshake. If your computer does not drive CTS then connect pin 5 to the computers DTR line and DSR line.

Protocol

- 19200 baud, 8 data bits, 1 stop bit, no parity using an RTS / CTS handshake.
- TX and RTS are at standard RS232 levels.
- RX and CTS can be at RS232 or LOGIC levels.
- All data transmissions to the PC will end in a carriage return.
- All commands from the PC must end with a carriage return.
- All commands from the PC that do not require data to be returned are acknowledged with a carriage return.

RS232 Commands

Please note that all of the following commands are case sensitive :

'T' command

In answer to the ‘T’ command the current status and temperature information is returned in the form of the 11 byte string detailed below :

Byte 0	Status byte SB1	Information about what the programmer is currently doing
Byte 1	Error byte EB1	Indicates sources of errors in the programmer
Byte 2	Pump byte PB1	Current speed of the LNP Cooling Unit
Byte 3	Gen status GS1	Used by the CSS 450 or the MDS 600 unit for status information
Byte 4	Not used	
Byte 5	Not used	
Byte 6	MSB	Temperature *10 sent as a signed integer ASCII hex value
Byte 7		
Byte 8		
Byte 9	LSB	
Byte 10	Carriage Return	

Temperature Information

To save sending the decimal point the temperature is multiplied by 10. This value is converted to a signed integer value covering the range -1960 to 15000 as F858H to 3A98H. These are then transmitted as :

MSB	‘F’	46H	‘3’	33H
	‘8’	38H	‘A’	41H
	‘5’	35H	‘9’	39H
LSB	‘8’	38H	‘8’	38H

Status byte (SB1)

Value	Function
01H	Stopped
10H	Heating
20H	Cooling
30H	Holding at the limit or limit reached end of a ramp
40H	Holding the limit time
50H	Holding the current temperature (used in heating/cooling for quick hold)

Error byte (EB1)

Bit 0	Cooling rate too fast	Cooling rate cannot be maintained
Bit 1	Open circuit	Stage not connected or sensor is open circuit
Bit 2	Power surge	Current protection has been set due to an overload
Bit 3	No Exit 300	TS 1500 tried to exit profile at a temperature >300° (Not allowed)
Bit 4	Both stages	TMS 92 has a TS 1500 and a THM stage connected (Not allowed)
Bit 5	Link error	Problems with the RS 232 data transmission
Bit 6	NC	
Bit 7	1	Default value

CO 102 and PE 60 Error Byte

Bit 1 is Open circuit on Stage 1 and Bit 2 is Open circuit on Stage 2.

Both Stages Error Bit

With a TMS 92 it is possible to have a TS1500 stage connected to the PS1500 power supply and at the same time a 600ºC silver block stage connected to the programmer. You must select from the TMS 92 keyboard at power on which stage to use.
If using a CI92 it will default to the 600ºC silver block stage.

Pump byte (PB1)

Current pump speed in hex from 0 to 30 with the most significant bit set. The LNP only shows these speeds on the front panel LED's by five bands, each one comprised of 6 speeds.

Value	Function
80H	Stopped
81H	Minimum speed (Band 1 LED on the front panel of the LNP)
9EH	Maximum speed (Band 5 LED on the front panel of the LNP)

General status (GS1)

This will depend on the type of instrument connected.

MDS 600

Bit 0	X Motor finished moving
Bit 1	Y Motor finished moving
Bit 2	Z Motor finished moving
Bit 3	Not used
Bit 4	In scan mode
Bit 5	Paused in scan or paused in move
Bit 6	Not used
Bit 7	Set as default value

Temperature Programmer Commands

The programmer is controlled as if it were a single ramp device e.g. a heating rate or cooling rate to a specified limit temperature. Once the limit temperature is reached the SB1 byte will return 30H at which point the temperature will be held forever or until a new command is received.
It is the responsibility of the computer to look after the hold time. This enables virtually limitless profiles to be followed.

Rate Command

Sets the heating or cooling rate in °C/min multiplied by 100. This saves sending decimal points as the minimum heating/cooling rates is 0.01°C/min which would be sent as 1.
The value is prefixed by R1 and ends with a carriage return.

R12000CR Sets the current rate to 20°C/min

Limit Command

Sets the limit temperature in °C multiplied by 10. This saves sending decimal points as the limit temperature may be set to a resolution of 0.1°C.
The value is prefixed by L1 and ends with a carriage return.

L11250CR Sets the current limit to 125°C

Start Command

Tells the programmer to start heating or cooling at the rate specified in R1 and to a limit set by L1.

SCR Start the programmer either heating or cooling

When the limit is reached the SB1 byte will return 30H.

Stop Command

ECR Tells the programmer to stop heating or cooling.

Hold Command

If the programmer is heating or cooling this command will hold at the current temperature until either a heat or a cool command is received.
When holding at the limit value either a heat, cool or a hold command will change the programmer function. When the programmer is holding at the specified limit the SB1 byte will return 40H, otherwise 50H will be returned.

OCR Hold the current limit

LNP Pump Command

Controls both the speed and type of control of the LNP cooling pump connected to the programmer.

Pa0CR	Switches the LNP to automatic mode.
Pm0CR	Switches the LNP to manual mode.

To set the speed from 0 (off) to 30 (maximum) send the value as speed+30H. This will only work when the pump is in manual mode.

P0CR	Speed is 0 which is off.
P9CR	Speed is 9.
PNCR	Speed is 30 (maximum). 30+30H is 4EH which is 'N'

Data and command checks

All data and commands that are received by the programmer are checked for validity. If errors are found an error message will be displayed and the unit will have to be reset.

Programming information

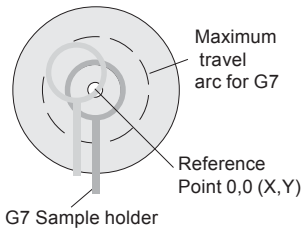
Although the 'T' command is handled virtually instantaneously there is both a transmission time from the computer and from the programmer to take into account. Assuming there are no hardware delays this will be approximately 8 ms at 19200 baud. Therefore, if the computer's buffer is read immediately after sending command 'T', it is possible that incorrect data would be read back, especially if the computer does not respect the RTS/CTS handshake lines. If the computer language used allows the input buffer to be checked to see if it is empty, this can be used as a wait or interrupt request so that hardware buffers can be read into a string variable. If this cannot be done then a small delay will have to be inserted between sending out the command and receiving the data back. This delay will be in the order of about 10mS.

MDS 600 Motor Control Commands

All commands sent from Windows to the MDS 600 are pre-fixed with an 'M' and must end with a carriage return. Commands are always acknowledged with a carriage return or by a return string with a carriage return. This acknowledge will not be sent from the MDS 600 until the command has been processed.

The MDS 600 stage is fitted with precision stepper motors which have 200 steps per rev and are microstepped to give 20000 steps per rev. The pitch of the X,Y motors on the stage is 1mm so distances can be calculated directly within the MDS 600.

However, on the focus or 'Z' motor the value is dependent on the single turn of the microscopes's focus wheel, so the MDS 600 controller must be told this value in order to calculate the steps correctly.



The distances are all in absolute co-ordinates and are based around the centre of the block which is normally referenced with the MF1CR command to be position 0,0.

Motor Status Byte

The current status of the MDS 600 controller can be read using the following command.

M?CR	Asks for the status byte which is shown on page 5 as GS1

Motor Reference Setup

If the stage is not fitted with reference sensors, the current motor position is set to be 0,0,0 (X,Y,Z). For stages fitted with sensors the motors will be moved until they operate.

MF1CR	Reference point

Goto Reference Position

Moves the motors to the reference position (should be block centre).

MF2CR	Sets the reference point

Stopping the Motors

MSACR	Stops the X,Y and Z motor
MSZCR	Stops the Z motor
MSXCR	Stops the X and Y motor

Setting the Speed

The speed is set in um/sec multiplied by 10 with values from 5 to 6000um/sec and is **not** range checked.

MVX20000CR	Sets the X and Y speed to 2000um/sec
MVX50CR	Sets the X and Y speed to 5um/sec
MVZ5000CR	Sets the Z speed to 500um/sec.

Moving in the Z Axis

All distances are absolute co-ordinates in um multiplied by 10. To protect the objective lens the Z motor can only be motored downwards after power on, as the MDS 600 assumes this is a safe reference position.

MMZ10000CR Moves the Z motor 10 mm from the reference position.

Moving in the X,Y Axis

All distances are absolute co-ordinates in um.

MMX3500CR Moves the X motor 3500um from the centre of the block
MMY-3500CR Moves the Y motor -3500um from the centre of the block

Moving All Axes

MMR3500,-3500,10000CR Combination of the instructions shown above.

Software Travel Limits for X and Y

This command sets a maximum travel distance from the reference in um for both the X and Y axes (see diagram)

MLX3500CR Sets a maximum travel in X and Y of 3500um

Software Travel Limits for Z

This command sets the maximum travel distance from the reference in um mutliplied by 10 which gives a resolution of 0.1 um. The reference point for the Z axis is set at power on and will only allow the stage to be moved downwards. To protect the objective lens from damage the microscope table should be adjusted so that this reference point leaves a small gap between the lens and the top window of the stage.

MLZ100000CR Sets the maximum travel in Z to 10mm

Microscope Focus Wheel Setting

The distance the microscopes table moves for one turn of the focus wheel varies from manufacturer to manufacturer and in order for the Z drive to move the correct distance this value must be sent to the MDS 500 control unit in um multiplied by 10. e.g. for an Olympus BX 60 this is 100um.

MMm1000CR Sends the value of 1000 for the Olympus BX 60

Current Position

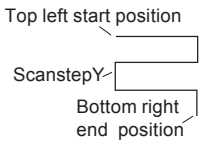
The absolute co-ordinates of the motor position can read at any time and are returned in one string with the X,Y,Z values delimited by a comma.

MpCR Ask for current position

If the motor was at the reference position then the return string would be : M?0,0,0CR

Scanning

The motor and sample holder can be moved in a 'snake' pattern to enable an area to be scanned. The area is defined by a top left co-ordinate and a bottom right co-ordinate with a step distance in Y to determine the no of increments in Y for each X move. This will be a function of the lens magnification.



MmA150CR Store the current position as the top left start position

MmA151CR Store the current position as the bottom right end position

MA1CR Store the ScanStepY value in um

Scan Control

MPCR Pause the X,Y,Z scan movement

MRCR Continues the scan from where the pause was used

MA6CR Start the scan movement

DSC 600 Optical DSC Commands

Please note that all of the following commands are case sensitive :

Background Information

The TMS 93 is fitted with an additional gain stage module with auto-zeroing circuitry which is sampled by a 16 bit a/d converter at a programmable rate set by the sample time command.
When powered on the **default sampling time** is 0.3 seconds.
An internal circular buffer, which can hold 375 integer temperature values and 375 integer dsc values, is filled according to the sampling ratem, and is derived from a crystal controlled clock.
At the default sampling time this allows about 112 seconds before the buffer over-runs which is enough time for most Windows applications to complete, before re-sampling for data.
To avoid a data over-run the Windows applications should request data faster than the internal sampling rate and will return 32767 when there is no valid data in the buffer.
When the profile is finished the last data item is marked as 32765.

External Data Markers

For data collection where it is important to synchronise the dsc with some other equipment it is possible to mark the data with a value of 32766.
The TMS/CI 93's 9 pin I/O port carries two signals. Pin 2 is an open drain signal, which when pulled up will give a 2uS positive going pulse, when ramp 2 starts. For ease of use this line can be pulled up with a 4K7 to pin 9.
Pin 8 is the input for a +5V positive going pulse, which gives a timemarker output on the DSC data. This signal should be referenced to GND on pin 5.

Sampling time command

This command is not a standard ASCII code, it has the value in decimal of 231 or E7 in hex followed by 4 characters and then a carriage return.
The sample times in seconds are every 0.3, 0.6, 0.9, 1.5, 3, 6, 9, 15, 30, 60, 90, and 150 seconds. The required value should be divided by 50mS so for a 0.3 second sampling time a value of 6 should be sent. This should be right padded using spaces to make four characters.
e.g. for 0.3 second sampling then the value is 0.3/50e-3 = 6
Message in hex is 231 20 20 20 36 0D
e.g. for 60 second sampling then the value is 60/50e-3 = 1200
Message in hex is 231 31 32 30 30 0D

'B' command

BCR Clears the internal buffers and resets the buffer pointer to the start.

'D' command

DCR asks for the temperature and dsc data value which were sampled at the same time and is not the same as the 'T' command which could be delayed by Windows data collection.

In answer to the 'D' command the current status and temperature information is returned in the form of the 9 byte string detailed below :

Byte 0	MSB	
Byte 1		
Byte 2		Temperature *10 sent as a signed integer ASCII hex value
Byte 3	LSB	
Byte 4	MSB	
Byte 5		
Byte 6		DSC value sent as a signed integer ASCII hex value
Byte 7	LSB	
Byte 8	Carriage Return	

Please note that when using a TMS94 with firmware V2.1 or higher, a CI94 with firmware V1.4 or higher, or a TP94 with firmware V1.5 or higher, that these instruments will return a 13 byte string. Bytes 0 to 7 will be as above, bytes 8 to 12 will not be used and byte 13 will be a Carriage Return.

Temperature Information

To save sending the decimal point the temperature is multiplied by 10. This value is converted to a signed integer value covering the range -1960 to 15000 as F858H to 3A98H. These are then transmitted as :

MSB	'F'	46H	'3'	33H
	'8'	38H	'A'	41H
	'5'	35H	'9'	39H
LSB	'8'	38H	'8'	38H

Dsc Information

This value is converted to a signed integer value covering the range -32767 to 32764 as 8001H to 7FFCH. These are then transmitted as :

MSB	'8'	38H	'7'	37H
	'0'	30H	'F'	46H
	'0'	30H	'F'	46H
LSB	'1'	31H	'C'	43H

e.g. For a temperature of 120°C and a DSC value from the a/d of 3400 then the following will be transmitted.
Temperature 120*10=1200D or 04B0H which is a string of 30 34 42 30.
Dsc 3400D or 0D48H which is a string of 30 44 34 38.
The return string will then be :

30 34 42 30 30 44 34 38 CR

'SP' command

SPCR asks to end the data logging after the profile is finished by sending back a 32765 in the dsc data string.

'SC' command

SCCR asks to end the data logging when a stop programming command is reveived such as the ECR command.

Ver 2.1 06/01/2000	Incorrect MMp command changed to Mp
Ver 2.2 26/04/2000	Incorrect Pm and Pa commands missing speed value. Title changed to include T94 programmer
Ver 2.3 02/04/2001	Cleared up references to T92 / T93 + T94, removed WFW 3.11 notes.
Ver 2.4 30/07/2001	Changes to 'D' command on T94 units

Linkam Scientific Instruments Ltd
8 Epsom Downs Metro Centre, Waterfield, Tadworth, Surrey, KT20 5LR, England
☎ +44 (0) 1737 363476 +44 (0) 1737 363480
✉ info@linkam.co.uk http://www.linkam.co.uk