TECAN.

Liquid Handling Arm
LIHACU
Firmware Command Set

Document Status (Draft / Released / Replaced / Invalid):	*Released*
Filename:	FCS_LIHADCU V1.7.doc
Author:	*Hape Romer / Markus Schild / Stephan Böhmer / Ludwig Heusser*
Document Version:	*V1.7*
Document Release Date :	2013-10-29
Document Release Signature	Heusser
Storage place of valid version:	*Development folder LIHA FW*

© Copyright by Tecan Schweiz AG

Table of Contents

1 DOCUMENT HISTORY 7

2 FIRMWARE UPDATE HISTORY 11

3 INTRODUCTION 15

3.1 PURPOSE 15
3.2 SCOPE 15
3.3 DEFINITION OF TERMS AND ABBREVIATIONS 15
3.4 DOCUMENT CONVENTIONS 16
3.5 REFERENCED DOCUMENTS 16
3.6 DEVICE OVERVIEW 17
3.7 OPERATION & SETUP 18
3.7.1 Boot loading 18
3.7.2 Firmware Download / Boot commands 18
3.7.3 Configuration 19
3.7.4 Calibration 19
3.8 AXES CONVENTIONS 20
3.8.1 X,Y and Ys- Axis Overview 20
3.8.2 Axis Coordinate Plane Standard Axes X&Y 20
3.8.3 Recalculation Rules 20
3.8.4 Z - Axis Overview 21
3.8.5 Axis Coordinate Plane Z-axis 21
3.8.6 Recalculation Rules 21

4 COMMANDS 22

4.1 REPORT COMMANDS (BASE FUNCTIONALITY) 22
RFV Report Firmware Version: 22
RDF Report Diagnostic Functions: 22
RGD Report Global Data: 23
RED Read FLASH EPROM Data: 23
RDA Report Device Allocation Array of Subdevices: 23
RKA Report Keep Alive Function: 24
RSU Report Stack Usage: 24
RBT Report Board Temperature: 24
4.2 REPORT COMMANDS (LIHA SPECIFIC FUNCTIONALITY) 25
RSL Report Second LIHA: 25
RNT Report Number of Tips on Arm: 25
RSD Report Presence Lower Diti Eject Option: 25
RDE Report Status of Lower Diti Eject Option: 25
RST Report Lower Diti Eject Logical Positions: 26
RDT Report Diti Discard / Aspirate Parameter: 26
RYS Report Minimum Y Space Distance: 26
RYB Report Y Backlash and Z Positioning Parameter: 26
RPX Report Current Parameter for X-Axis: 27
RPY Report Current Parameter for Y-Axis: 27
RPZ Report Current Parameter for Z-Axis: 28
RTG Report Optional Tip Guard Status: 28
RVZ Report Z-Axis Values and Parameters: 28
RGZ Report Global Z-Axis Values and Parameters: 29
RFP Report Force Parameter for all Movements: 29
RTL Report Individual Z-Start for Liquid Search Commands: 29
RML Report Individual Z-Max for Liquid Search Commands: 29

RBL Report Individual Submerge for Liquid Search Commands: *30*
RDL Report Individual Safe Detection Retract Distance for Liquid Search: *30*
RDR Report Individual Retract Distance for Clot Detection: *30*
RSR Report Individual Retract Speed for Clot Detection: *30*
RLR Report Individual Retract Limit for Clot Detection: *31*
RDM Report Liquid Detection Mode: *31*
RLA Report Liquid Detection Acceleration: *31*
RTZ Report Z-Axis Relative Tracking Values: *31*
RTS Report Tip Status Diti: *32*
RSM Report X-Axis Smooth Move Mode: *32*
REE Report Extended Error Code or Axis Configuration String: *32*
RDX Report X-Axis Diagnostic Functions: *32*
RDY Report Y-Axis Diagnostic Functions: *33*
RDZ Report Z-Axis Diagnostic Functions: *33*
RYR Report Y Auto Range in Increments: *33*
RHS Report Enhanced Speed Setting for EVO75: *33*
RBK Report Z Drive Brake Status (only 8 + 1 Configuration): *34*
RXT Report Discard Offset (8+1): *34*
4.3 REPORT COMMANDS (DILUTOR SPECIFIC FUNCTIONALITY) 34
RPP Report Plunger Drive Parameter: *34*
RDS Report Last Error Code of Dilutor: *34*
RDD Report Dilutor Drive Status: *35*
RYV Report Syringe Volume: *35*
4.4 REPORT COMMANDS (TEPS SPECIFIC FUNCTIONALITY) 35
RAT Report Adjustment Position of X and Y-Axis Direction: *35*
RAZ Report Adjustment Position of Z-Axis Direction: *36*
4.5 REPORT COMMANDS (PMP SPECIFIC FUNCTIONALITY) 36
RAP Report Pressure LLD Parameter (Aspirate Part): *36*
RDP Report Pressure LLD Parameter (Dispense Part): *36*
RVP Report PMP Pressure Value Before and After Detection: *37*
RPE Report PMP Error Handling: *37*
4.6 SET COMMANDS (BASE FUNCTIONALITY) 37
SFV Set Serial Number: *37*
SGD Set Global Data: *38*
SED Set FLASH-EPROM Data: *38*
SRS Reset System (Whole Subsystem inclusive this DCU): *38*
SBC Send Broadcast to all Subdevices: *38*
SCC Send Broadcast to Device: *39*
SKA Set Keep Alive Function: *39*
SOF Firmware Download: *39*
4.7 SET COMMANDS (LIHA SPECIFIC FUNCTIONALITY) 39
SYS Set Minimum Y-Space Distance: *39*
SYB Set Y Backlash and Z Positioning Parameter: *40*
SRX Set X-Axis Range: *40*
SRY Set Y-Axis Range: *40*
SRZ Set All Z-Axis Range: *40*
SHZ Set Individual Z-Travel Height: *41*
STZ Set Z-Axis Relative Tracking Distance: *41*
SSL Set Search Speed for Liquid Search Commands: *41*
SSX Set Slow Speed for X-Axis: *41*
SSY Set Slow Speed for Y-Axis: *42*
SSZ Set Individual Slow Speed for Z1..Z8: *42*
SPS Set Pierce Parameter for Piercing Commands: *42*
SFP Set Force Parameter for all Movements: *42*

SSP Set Pick Parameter for Diti Commands: *43*
SSD Set Discard Parameter for Diti Commands: *43*
SST Set Lower Diti Eject Logical Positions: *43*
SDE Switch Lower Diti Eject On or Off: *43*
SDT Set Diti Discard / Aspirate Parameter: *44*
STL Set Individual Z-Start for Liquid Search Commands: *44*
SML Set Individual Z-Max for Liquid Search Commands: *44*
SBL Set Individual Submerge for Liquid Search Commands: *44*
SDL Set Individual Safe Detection Retract Distance for Liquid Search Cmd: *45*
SDR Set Individual Retract Distance for Clot Detection Commands: *45*
SSR Set Individual Retract Speed for Clot Detection Commands: *45*
SLR Set Individual Limit for Clot Detection Commands: *45*
SDM Set Liquid Detection Mode: *46*
SLA Set Liquid Detection Acceleration: *47*
SFX Set X-Move Parameters: *47*
SFY Set Y-Move Parameters: *47*
SFZ Set Z-Move Parameters: *48*
SOX Set Initialization Offset for X-Axis: *48*
SOY Set Initialization Offset for Y-Axis: *48*
SOZ Set Initialization Offset for Z-Axis: *48*
SAX Set Scale Adjust Factor for X-Axis: *49*
SAY Set Scale Adjust Factor for Y-Axis: *49*
SAS Set Scale Adjust Factor for Y-Space Axis Only: *49*
SSM Set X-Axis Smooth Move Mode: *49*
SLX Set New X-Axis Scaling Factor and Motion Direction: *50*
SLY Set New Y-Axis Scaling Factor and Motion Direction: *50*
SLZ Set New Z-Axis Scaling Factor and Motion Direction: *50*
SMC Set all LIHA Axis Move Counter to Zero: *50*
SHS Set Enhanced Speed Setting for EVO75: *51*
SXT Set Discard Offset (8+1): *51*
SBK Set Z Drive Brake On or Off (only 8 + 1 Configuration): *51*
4.8 SET COMMANDS (DILUTOR SPECIFIC FUNCTIONALITY) 51
SEP Set End Speed for Plungers: *51*
SPP Set Stop Speed for Plungers: *52*
STP Set Start Speed for Plungers: *52*
4.9 SET COMMANDS (PMP SPECIFIC FUNCTIONALITY) 52
SAP Set Pressure LLD Parameter (Aspirate Part): *52*
SDP Set Pressure LLD Parameter (Dispense Part): *53*
SVP Set Delta Pressure Overrun Limit: *53*
SPE Set PMP Error Handling: *53*
4.10 ACTION COMMANDS (BASE FUNCTIONALITY) 54
AWE Write System Parameters to FLASH-EPROM: *54*
ARE Read System Parameters to FLASH-EPROM: *54*
ACW Erase all Setup Data in the Flash: *55*
Txx Pipeline to Slave Device: *55*
4.11 ACTION COMMANDS (LIHA SPECIFIC FUNCTIONALITY) 55
PIA Position Initialization X/Y/Z – Axis: *55*
PIB Position Pre Initialization: *55*
PIF Fake Initialization X/Y/Z – Axis: *56*
PIX Position Initialization X-Axis: *56*
PIY Position Initialization Y-Axis: *56*
PIZ Position Initialization Z-Axis: *56*
PAA Position Absolute for All Axis: *57*
PXZ Fast Positioning Absolute for X and Z Axis: *57*

© Copyright by Tecan Schweiz AG

PAX Position Absolute X-Axis: *58*
PAY Position Absolute Y-Axis: *58*
PSY Y-Spacing Of Tips: *58*
PAZ Position Absolute Z-Axis: *59*
PRX Position Relative for X-Axis: *59*
PRY Position Relative Y-Axis: *59*
PRZ Position Relative Z-Axis: *59*
PCX Position Relative in Increment Resolution for X-Axis: *60*
PCY Position Relative in Increment Resolution for Y-Axis: *60*
PTG Position Logic for Optional Tip Guard Drive: *60*
MAX Position Absolute with Slow Speed X-Axis: *60*
MAY Position Absolute with Slow Speed Y-Axis: *61*
MAZ Position Absolute with Slow Speed Z-Axis: *61*
MAA Position Absolute for all Axis with Slow Speed: *61*
MRX Position Relative with Slow Speed X-Axis: *62*
MRY Position Relative with Slow Speed Y-Axis: *62*
MRZ Position Relative with Slow Speed Z-Axis: *62*
MDT Move Tip, Detect Liquid, Submerge: *63*
MET Move Tip, Detect Liquid, Submerge: *63*
MCT Check for Clot on Selected Tips: *64*
APT Pierce With Tip: *64*
AGT Get Disposable Tip: *64*
ADT Discard Disposable Tip: *65*
AST Discard Disposable Tip with Lower Diti Eject Option: *65*
AXT Discard Disposable Tip with Lower Diti Eject Option (only 8 + 1 Configuration): *66*
BMX Stop X Drive Movement Immediately: *66*
BMY Stop Y Drive Movement Immediately: *67*
BMZ Stop Z Drive Movement Immediately: *67*
BMA Stop all Axis Immediately: *67*
CST Calibrate Automatically Lower Diti Eject Logical Positions: *67*
ARX Auto Range X-Axis: *68*
ARY Auto Range Y-Axis: *68*
ARZ Auto Range Z-Axis: *68*
NOC Automatic Reference Pin Coarse Detection: *69*
NOK Automatic Reference Hole Detection: *69*
MSD X/Y/Z-Spiral Move with Dilutor Tracking: *70*
4.12 ACTION COMMANDS (DILUTOR SPECIFIC FUNCTIONALITY) 72
PPR Move Plunger Relative: *72*
PPA Move Plunger to Absolute Position: *72*
MTR Move Tracking Relative: *73*
PID Initialize Plunger and Valve Drive (Reverse Polarity): *73*
PVL Position Valve Logical: *73*
AHS Start Hit Pinch Valve Solenoids: *74*
APS Start Piezo Pump for N Drops: *74*
ADV Dispense Volume: *74*
4.13 ACTION COMMANDS (TEPS SPECIFIC FUNCTIONALITY) 75
ATP Auto Tip Step Positioning: *75*
AAZ Auto Adjustment Z-Axis direction: *75*
AAT Auto Adjustment X- and Y-Axis direction: *76*
4.14 BROADCAST MESSAGES 77

5 ERROR CODES 78

6 TRACEABILITY 79

6.1 REQUIREMENT DOWNWARDS TRACEABILITY 79
6.2 REQUIREMENT UPWARDS TRACEABILITY.....83

7 INDEX OF COMMANDS 87

1 Document History

Version	Date	Author	Description of document changes	Corresponding Firmware
1.00	3.6.03	Paul Guyer	**Project status M4**, Changes according review, LiHa_FCS_Review20030603 -delete MHZ command, nobody use it -delete error code 16 -other default parameter cmd SYB	DCULI0017-6 /2003
1.10	23.7.2003	Paul Guyer	-Command RSU, RPX and RPY with correction of selector -SLZ cmd: change default value to 801 -MAA and PAA cmd: with explanation of 1536 pipetting -MCT cmd with LLD position report -SDZ no initialisation is needed -RDS new command -BMY cmd, with space movement -SYB cmd, with additional commands -cap.3.6.3, 2 tip with big space -small changes according test report MBR 2003.06.25 -SSP,SSD,SPS cmd, current note! -SDM cmd, no changes -AGT cmd, with default parameters -PPR,PPA,MTR,PID,PVL,AHS,APS, ADV,ATP command with error message 28. Get errors with RDS command -SGD cmd, write down with AWE -AWE cmd, with backdoor warning -PAX cmd, with smooth move info -SFX cmd, with low limit acceleration of 380 -SSM cmd, this command has some influence to PAX, PRX, MAX, MRX	DCULI0018-7 /2003 (release candidate V1.00)
1.11	29.10.2003	Paul Guyer	-PAZ, MAZ, MRZ, PRZ move range until minus displacement -PAZ, MAZ, MRZ, PRZ with Z-backlash -RFV command with selector 15 -SYB command with default Z-backlash of 0.4mm -SLZ command with right default parameter of 782 -PAY command with more description -Error message 29&30 by REE Cmd -functional table of content	DCULI110-10 /2003 DCULI111-11 /2003
1.12	17.02.2004	Paul Guyer	-new command RYV (Report Syringe Volume) -report first LLD position in the RVZ command with selector 0. -no error 3 message from dilutor	DCULI112-02 /2004 DCULI113-06 /2004

			commands (range check in the dilutors). Commands PPR, PPA, MTR, SEP, SPP, STP. -change error description of the MTR command. -SFX command with acceleration of 1600	
1.20	21.09.2004	Hape Romer	Draft version for target Firmware V1.20 -add LLD-boxes to overview -RPZ command with selector 13 reserve -SFP, new command -RYR&SYR are new commands -after SYS, Y reinitialisation required -SYB command with new description and ranges -STL, SML, SBL, SDL, SDR without Z-displacement and no negative range of -32000 -change description of SDM command -SFX command with higher range of 11250 for both parameters -SOX and SOY with new description -AWE and ARE more parameter get saved -PIZ command with new default value -PAA and PAZ no Z-displacement -PRX, PRY, MRX, MRY with displacement -MET and MDT with with –1000 submerge distance and no Z-displacement -MCT with new error message 23 and no Z-displacement -AGT without displacement -AST and ADT with default setting -after Break with selector 1, no initialisation is needed -CST with error message 29 -PPR, PPA and MTR with more description -AAT with smaller speed settings -AAZ with new default setting of relative distance and smaller speed range -SOX with a minimum offset of 10 -SYB default value of Y-backlash is 20	DCULI120-01 /2005
1.30	15.07.2005	Hape Romer	- **RKA** new base function command - **RSL** new command to report second LIHA - **RDD** new command to report dilutor drive status - **RDT** new command to report diti discard / aspirate parameter - **RCA** command removed **- RAP** new PMP command to report pressure LLD parameter (Aspirate Part) **- RDP** new PMP command to report pressure LLD parameter (Dispense Part) **- RPV** new command to report PMP pressure value before and after detection **- SKA** new base function command **- SCA** command removed	DCULI130-07/2005

			- SHZ default value is new 2100 **- SDT** new command to set diti discard / aspirate parameter **- SDM** new detection modes **- SAP** new PMP command to set pressure LLD parameter (Aspirate Part) **- SDP** new PMP command to set pressure LLD parameter (Dispense Part) - **ADT** / **AST** are supporting now aspiration while diti discard	
1.31	10.01.2006	Hape Romer	**RPV** command renamed to **RVP** - **SVP** new command for PMP pressure value definition - **MDT/MET** command with new error code 21 - New error code 21 called “Delta pressure overrun”	DCULI131-2006
1.4	20.11.2006	Hape Romer	- enhanced **AGT** functionality - new commands **SHS/RHS** for EVO75 speed configuration - **RDF** with new selector 4 - **RFV** with new selector 9 & 16	DCULI140-2006
1.41	22.03.2007	Hape Romer	- new **PXZ** command for multi- dispense speed increase	DCULI141-2007
1.42	25.06.2007	Hape Romer	- New **PTG** Tip Guard positioning command - New **RTG** Tip Guard status command - **PIA** supports new Tip Guard -New error code 22 “Tip Guard in wrong position” - **SHZ** with enhanced Range - **AGT** supports now a retract switch - **RIM** command removed - **SIM** command removed	DCULI142-2007
1.43	31.08.2007	Hape Romer	No FCS contents change, only bug fixing, see Firmware Update History	DCULI143-2007
1.50	29.10.2007	Hape Romer	- **RTS** supports the 8+1 configuration - **AGT** supports the 8+1 configuration - New **AXT** diti discard command - **CST** supports the 8+1 configuration - New **SBK** & **RBK** commands supporting the 8+1 brake **- PID** supports the 8+1 configuration - **ADT** / **AST** supporting the 8+1 configuration **- MDT** / **MET** supporting the 8+1 configuration - **MCT** supports the 8+1 configuration - **SDZ** is removed	DCULI150-2007
1.52	07.07.2008	Hape Romer	- New **SXT** command supporting the 8+1 configuration - New **RXT** command supporting the 8+1 configuration - correction in the Firmware History - add defaults in STX and update the description.	DCULI152-2008
1.6	2010-03-15	Stephan Böhmer	- add RPE and SPE command. - add ACW command	DCULI160-2010

			- update traceability table. - added more information to 3.7.3 - added Axes Conventions Overview and more information - added Comment about spacing to 3.8.1 - added Offset 3 to SXT and RXT command - change valid range of Offset 1 in SXT command from 0..40 to -20..60 - various minor changes for better understanding	
1.61	2011-02-16	Markus Schild	- add MSD command for spiral moves	LIHACU-V1.60005-02/2011
1.62	2012-01-05	Markus Schild	- add new parameter ZTrackingDistance to MSD command. - correct validity of some parameters of MSD command.	LIHACU-V1.60006-01/2012
1.63	2012-01-24	Markus Schild	MSD: change order of selectors	LIHACU-V1.60006-01/2012
1.64	2012-08-15	Markus Schild, Ludwig Heusser	Changes according to FCS review from 2012-01-30.	LIHACU-V1.70-08/2012
1.65	2012-09-05	Ludwig Heusser	MSD command: Separated the deltaDistance, parameter in XDeltaDistance, YDeltaDistance to support rectangle spiral form.	LIHACU-V1.70001-09/2012
1.66	2013-09-12	Ludwig Heusser	No content change, corrrected support of MSD command on EVO75.	LIHACU-V1.70003-09/2013
1.67	2013-10-25	Ludwig Heusser	Firmware Update History.	LIHACU-V1.70003-09/2013
1.7	2013-10-29	Ludwig Heusser	Release version	LIHACU-V1.71-10/2013

2 Firmware Update History

FW-Version	Description of functional changes
LIHACU V1.00-7/2003	-bug fix of PIB,RAT,PIZ,PIY cmd -delete RTP command -SYB cmd, Y-backlash is 0, can't be changed -dilutor commands timeout to endless, exception PID, PVL -SDZ cmd, no initialisation is needed -PAA/MAA, MoveY function, Z-backlash and movement reduced to a minimum. -changes according code review (dilutor check, endless timeout axis & dilutors) -PIY cmd, space offset to 15 and timeout to 200ms -2 tip configuration with space, space range can until Y-range -AGT cmd, with special init offset (20 1/10mm) -MoveY function with no wait action commands -BMY cmd, after a BMY0 command the space has to move to the command position (it is possible to get an error 6) -RDS cmd, RDS is a new command, Report Dilutor Status -PIB/ARY/PIY cmd, all commands need some changes because of the DCS2 position window. -NOK cmd, this command has a longer time out between steps in Y-direction -ARZ cmd, with offset range check
LIHACU V1.01-7/2003	-bug fix of PIB command -bug fix of PIX command -bug fix of PIY command -bug fixes according PVCS Tracker inputs #75, #76, #77
LIHACU V1.10-10/2003	**Requires new DC-Servo2 firmware V1.10** -increase PWM limit to 35 by using NOK/NOC commands -Z-backlash function by commands PAZ, MAZ, PRZ, MRZ -change motor parameter of Y- and X-axes -take slow speed by using Y-spacing of 9.0mm -change Z-backlash value from 0.2 to 0.4mm -bug fixes according PVCS Tracker inputs #79,#88 ,#91,#94, #95, #97, #98, #99
LIHACU V1.11-11/2003	-bug fixes according PVCS Tracker inputs #108 #109
LIHACU V1.12-02/2004	-new command RYV (Report Syringe Size) -report first LLD position in the RVZ command with selector 0. -improve LLD action. -it is possible to set acceleration of the X-axis, if SSM is active. -increase acceleration of X-axis to 1600 -Liquid level double detection with position check and move to lower position. -no whistle of the X-axis, reduce P-gain after move. -bug fixes and future request according PVCS Tracker inputs #115, 116, 123, 124 125, 128 -possibility of using 2 tip LiHa with spacing and EVO75 with 1&2 tips -change motor parameter of Z-axes

© Copyright by Tecan Schweiz AG

LIHACU V1.13-06/2004	-bug fixes according PVCS Tracker inputs #145, 146, 147 -change motor regulation parameter back to the old values. P=10000 & I=10000 -PAZ, MAZ commands, improve possibility to communicate over the backdoor address without error message 4 -increase PWM level of Z-Reached function to 40
LIHACU V1.20-01/2005	-bug fixes according PVCS Tracker inputs: #137, 142, 143, 148, 149, 150, 151, 152, 153, 167, 168, 169, 170, 171, 172, 173, 174, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 208, 212, 213, 218, 221, 223, 224 -it's no more needed to have any Semaphores in the code, that makes communication to DC-Servo2 easier. -redesign of Y-space function; same function as earlier in the Genesis firmware. Be careful for accurate positioning, it's not the same than earlier FW versions! Use 2mm Y-Backlash for same precision. -default Y-backlash is 20 -Regulation parameter of both Y-axes changed to P=10000 and I=50000 -command SYB without 4th parameter (settable pressure value), new ranges for other parameters -the Z-backlash movement in the PAA command is now working with every command call -in the smooth move mode there is a new acceleration calculation to stabilize small movements. Also X-axis regulation parameters changed to P=4000 and D=2000. Also D-parameter of X-axis has changed. -improve error handling of all move commands with modified CheckRange function -status check of VCC and XP2000 is handled without a relative move -improve error handling of dilutor commands -all Z-displacement settings are removed (handled by software) -RTE is renamed to RBT (report temperature) -new commands RFP & SFP set force parameters of Z-axis for pierce functionality -APT command with faster multiple piercing. -new command RYR reports increments of Y-axes -change default value of Y-init offset to10 and displacement to –887, minimum offset value of X-axis is 10. -after BMx1 no initialization is needed -after BMx2 error status of axes are 10(drive no load) -after initialization of the Y-axes, spacing = 90 1/10mm

LIHACU V1.30-07/2005	**Requires new DC-Servo2 firmware V1.20** - Change requests according PVCS Tracker entry's: #136 → Improve of clot detection #225 → Support of second LIHA #226 → Aspiration while diti discard #228, 229 → Support of PMP module - Bug fixes according PVCS tracker entry's: #177 → Not working PIF #209 → Z-add precisely calculation #210 → 2 PIA needed after a SYS command #211 → Init doesn't work the first time after a BMA2 #214 → Some counters Rdxy does not count correctly #215 → PIA with BMA2 and AGT with BMAx not breakable #216 → Incorrect Error code of MAZ after a (blocked) MDT #217 → Second Channel report with error 4 during MET or MET with error 24 #219 → PIB doesn't work correctly on 2 tip individual space with Lower Diti Eject #220 → SYB Y backslash should influence Y Range #222 → Y security Distance at max position is different than written in CS #227 → LiHa FW react different by MDT (Z-add) cmd than GenesisCU #260 → CST does not stop by crashing
LIHACU V1.31-2006	- Definite support of the PMP module - Change requests according PVCS Tracker entry's: #215 PIA with BMA2 and AGT with BMAx not breakable #226 Aspiration while Diti discard #228 PMP Support #265 Some counters Rdxy do not count correctly
LIHACU V1.40-2006	- Change request No. 3151, enhanced AGT performance functionality - Merge of LIHA versions V1.31/V1.32/V1.33 for EVO75 - Change requests according PVCS Tracker entry's: #289 → PVO is send as SET instead as Action cmd #292 → PIB move to wrong side #293 → PIA get error 1 if spacing is open max as possible #294 → RFV shows required DC-Servo2 FW Version #296 → Blocked Flash Devices #307 → Diti fetch command with even/ odd or all together selector #309 → Merge V1.31 / V1.32 and 1.33 Speed handling (EVO75) #310 → SYS add Ys axis also if it is not installed #311 → REE report @ instead something else after a crash
LIHACU V1.41-2007	**Requires new DC-Servo2 firmware V1.21** - New PXZ command - Change requests according PVCS Tracker entry's: #328 → AGT even / mode is not working properly #329 → New round move command for X and Z drive
LIHACU V1.42-2007	- New Tip Guard support with **PTG** / **RTG** commands **- AGT** supports now a retract switch Change requests according PVCS Tracker entry's: #44 (Firmware2) → Tip Fetch (AGT) without retract move #45 (Firmware2)→ Support new Tip Guard mechanism
LIHACU V1.43-2007	Change requests according PVCS Tracker entry's: #54 (Firmware2) → Non volatile data loss problem
LIHACU V1.50-2007	- New 8+1 arm configuration supported Change requests according PVCS Tracker entry's: #58 (Firmware2) → New LIHA 8+1 configuration
LIHACU V1.51-2008	Change requests according PVCS Tracker entry's: #67 (Firmware2) → 8+1 AXT Diti eject timing is not reliable #68 (Firmware2) → MDT returns an error 9 also in case of a correct liquid detection

LIHACU V1.52-2008	Change requests according PVCS Tracker entry's: #76 (Firmware2) → AXT 8+1 Discard Offsets must be selectable
LIHACU V1.60-2011	- Dilutor-Moves now only check used channels on PmP (SCR#100) - implement commands RPE and SPE for PMP Error Handling (SCR#101) - PIZ_cmd(): default InitRange new: Axes[AxisNo].Range + Axes[AxisNo].InitOffset + 500 (old + 100) - parameter DiscardOffset3 added to SXT_cmd() and RXT_cmd() - changed cDiscardOffset1 and cDiscardOffset3 as well as cStartDiscardOffset1 and cStartDiscardOffset3
LIHACU V1.70-08/2012	Change requests according PVCS Tracker entry's: #117 (Firmware2) Add new command MSD to start X, Y, Ys, Z and dilutor move. Speed of X and Y can be set while Z move uses Z-Fast Speed. Dilutor speeds must be set with the common commands (SEP, SPP, STP).
LIHACU-V1.71-10/2013	MSD command: - Corrected dilutor initialization on EVO75 (SCR#120). - Separated the deltaDistance, parameter in XDeltaDistance, YDeltaDistance to support rectangle spiral form (SCR#122).

3 Introduction

3.1 Purpose

This document contains detailed information about all firmware commands implemented in the firmware of the Liquid Handling Arm. It also assures the upward and downward Traceability between this document and the firmware requirements document Docu. No.392 734.

This Command Set describes the functionality of the Liquid Handling Arm. The Firmware commands control movements and other connected modules.

3.2 Scope

This document is intended for software engineers in order to write service and setup tools or application software. It is not part of the end-user documentation.

3.3 Definition of Terms and Abbreviations

The document uses the following terms:

Term	***Definition***
Command	A sequence of three alphanumeric characters, “A…. Z”
Controller	Micro Processor with on chip peripheral
Device	A physical part of hardware with an embedded controller
Module	Same as device
Node	CAN bus node address. (Ref. 6)
Interrupts	Software or hardware requests for action from a subroutine or hardware module.
Messages	Requests for action from requesting task to supporting task(s).
Micro plate	Liquid container plate with typically 8x12 wells. (or 384 or 1536)

The document uses the following abbreviations:

Abbreviation	***Definition***
CAN	Controller Area Network
CPU	Central Processor Unit
DCS2	Board for DC-motor, second generation
DCU	Device Control Unit
HCAN	Highest level CAN bus
HDI	HITACHI Debugging Interface
HEW	HITACHI Embedded Workshop
FCS	Firmware Command Set
FLASH EPROM	Electrical Erasable Programmable Read Only Memory.
FMEA	Failure Mode, Effects Analysis
FRS	Firmware Requirement Specification
FSD	Firmware System Design
IVD	Invitro diagnostic directive
LCAN	Local CAN bus
LLD	Liquid Level Detection
MPO	Monitored Pump Option
PMP	Pressure Monitor Pipetting
PRD	Product Requirement Document
RAM	Random Access Memory

© Copyright by Tecan Schweiz AG

RTX	Real Time eXecutive
TeCU	Tecan Master Control Unit
TePS	Sensor Plate Tool
USB	Universal Serial Bus
VCC	Volume Control Center
XP2000	New version of Volume Control Center (called XPSmart)

3.4 Document Conventions

The document uses the following convention:

- Parameters marked with an asterisk denote parameters that may be omitted. Such omitted parameters retain the current setting or position.
  Parameters without asterisk denote, that the default value will be taken.
- PAA CMD (2tip fix space):
  The Y-space axis is not implemented. In that case the Ys parameter must be a placeholder.
  E.g. PAA1000,400,,Z1,Z2

3.5 Referenced Documents

[1] PMP Firmware Command Set V1.0, Tecan Document No. 393 747

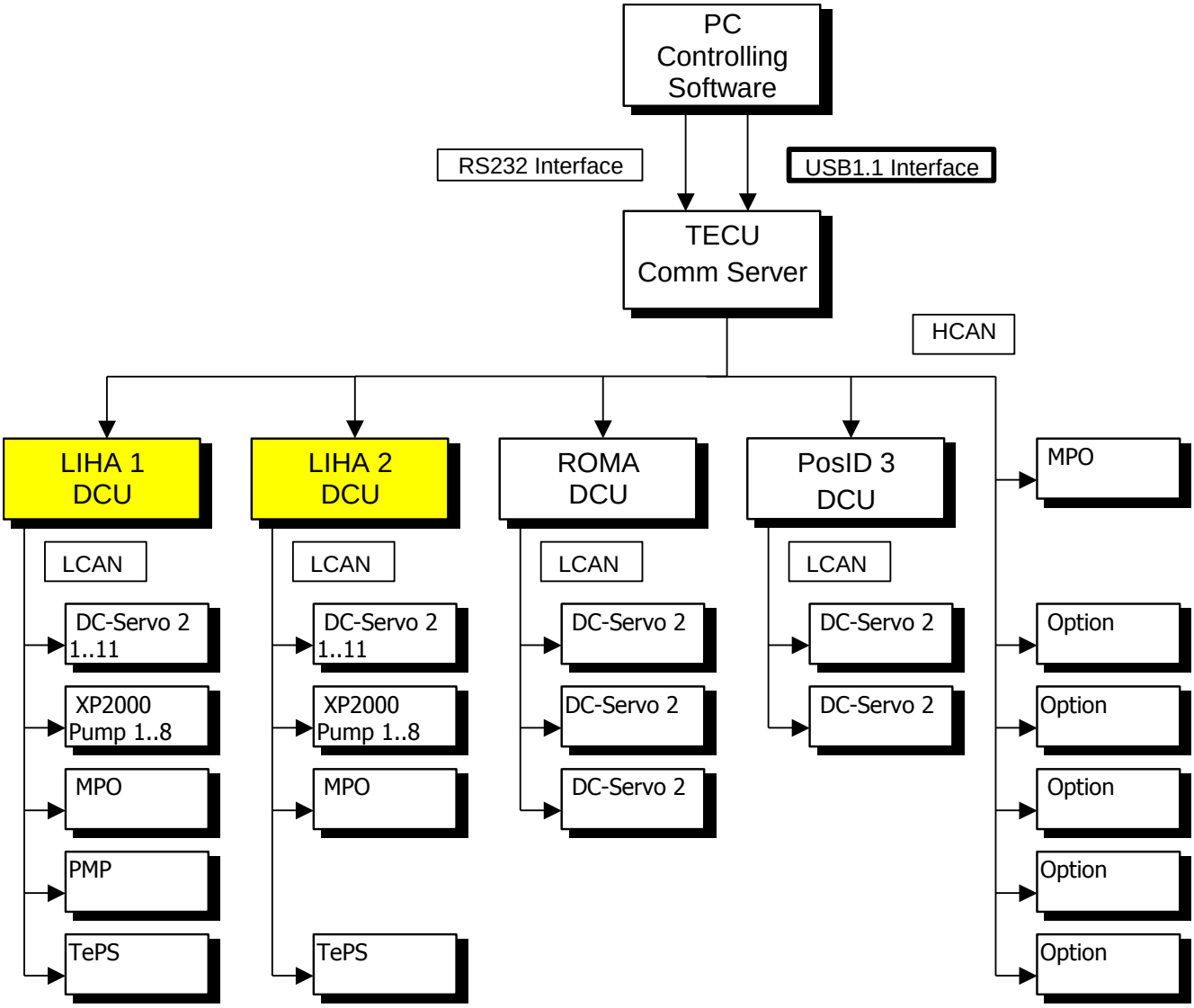
[2] XP2000 Firmware Command Set V1.2 Tecan Document No. 392 134

[3] DCS2 Firmware Command Set V1.2, Tecan Document No. 392 780

[4] TePS Firmware Command Set V1.0, Tecan Document No. 392 749

3.6 Device Overview

The LIHA device control unit must be connected to the TeCU by the highest level CAN bus called HCAN. The TeCU acts as a communication server. It transfers transparent information to the LIHA DCU and vice versa. The LIHA DCU decodes this information and feeds the DC-Servo2 controllers, pumps, adjustment tool, PMP and MPO, which are connected to it's local CAN bus (LCAN). It is possible to connect several LIHA DCU's or other options to the system.
The diagram below gives an example overview of the communication structure. The number of participants and their combination can vary depending on the target instrument.



3.7 Operation & Setup

Preliminary actions have to be performed in order to operate the module.

A. Installation of bootware
B. Assure correct CAN-Bus termination (60 Ohm)
C. Set address switch to the correct address
D. Installation of firmware
E. Hardware configuration
F. Calibration

3.7.1 Boot loading

The boot itself cannot be loaded via the CAN interface. It has to be programmed on a dedicated flash programmer *before* the assembly.

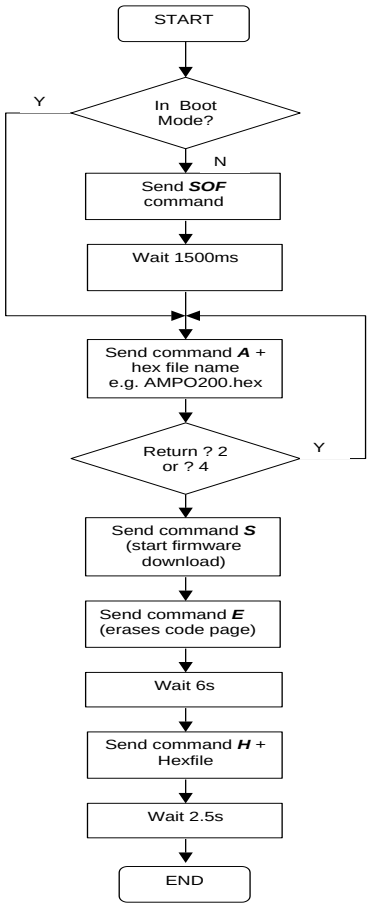
3.7.2 Firmware Download / Boot commands

The firmware download is initiated with an ***SOF*** command if there is already a valid firmware running. The program now jumps into the boot mode.

The boot program supports the following commands:

- ***'A'*** followed by the hex file name checks if the first three characters of the hex filename do correspond with the three characters <'xxx'>. This protects the module from loading a firmware that belongs to another device.
- ***'S'*** initiates the firmware download process. It applies the program voltage for the FLASH memory and copies the download procedure into the RAM memory range.
- The command ***'E'*** erases Flash application page.
- ***'H'*** followed by a bytestream writes the directly into the FLASH memory. A 'EOF' string indicates the end of the Hexfile. A redundancy checksum is calculated and compared with a desired value. The program jumps into the firmware page and executes the downloaded code. In case of a deviation between checksums the program remains in the boot mode.

firmware download sequence



3.7.3 Configuration

There is an application switch located on the Optibo board. The application switch has to correspond with the LiHa application. In case of wrong adjustment, the initialization will get an error message.

Switch position	**LiHa Application**	**Instrument**	**Note**
0	8 tip LiHa with spacing	EVO 100/150/200	
1	4 tip LiHa with spacing	EVO 100/150/200	
2	2 tip LiHa with spacing	EVO 100/150/200	Y-Space possible to range size. Maximum value is 5000 1/10mm.
3	2 tip LiHa fixed space	EVO 75	Spacing 18mm
4	1 tip LiHa	EVO 75	
5	8+1 tip LiHa	EVO 75	1 tip normal, 7 tip manifold 1x XP6000

LiHa-Type	Switch Pos.	Number of tip's	Number of independent Z- Drives	Number of Y- Drives	Number of Dilutors	Number of tip's with Liquid detection	Number of tip's with Diti presence check
8 tip LiHa with spacing	0	8	8	2	8	8	8
4 tip LiHa with spacing	1	4	4	2	4	4	4
2 tip LiHa with spacing	2	2	2	2	2	2	2
2 tip LiHa fixed space	3	2	2	1	2	2	2
1 tip LiHa	4	1	1	1	1	1	1
8+1 tip LiHa	5	8	2	1	1 (8 manifold)	1	1

The LiHa firmware assumes the following addresses:

Devices	Direct address
LiHa itself for example	C5 (C6 backdoor)
DC Servo2	C5T00..C5T07 Z-Axis C5T08 Ys-Axis (only with spacing) C5T09 Y-Axis with spacing C5T0A X-Axis C5T0B Optional TipGuard or Y-Axis without spacing
Dilutors	C5T20.. C5T27
MPO	C5T30
TePS (sensor plate)	C5T32
PMP	C5T36

3.7.4 Calibration

It needs some calibration for the axis. Special calibration commands are available.
With S&S software the calibration can be accomplished.

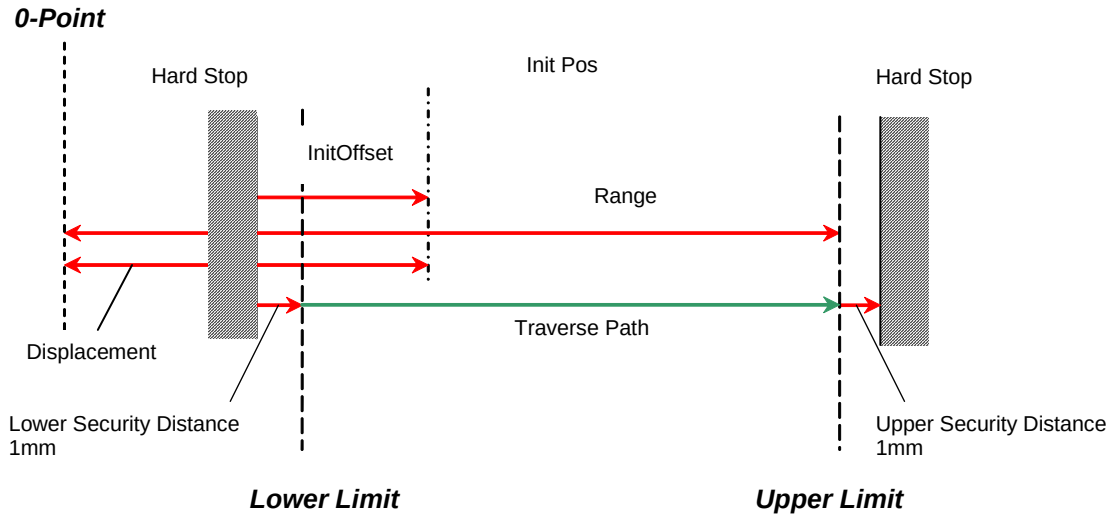
© Copyright by Tecan Schweiz AG

3.8 Axes Conventions

3.8.1 X,Y and Ys- Axis Overview

The X-axis positions are related to the lower Hard Stop. X, Y and Ys initialize at the lower Hard Stop position. They move to the InitOffset position and set the reported position to the displacement after successful initialization. For maximum Spacing of Y and Ys refer to chapter 3.7.3 and PSY command.

3.8.2 Axis Coordinate Plane Standard Axes X&Y



Lower Limit *= Displacement - InitOffset + Lower Security Distance*
Upper Limit *= Range*
Allowed X Range *= (LowerXLimit .. UpperXLimit)*
Allowed Y Range *= (LowerYLimit .. UpperYLimit)*
Allowed Ys Range *= (LowerYLimit+minSpacing*(Tips-1) .. UpperYLimit+minSpacing*(Tips-1))*

3.8.3 Recalculation Rules

the following recalculations are performed automatically:

Changing the Offset *(<RPX 4> / <SOX>) / (<RPY 4> / <SOY>)*

(reported) new position = old position + old InitOffset – new InitOffset
new Range = old Range – new InitOffset + old InitOffset

Changing the Displacement *(<RPX 7> / <SOX>) / (<RPY 7> / <SOY>)*

(reported) new position = old position + new Displacement – old Displacement

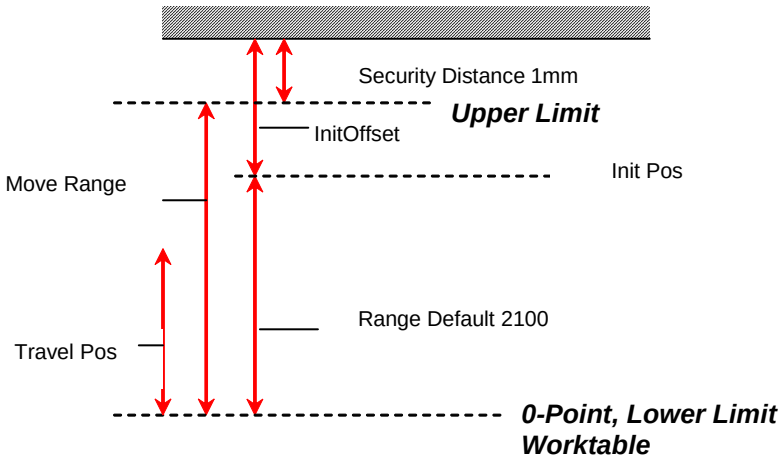
Changing the Range *(<RPX 5> / <SRX>) / (<RPY 5> / <SRY>)*

nothing else gets changed

3.8.4 Z - Axis Overview

The Z-Axis initializes to the upper Hard Stop position. It moves to the InitOffset position after successful initialization. The positions are related to the tip bottom. The zero-position is equal to the worktable surface. Each time the length of the tips gets changed, the Range needs to be adapted accordingly.

3.8.5 Axis Coordinate Plane Z-axis



Lower Limit *= 0*
Upper Limit *= Range + InitOffset – Security Distance*
Allowed Z Range *= (0.. UpperZLimit)*

3.8.6 Recalculation Rules

the following recalculations are performed automatically:

<u>Changing the Offset *(<RPZ 4> / <SOZ>)*</u>
(reported) new position = old position + old InitOffset – new InitOffset

<u>Changing the Displacement *(<RPZ 7>)*</u>
Displacement can't be changed. Reported Displacement will return always 0.

<u>Changing the Range *(<RPZ 5> / <SRZ>)*</u>
nothing else gets changed

4 COMMANDS

4.1 Report Commands (Base Functionality)

RFV Report Firmware Version:

RFV Selector			
This command reports several systems depending information about the actual loaded firmware or hardware. This information can be used to identify the characteristics of the selected device.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..15	0	Report selected system information.
Response	***if***		***Range***
Selector	0		Report actual downloaded application firmware version. Structure: 'LIHACU-Vx.xx-MM/YYYY'.
	1		Report programmed bootstrap version.
	2		Report instrument serial number.
	3		Report actual hardware version of installed DeviceCU board.
	4		Report CAN bus node selection port.
	5		Report TECAN copyright.
	7		Number of node addresses of this device.
	8		Report application switch see chapter 3.7.3.
	9		Report actual DCU library version.
	10		Report expected HEX file name for firmware download. Structure: 'DCULI'.
	15		Report application firmware as integer, V2.00 = 200.
	16		Report expected DC-Servo2 firmware version.
Error	(3) Invalid operand.		

RDF Report Diagnostic Functions:

RDF Selector			
All the diagnostic values will be saved at power off of the instrument or if a power fail situation occurs. The stored data can be reported by this command.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..3	0	Reports selected diagnose function.
Response	***if***		***Range***
Selector	0		Report the number of power ups.
	1		Report the overall operating time in minutes.
	2		Report the number of firmware downloads in Flash-EPROM.
	3		Report the number of parameter page erasing in Flash-EPROM.
	4		Report the number of parameter page recovery cycles.
Error	(3) Invalid operand.		

RGD Report Global Data:

RGD Selector			
This command reads the selected global data from the volatile memory. A maximum of 100 variables (type of integer) can be set with the **SGD** command. Data is specified by S&S LiHa specification. CAUTION! This command is for internal use only (TECAN software). Overwriting of such variables can cause malfunction of the instrument and software.			
Parameter	***Validity***	***Default***	***Description***
Selector	1..100		Report the selected global data value.
Response	***if***		***Range***
Selector	1..100		-32768..32767
Error	(3) Invalid operand.		

RED Read FLASH EPROM Data:

RED Selector			
This command reads all the selected data from the Flash-EPROM mirrored in the volatile memory. To get an actual copy of the Flash-EPROM contents, an **ARE** command must be sent before reporting the data with the **RED** command. The size of this data array has not a fixed length. It depends on the actual loaded firmware version. The length of the data array can be reported with the selector 0. The reported data is always type of integer. CAUTION! This command is for service purposes only (board exchange). Overwriting of such variables can cause malfunction of the instrument and software.			
Parameter	***Validity***	***Default***	***Description***
Selector	0	0	Report overall Flash-EPROM size in number of integers.
	1..**RED0**		Report value of type integer.
Response	***if***		***Range***
Selector	1..**RED0**		-32768..32767
Error	(3) Invalid operand.		

RDA Report Device Allocation Array of Subdevices:

RDA Layer, Type			
Reports the number of devices connected to the system in binary or decimal format. The system is divided in to eight layers, where each of them containing sixteen device nodes.			
Parameter	***Validity***	***Default***	***Description***
Layer	0..7	0	Report system devices of selected layer.
Type	0	0	Report value in binary format.
	1		Report value in decimal format.
Response	***if***		***Range***
Type	0		0..65535
	1		0..15
Error	(3) Invalid operand.		

RKA Report Keep Alive Function:

RKA			
This command reports the status of the keep alive function, which can be activated by the **SKA** command. In case of an enabled keep alive mechanism, this control unit is periodically testing the presence of all connected devices to the system. The actual connected devices can be watched by the **RDA** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Range***
	0		Keep alive turned off.
	1		Keep alive turned on.
Error	None.		

RSU Report Stack Usage:

RSU TaskID, Selector			
This command reports the selected task name and the corresponding depth of the specified task. CAUTION! This command is for service purposes only.			
Parameter	***Validity***	***Default***	***Description***
TaskID	1..12		Select task number.
Selector	0..1		Select information type.
Response	***if***		***Range***
TaskID	1		Report the “MCANTx”
	2		Report the “MCANRx”
	3		Report the “MCANRep”
	4		Report the “SCANTx”
	5		Report the “SCANRx”
	6		Report the “MBOOT”
	7		Report the “SBOOTx”
	8		Report the “SuperV”
	9		Report the “Interrupt”
	10		Report the “XPatch”
	11		Report the “Device0”
	12		Report the “Device1”
Selector	0		Reports the task name as string of maximal eight characters.
	1		Report the depth of the selected task.
Error	(3) Invalid operand.		

RBT Report Board Temperature:

RBT			
This command reports the temperature of the sensor on the **DCU2-Board**.			
Parameter	***Validity***	***Default***	***Description***
			Reports the temperature in 1/10 degree Celsius (e.g. 257 → 25,7°C).
Error	None		

4.2 Report Commands (LIHA Specific Functionality)

RSL Report Second LIHA:

RSL			
This command reports the presence of a second LIHA on the system. The second LIHA has a special liquid detection board, which allows distinguishing a normal LIHA from a “second” LIHA.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
	0		Normal (first) LIHA.
	1		Second LIHA.
Error	None.		

RNT Report Number of Tips on Arm:

RNT Selector			
This command reports the number of tips on the arm in binary (TipSelect) or in decimal format.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..1	0	Different format
Response	***if***		***Description***
Selector	0		Binary format [0..255].
	1		Decimal format [0..8].
Error	(3) Invalid operand.		

RSD Report Presence Lower Diti Eject Option:

RSD			
The **RSD** command reports if the lower diti eject option is installed (hardware) on the LIHA arm.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
	0		No lower diti eject option is installed.
	1		Lower diti eject option is installed.
Error	None.		

RDE Report Status of Lower Diti Eject Option:

RDE			
This command reports if the lower diti eject option is ON or OFF, set by command **SDE.**			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
	0		Inactive (power OFF).
	1		Active (power ON).
Error	(5) Device not implemented.		

RST Report Lower Diti Eject Logical Positions:

RST			
This command reports the logical positions either set by the **SST** command or automatically calibrated by the **CST** command. There are two positions. One is used for the upper eject position and the other is used for the lower eject position. Additionally, there is a third parameter, which describes the discard distance to throw away the disposable tips.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
1st value	e.g. 900		Upper eject position.
2nd value	e.g. 700		Lower eject position.
3rd value	e.g. 45		Discard distance.
Error	None.		

RDT Report Diti Discard / Aspirate Parameter:

RDT			
This command reports the diti discard aspiration parameter for the dilutor movement while throwing off a diti with the **ADT** or **AST** command set by the **SDT** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
1st value			Aspiration while diti discard 0 = off, 1 = on.
2nd value			Plunger speed in half step per second.
3rd value			Delay between plunger start and Z-drive start in ms.
Error	None.		

RYS Report Minimum Y Space Distance:

RYS			
This command reports the Y-Space distance defined with the **SYS** command			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Report Y-Space distance.
Error	None.		

RYB Report Y Backlash and Z Positioning Parameter:

RYB			
This command reports the Y backlash distance and the Z positioning parameter defined by the **SYB** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Range***
1st value			Report Y backlash distance.
2nd value			Report Z overdrive distance.
3rd value			PWM limit to protect Y-motors.
Error	None.		

RPX Report Current Parameter for X-Axis:

RPX Selector			
This command reports the current parameter of the X-axis.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..11	0	Report selected X-axis parameter.
Response	***if***		***Range***
Selector	0		Report current position in 1/10 mm.
	1		Report acceleration in 1/10 mm/s^{2}.
	2		Report end speed in 1/10 mm/s.
	3		Report initialization speed in 1/10 mm/s.
	4		Report initialization offset in 1/10 mm.
	5		Report actual machine range in 1/10 mm.
	6		Report deviation in encoder increments.
	7		Report displacement offset in 1/10 mm.
	8		Report scale adjust factor.
	9		Report slow speed in 1/10 mm/s.
	10		Report scale factor.
	11		Report target position in 1/10 mm.
Error	(3) Invalid operand.		

RPY Report Current Parameter for Y-Axis:

RPY Selector			
This command reports the current parameter of the Y- and Ys-axis.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..11	0	Report selected Y-axis parameter.
Response	***if***		***Range***
Selector	0		Report current position in 1/10 mm.
	1		Report acceleration in 1/10 mm/s^{2}.
	2		Report end speed in 1/10 mm/s.
	3		Report initialization speed in 1/10 mm/s.
	4		Report initialization offset in 1/10 mm.
	5		Report actual machine range in 1/10 mm.
	6		Report deviation in encoder increments.
	7		Report displacement offset in 1/10 mm.
	8		Report scale adjust factor.
	9		Report slow speed in 1/10 mm/s.
	10		Report axis scale factor.
	11		Report target position in 1/10 mm.
Error	(3) Invalid operand.		

© Copyright by Tecan Schweiz AG

RPZ Report Current Parameter for Z-Axis:

RPZ Selector			
This command reports the current parameter settings of all Z-axis.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..12	0	Report selected Z-axis parameter.
Response	***if***		***Range***
Selector	0		Report current position in 1/10 mm.
	1		Report acceleration in 1/10 mm/s^2.
	2		Report fast speed in 1/10 mm/s.
	3		Report initialization speed in 1/10 mm.
	4		Report initialization offset in 1/10 mm.
	5		Report actual machine range in 1/10mm
	6		Report deviation in encoder increments.
	7		Report every time 0.
	8		Report scale adjust factor.
	9		Report slow speed in 1/10 mm/s.
	10		Report axis scale factor.
	11		Report target position in 1/10 mm.
	12		Report travel position in 1/10 mm.
Error	(3) Invalid operand.		

RTG Report Optional Tip Guard Status:

RTG Selector			
This command reports the current parameter settings of the optional tip guard drive.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..2	0	Report selected tip guard parameter.
Response	***if***		***Range***
Selector	0		Report whether the tip guard is installed or not. 0 = not installed, 1 = installed.
	1		Report the tip guard logical position. -1 = off position, 0 = released, 1 = closed.
	2		Report the tip guard error status.
Error	(3) Invalid operand, (5) Device not implemented.		

RVZ Report Z-Axis Values and Parameters:

RVZ Selector			
This command reports the following values and parameters for the Z-axis. Selector 1&2: There can be an old position value in the capture position register. Check first event register!			
Parameter	***Validity***	***Default***	***Description***
Selector	0..4	0	Report selected Z-axis parameter.
Response	***if***		***Description***
Selector	0		First capture position if Safe Proc is active (set by **SDM**).
	1		Reports capture position (second capture position if Safe Proc is active, set by **SDM**).
	2		Reports capture events.
	3		Report search speed, set by **SSL** cmd.
	4		Report slow speed, set by **SSZ** cmd.
Error	(3) Invalid operand.		

RGZ Report Global Z-Axis Values and Parameters:

RGZ Selector			
This command reports the current parameter settings of the Z-axis. Only one axis parameter can be reported at time.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..2	0	Report selected Z-axis parameter.
Response	***if***		***Description***
Selector	0		Report pierce speed, PWMLimit, CurLimit set by **SPS** command.
	1		Report pick speed, PWMLimit, CurLimit set by **SSP** command.
	2		Report discard speed, PWMLimit, CurLimit set by **SSD** command.
Error	(3) Invalid operand.		

RFP Report Force Parameter for all Movements:

RFP			
The **RFP** command reports whether the force parameters are turned on or off by the **SFP** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			0 = off, 1 = on.
Error	None.		

RTL Report Individual Z-Start for Liquid Search Commands:

RTL			
This command reports the individual Z-start height for all Z-axis. These parameters are used by the **MDT** and **MET** command if no Z-start is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all Z-Start heights (Z-start1,..,Z-start8).
Error	None.		

RML Report Individual Z-Max for Liquid Search Commands:

RML			
This command reports the individual Z-max height for all Z-axis. These parameters are used by the **MDT** and **MET** commands if no Z-max is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all Z-max heights (Reports all Z-max heights).
Error	None.		

© Copyright by Tecan Schweiz AG

RBL Report Individual Submerge for Liquid Search Commands:

RBL			
This command reports the individual submerge distance for all Z-axis. These parameters are used by the **MDT** and **MET** command if no submerge is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all submerge distances (Submerge1,..,Submerge8).
Error	None.		

RDL Report Individual Safe Detection Retract Distance for Liquid Search:

RDL			
This command reports the individual safe detection retract distance for all Z-axis. These parameters are used by the **MDT** and **MET** command if no global distance is selected.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all the safe detection retract distances (SaveDetRetractDist1,.., SaveDetRetractDist8).
Error	None.		

RDR Report Individual Retract Distance for Clot Detection:

RDR			
This command reports the individual retract distance for all Z-axis. These parameters are used by the **MCT** command if no global retract distance is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all retract distances (RetractDist1,..,RetractDist8).
Error	None.		

RSR Report Individual Retract Speed for Clot Detection:

RSR			
This command reports the individual retract speed for all Z-axis. These parameters are used by the **MCT** command if no global retract speed is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all retract speeds (RetractSpeed1,..,RetractSpeed8).
Error	None.		

RLR Report Individual Retract Limit for Clot Detection:

RLR			
This command reports the individual retract limit for all Z-axis. These parameters are used by the **MCT** command if no global retract limit is set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports all retract limits (Limit1,..,Limit8).
Error	None.		

RDM Report Liquid Detection Mode:

RDM			
This command reports all the different possible parameters and procedures of the liquid detection setup. Parameters are described in the **SDM** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports liquid detection settings. Detection Proc, Sensitivity.
Error	None.		

RLA Report Liquid Detection Acceleration:

RLA			
This command reports the acceleration in Z-axis for liquid detection, set by **SLA** command. This parameter is only active while searching for liquid with the **MDT** command. After completion of liquid detection, the normal acceleration, set by the **SFZ** command, is in use.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports the actual setting of the liquid detection acceleration.
Error	None.		

RTZ Report Z-Axis Relative Tracking Values:

RTZ			
This command reports all tracking distance values of the Z-drives. These parameters are used by **MTR** move command and can be set by **STZ** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Range***
			Reports all relative values of Z-axis1.. Z-axis8.
Error	None.		

RTS Report Tip Status Diti:

RTS			
This command reports the number of mounted disposable tips on the arm in binary format. If normal steel tips are mounted, the answer is always 255. In case of an 8+1 configuration (App. Switch 5), only tip number 1 will be actively handled.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Range***
			0..255
Error	None.		

RSM Report X-Axis Smooth Move Mode:

RSM			
This command reads the X-axis smooth move mode. By default the smooth move mode is active. In this case the acceleration and speed parameters will be recalculated depending on the distance to move. When selecting mode 1, the original acceleration and speed parameters set by the **SFX** command are in use.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
	0		Smooth move mode active.
	1		Normal speed parameter.
Error	None.		

REE Report Extended Error Code or Axis Configuration String:

REE Selector			
This command gets the axis specific error codes. Possible are all the errors generated by the LIHA device. To visualize the error codes as ASCII characters, an offset of 40 hexadecimal is added to the error value. Alternatively the maximal axis configuration can be reported as a string. The axis configuration corresponds to the extended error codes.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..1	0	Reports selected diagnose function.
Response	***if***		***Description***
Selector	0		Report extended error codes.
	1		Report axis configuration string ‘XYSZZZZZZZZ’.
Error	(3) Invalid operand.		

RDX Report X-Axis Diagnostic Functions:

RDX Selector			
All the diagnostic values will be saved at power off of the instrument or if a power fail situation occurs. The stored data can be reported by this command.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..2, 5	0	Reports selected diagnose function.
Response	***if***		***Description***
Selector	0		Report the number of move counter.
	1		Report the distance counter in meter.
	2		Report the no load (crash) counter.
	5		Report the clearable move counter.
Error	(3) Invalid operand, (16) Power fail circuit error.		

RDY Report Y-Axis Diagnostic Functions:

RDY Selector			
All the diagnostic values of axis Y&Ys will be saved at power off of the instrument or if a power fail situation occurs. The stored data can be reported by this command. The answer format is for an available y-spacing: Y,Ys; without y-spacing: Y only.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..2, 5	0	Reports selected diagnose function.
Response	***if***		***Description***
Selector	0		Report the number of move counter.
	1		Report the distance counter in meter.
	2		Report the no load (crash) counter.
	5		Report the clearable move counter.
Error	(3) Invalid operand.		

RDZ Report Z-Axis Diagnostic Functions:

RDZ Selector			
All the diagnostic values will be saved at power off of the instrument or if a power fail situation occurs. The stored data can be reported by this command.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..5	0	Reports selected diagnose function.
Response	***if***		***Description***
Selector	0		Report the number of move counter.
	1		Report the distance counter in meter.
	2		Report the no load (crash) counter.
	3		Reports the number of fetched disposable tips.
	4		Reports the number of piercing.
	5		Report the clearable move counter.
Error	(3) Invalid operand.		

RYR Report Y Auto Range in Increments:

RYR			
This command reports the Y auto range in encoder increments evaluated by the **ARY** command. These values can be used to evaluate or calculate the scale adjust factor for the Y space drive, which can be set by the **SAS** command. The calculation formula for the Ys scale is the following: **SAS** = (10'000 / Y) * (Y – Ys) + 10'000			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports Y and Ys range in encoder increments.
Error	None.		

RHS Report Enhanced Speed Setting for EVO75:

RHS			
This command reports the enhanced speed setting, which can be activated by the **SHS** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports the enhanced speed setting switch.
Error	None.		

RBK Report Z Drive Brake Status (only 8 + 1 Configuration):

RBK			
This command returns the actual status of the Z-axis brake. This function is only valid for the 8+1 configuration (App. Switch 5).			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			0 = break active (power off), 1 = break released (power on).
Error	(5) Device not implemented.		

RXT Report Discard Offset (8+1):

RXT			
This command is used only for an 8+1 LIHA. It reports the discard offset 1, 2 and 3.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports discard offset 1,2 and 3 in 1/10 mm.
Error			

4.3 Report Commands (Dilutor Specific Functionality)

RPP Report Plunger Drive Parameter:

RPP Selector			
This command reports the plunger drive move parameter for all installed dilutors. For detailed information about the specific meaning for each selector, refer to the corresponding command in the XP2000 Command Set.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..12	0	Reports selected drive parameter.
Response	***if***		***Description***
Selector			See Command Set of dilutor.
Error	(3) Invalid operand.		

RDS Report Last Error Code of Dilutor:

RDS			
This command reports the collected error codes returned by the last command to all dilutors. For detailed information about the meaning of the error code, use the XP2000 Command Set. E.g. **RDS** response of 5,7,7,7,7,7,0,0 means: Dilutor1 not connected, Dilutor2-6 not initialized, Dilutor7&8 initialized.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Report error codes of the dilutors, see Command Set of dilutor.
Error	None.		

RDD Report Dilutor Drive Status:

RDD Selector			
This commands returns the dilutor drive status reported by the dilutor **REE** command. The answers given by the dilutor drives will be collected to one string, where the selector 0 is returning the plunger drive status and selector 1 is returning the valve drive status. The number of status characters is always eight even if there are less then eight pumps connected. The not installed drives are marked by an error 5 code 'E'.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..1	0	Drive selector.
Response	***if***		***Description***
Selector	0		Report Plunger Drive Status
	1		Report Valve Drive Status.
Error	(3) Invalid operand.		

RYV Report Syringe Volume:

RYV			
This command reports the syringe volume of all installed dilutors. For detailed information refer to the corresponding command in the XP2000 Command Set.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Reports syringe volume of Dilutor1..Dilutor8.
Error	None.		

4.4 Report Commands (TePS Specific Functionality)

RAT Report Adjustment Position of X and Y-Axis Direction:

RAT Selector			
This command reports measured X- or Y-position with selected Z-axis. With these sensor values 1&2 it is possible to calculate the X- and Y-position of the corresponding Z-axis. Corresponding action command **AAT**. Example: #C5RAT0, this command reports 8 values with the following format: 1444,1544,0,0,0,0,0,0 The first value (1444) is the first measured tip, it depends in which direction the movement will be done. The other value (3..8) give you the result 0, there is no tip position measurement done.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..3	0	Selector of sensor and edge
Response	***if***		***Description***
Selector	0		Report position entering in sensor 1 beam, in 1/10 mm of all tips.
	1		Report position-leaving sensor 1 beam, in 1/10 mm of all tips.
	2		Report position entering in sensor 2 beam, in 1/10 mm of all tips.
	3		Report position-leaving sensor 2 beam, in 1/10 mm of all tips.
Error	(3) Invalid operand.		

RAZ Report Adjustment Position of Z-Axis Direction:

RAZ			
This command reports measured position of the Z- axis. The position value recorded by the **AAZ** Cmd.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
			Report Z-axis height position in 1/10 mm.
Error	None.		

4.5 Report Commands (PMP Specific Functionality)

RAP Report Pressure LLD Parameter (Aspirate Part):

RAP			
This command reports the pressure LLD parameter of the aspiration part set by the **SAP** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
1st value			Report plunger speed in half step per second.
2nd value			Report delay between plunger start and pLLD start in ms.
3rd value			Report relative aspiration distance in plunger steps.
4th value			Report relative Aspiration Distance after pLLD in plunger steps.
Error	(5) Device not implemented.		

RDP Report Pressure LLD Parameter (Dispense Part):

RDP			
This command reports the pressure LLD parameter of the dispense part set by the **SDP** command.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
1st value			Report retract distance of first dispense cycle in 1/10 mm/s.
2nd value			Report plunger speed in half step per second of first dispense cycle.
3rd value			Report relative dispense distance of plunger in steps of first dispense cycle.
4th value			Report delay between dispense cycle 1 and cycle 2 in ms.
5th value			Report retract distance of second dispense cycle in 1/10 mm/s.
6th value			Report plunger speed in half step per second of second dispense cycle.
Error	(5) Device not implemented.		

RVP Report PMP Pressure Value Before and After Detection:

RVP Selector			
This command reports the pressure values captured before and after a liquid detection activated by the **MDT**/**MET** command. Additionally the delta pressure limit set by the **SVP** command can be reported by the selector 2 for each channel. The reported values represent always all eight channels.			
Parameter	***Validity***	***Default***	***Description***
Selector	0..2	0	Selects the “Before” or “After” values.
Response	***if***		***Description***
Selector	0		Report pressure values before detection in 1/10 mBar.
	1		Report pressure values after detection in 1/10 mBar.
	2		Report delta pressure limit in 1/10 mBar.
Error	(3) Invalid operand, (5) Device not implemented.		

RPE Report PMP Error Handling:

RPE			
This command reports if the PMP Error test is active or not. The PMP Error test checks the status of PmP at the end of the commands MET, MDT, PPA, PPR and MTR. If the test is not in use, the commands do not report a subdevice error even if PmP has an error. If the test is active a subdevice error will be reported if a PmP error occurred (for example a pressure out of range with dilutor stop). CAUTION! The state is volatile and must be set again after each startup of the LIHADCU firmware.			
Parameter	***Validity***	***Default***	***Description***
Response	***if***		***Description***
	0		PMP test is not in use.
	1		PMP test is active.
Error	(5) Device not implemented.		

4.6 Set Commands (Base Functionality)

SFV Set Serial Number:

SFV Key, Number			
This command sets the device serial number. A total of sixteen characters can be stored. If the given string is longer then sixteen characters or the first character is not a number, an invalid operand error will be generated. This data will be stored definitely in non-volatile memory (Flash-Memory) either when power down the instrument or while using the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Key	xxxxx	-	Secret.(source code LiHa. File: globs.h).
Number	Up to 16 ASCII characters	0 ASCII	Serial number value stored as string.
Error	(3) Invalid operand.		

SGD Set Global Data:

SGD Selector, Value			
This command writes global data into an array in volatile memory. A maximum of 100 variables (type of integer) can be handled. This data will be stored definitely in non-volatile memory (Flash-EPROM) either when power down the instrument or while using the **AWE** command. CAUTION! This command is for internal use only (TECAN software). Overwriting of such variables can cause malfunction of the instrument and software.			
Parameter	***Validity***	***Default***	***Description***
Selector	1..100	0	Select the global data entry.
Value	-32768..32767	0	Global data value of signed integer size.
Error	(3) Invalid operand.		

SED Set FLASH-EPROM Data:

SED Selector, Value			
This command writes Flash-EPROM data into the volatile memory mirror. This data will be stored definitely in non-volatile memory (Flash-EPROM) either when power down the instrument or while using the **AWE** command. The size of this data array has not a fixed length. It depends on the actual loaded firmware version. The actual length can be reported by the **RED0** command. CAUTION! This command is for service purposes only (board exchange). Overwriting of such variables can cause malfunction of the instrument and software.			
Parameter	***Validity***	***Default***	***Description***
Selector	1..**RED0**	-	Select the Flash-EPROM data entry.
Value	-32768..32767	0	Flash-EPROM data value of signed integer size.
Error	(3) Invalid operand.		

SRS Reset System (Whole Subsystem inclusive this DCU):

SRS			
This command resets the whole subsystem. All participants connected to the CAN bus of this device will be reset and also this controlling DCU will perform a soft reset. After such a command, the device is in an initial state as like after a normal power up.			
Parameter	***Validity***	***Default***	***Description***
Error	None.		

SBC Send Broadcast to all Subdevices:

SBC Message			
This command sends messages with the type broadcast to all devices connected to the CAN bus. The specific supported broadcast command functions must be described in the command set of the target device.			
Parameter	***Validity***	***Default***	***Description***
Message	0..255	0	Message number.
	0		SW Reset.
	4		Normal Break.
	5		Emergency Break.
	32		Keep Alive Message On.
	33		Keep Alive Message Off.
Error	(3) Invalid operand.		

SCC Send Broadcast to Device:

SCC DeviceID, Message			
This command sends messages with the type broadcast to specific devices connected to the CAN bus. Normally broadcast messages will be distributed to all participants of a network. With this command, it is possible to use the predefined broadcast commands and send them to only one specific participant in the network. If real broadcasts are required, the **SBC** command must be used instead of the **SCC** command. The specific supported broadcast command functions must be described in the command set of the target device.			
Parameter	***Validity***	***Default***	***Description***
DeviceID	0..127	0	DeviceID number.
Message	0..255	0	Message number.
	0		SW Reset.
	4		Normal Break.
	5		Emergency Break.
	32		Keep Alive Message On.
	33		Keep Alive Message Off.
Error	(3) Invalid operand.		

SKA Set Keep Alive Function:

SKA Mode			
This command activates or deactivates the keep alive function. In case of an enabled keep alive mechanism, this control unit is periodically testing the presence of all connected devices to the system. The actual connected devices can be watched by the **RDA** command. For proper function of this command, the corresponding functionality must be implemented in the slave device (see broadcast commands in the slave device command set). CAUTION: This command is for internal use only.			
Parameter	***Validity***	***Default***	***Description***
Mode	0	0	Keep alive turned off.
	1		Keep alive turned on.
Error	(3) Invalid operand.		

SOF Firmware Download:

SOF Firmware			
This command initiates the firmware downloading process. The **SOF** command should not be used as string command itself. Only in connection with a download utility program, this command makes sense.			
Parameter	***Validity***	***Default***	***Description***
Firmware		-	[INTEL.HEX file format]
Error	None.		

4.7 Set Commands (LIHA Specific Functionality)

SYS Set Minimum Y-Space Distance:

SYS Space*			
This command allows the redefinition of the LIHA Y-space minimum distance (mechanically). After redefinition of the Y space distance, the Y-drives must be reinitialized. This parameter can be stored in non-volatile memory with the **AWE** command. Exception: space of 2 tip LiHa, see chapter 3.7.3			
Parameter	***Validity***	***Default***	***Description***
Space	90..380	90	Set Y-Space distance in 1/10 mm.
Error	(3) Invalid operand.		

SYB Set Y Backlash and Z Positioning Parameter:

SYB BacklashY*, OverdriveZ*, PWMlimit*

This command is responsible for three different settings. Each of them is described separately below.
The first parameter defines the Y backlash distance. This distance will be used in case of moving the Y-axis from the back of the instrument to the front. This behavior guarantees that each target positioning will be driven from the same direction, which results in a higher precision. Setting the Y backlash reduces the Y range by either 2mm or by the Y backlash distance if its size is larger then 2mm. The 2mm distance is required, when moving with a 9mm space.
The second parameter is responsible for the Z overdrive. Each time a Z-drive is moving upwards, an overdrive move will be performed. This feature is not responsible for higher precision, it is used to lower the mechanical friction in the Y direction.
The third parameter is used to define the positioning force for the Y space drive. After a performed Y movement the Y-space current must be lowered to a minimal required current needed for a precise position.
All the parameters described above can be stored in non-volatile memory with the **AWE** command.

Parameter	*Validity*	*Default*	*Description*
BacklashY*	0..50	20	Set Y-Backlash distance in 1/10 mm.
OverdriveZ*	0..10	4	Set Z-Overdrive distance in 1/10 mm.
PWMlimit*	1..16	16	Set PWM limit for Y-space motor.
Error	(3) Invalid operand.		

SRX Set X-Axis Range:

SRX Range*

This command sets the X-axis range. It can be stored in non-volatile memory with the **AWE** command.

Parameter	*Validity*	*Default*	*Description*
Range*	0..1’000`000	1000	Set X-axis range in 1/10 mm.
Error	(3) Invalid operand.		

SRY Set Y-Axis Range:

SRY Range*

This command sets the Y- and Ys- (if available) range. It can be stored in non-volatile memory with the **AWE** command.

Parameter	*Validity*	*Default*	*Description*
Range*	0..1’000`000	1000	Set Y-axis range in 1/10 mm.
Error	(3) Invalid operand.		

SRZ Set All Z-Axis Range:

SRZ Zrange1*..Zrange8*

This command set all the Z-axis ranges. All the Z-ranges can be stored in non-volatile memory with the **AWE** command. After redefinition of the Z-ranges, also the Z-travel heights (set by **SHZ**) are reset to the new range values and the changed axis must be reinitialized.

Parameter	*Validity*	*Default*	*Description*
Zrange[I]*	0..1’000`000	2100	Set Z-axis range in 1/10 mm.
Error	(3) Invalid operand.		

SHZ Set Individual Z-Travel Height:

SHZ Z-travel1*..Z-travel8*			
The **SHZ** command sets (in volatile RAM) the individual Z-travel heights for the absolute field. The **SHZ** values are valid until the **SHZ** command is either reentered or until the machine is turned off. The only time those values are in effect, is when the machine is traveling in the absolute field (**PAA & MAA** command). It is possible that **SHZ** values will be overwritten by **SRZ** command.			
Parameter	***Validity***	***Default***	***Description***
Z-travel[I]*	0..Z-Range + 20 set by **SRZ** cmd	2100	Set Z-Travel height in 1/10mm.
Error	(3) Invalid operand.		

STZ Set Z-Axis Relative Tracking Distance:

STZ Zrelative1*..Zrelativ8*			
This command sets all the Z-drive relative values. These values are used by command **MTR**. The relative values are the tracking distance, used by Dispense and Aspirate. Positive values move the Z-axis upwards, negative values move the Z-axis down. In case of an 8+1 configuration (App. Switch 5) only the first and the second Zrelative parameters are relevant all others will be ignored.			
Parameter	***Validity***	***Default***	***Description***
Zrelativ [1..8]*	-2100..2100	0	Set Z-axis relative value in 1/10 mm.
Error	(3) Invalid operand.		

SSL Set Search Speed for Liquid Search Commands:

SSL Speed1*..Speed8*			
This command sets the search speeds (in volatile RAM) that the Z-axis will use by the liquid search commands **MDT** and **MET** while moving from Z-start to Z-max and back to Z-travel (**MDT**). In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
Speed[I]*	1..1500	400	Set speed in 1/10 mm/s.
Error	(3) Invalid operand.		

SSX Set Slow Speed for X-Axis:

SSX Speed*			
This function sets the slow speed for the X-axis. This setting is in action while using **MRX** or **MAX** commands without the SlowSpeed selector. It is possible to change the speed 'on the fly', by using this command via the alternative access channel.			
Parameter	***Validity***	***Default***	***Description***
Speed	1..4000	1000	Set X-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand.		

SSY Set Slow Speed for Y-Axis:

SSY Speed*			
This function sets the slow speed for the Y- and Ys- (if available) axis. This setting is in action while using **MRY** or **MAY** commands without the SlowSpeed selector. It is possible to change the speed 'on the fly', by using this command via the alternative access channel.			
Parameter	***Validity***	***Default***	***Description***
Speed	1..4000	350	Set Y-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand.		

SSZ Set Individual Slow Speed for Z1..Z8:

SSZ Speed1*..Speed8*			
This function sets an individual slow speed for all Z-axis. These settings are in action while using **MRZ** or **MAZ** commands without the SlowSpeed parameter. It is possible to change the speed on the fly, by using this command via the alternative access channel. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
Speed[I]*	1..4000	400	Set an individual speed for every Z-axis in 1/10 mm/s.
Error	(3) Invalid operand.		

SPS Set Pierce Parameter for Piercing Commands:

SPS Speed*, PWMLimit*, CurLimit*			
The **SPS** command sets the piercing parameter for all Z-axis (in volatile RAM) that they will use while moving from Z-start to Z-max. For detailed information about PWM limit and current limit, read the DC Servo Controller Command Summary document. These settings can be reported by the **RGZ0** command.			
Parameter	***Validity***	***Default***	***Description***
Speed*	1..1500	200	Set piercing speed in 1/10mm/s.
PWMLimit*	0..249	100	Set PWM value in counts.
CurLimit*	0..3	0	Set current limit.
Error	(3) Invalid operand.		

SFP Set Force Parameter for all Movements:

SFP OnOff			
The **SFP** command turns on or off the force parameter set by the **SPS** command generally for all Z movements. A changed force parameter, set by the **SPS** command is only active after a sent **SFP1**. The force parameters will be cancelled to its default values after the next Z drive initialization, which has the same effect as the **SFP0** command. CAUTION! It is may be possible to destroy Z-motors with higher force limits in normal use.			
Parameter	***Validity***	***Default***	***Description***
OnOff	0	0	No pierce force active.
	1		Pierce force set by SPS active.
Error	(3) Invalid operand.		

SSP Set Pick Parameter for Diti Commands:

SSP Speed*, PWMLimit*, CurLimit*			
The **SSP** command sets the pick parameter for all Z-axis (in volatile RAM) that they will use while picking up disposable tips. For detailed information about PWM limit and current limit, read the DC Servo Controller Command Summary document. These settings can be reported by the **RGZ1** command.			
Parameter	***Validity***	***Default***	***Description***
Speed*	1..1500	800	Set pick speed in 1/10mm/s.
PWMLimit*	0..249	60	Set PWM value in counts.
CurLimit*	0..3	0	Set current limit.
Error	(3) Invalid operand.		

SSD Set Discard Parameter for Diti Commands:

SSD Speed*, PWMLimit*, CurLimit*			
The **SSD** command sets the discard parameter for all Z-axis (in volatile RAM) that they will use while discarding disposable tips. For detailed information about PWM limit and current limit, read the DC Servo Controller Command Summary document. These settings can be reported by the **RGZ2** command.			
Parameter	***Validity***	***Default***	***Description***
Speed*	1..1500	250	Set discard speed in 1/10mm/s.
PWMLimit*	0..249	160	Set PWM value in counts.
CurLimit*	0..3	0	Set current limit.
Error	(3) Invalid operand.		

SST Set Lower Diti Eject Logical Positions:

SST Log1*, Log2*, DiscardDist*			
This command sets the logical positions for the lower diti eject manually. Normally the **CST** command is used to calibrate the diti eject mechanism. But under some circumstances it is useful to readjust the logical positions by hand. These parameters can be stored in non-volatile memory by the **AWE** command. *Attention: DiscardDist parameter is only used in the AST command. The AXT command ignores this parameter.*			
Parameter	***Validity***	***Default***	***Description***
Log1*	0..Z1-Range	1075	Upper eject position in 1/10 mm.
Log2*	0..Z1-Range	700	Lower eject position in 1/10 mm.
DiscardDist*	0..100	45	Discard distance in 1/10 mm.
Error	(3) Invalid operand.		

SDE Switch Lower Diti Eject On or Off:

SDE OnOff			
This command can be used to turn on or off the lower diti eject solenoid.			
Parameter	***Validity***	***Default***	***Description***
OnOff	0	0	Eject released (power off),
	1		Eject active (power on).
Error	(3) Invalid operand, (5) Device not implemented.		

SDT Set Diti Discard / Aspirate Parameter:

SDT AspOnOff*, AspSpeed*, AspDelay*

This command sets the diti discard aspiration parameter for the dilutor movement while throwing off a diti with the **ADT** or **AST** command. By default, this feature is turned off. When turning on aspiration while diti discard, an aspiration movement will be performed while throwing off a diti. After termination of this cycle, the plunger will move back to its origin position. Additionally the plunger speed and a certain delay between starting the plunger and activating the Z-drives can be defined. This mechanism reduces the contamination of the diti cone.

Parameter	*Validity*	*Default*	*Description*
AspOnOff *	0	0	Aspiration while diti discard off.
	1		Aspiration while diti discard on.
AspSpeed*	5..6000	1000	Set plunger speed in half step per second.
AspDelay*	0..5000	200	Delay between plunger start and Z-drive start in ms.
Error	(3) Invalid operand.		

STL Set Individual Z-Start for Liquid Search Commands:

STL Z-start1*..Z-start8*

This command sets the individual Z-start height for all Z-axis. These parameters are used by the **MDT** and **MET** command if there is no global Z-start selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.

Parameter	*Validity*	*Default*	*Description*
Z-start[I]*	0..max Z-Range set by **SRZ** cmd or 32767	2100	Set Z-axis start height in 1/10 mm.
Error	(3) Invalid operand.		

SML Set Individual Z-Max for Liquid Search Commands:

SML Z-max1*..Z-max8*

This command sets the individual Z-max height for all Z-axis. These parameters are used by the **MDT** and **MET** command if there is no global Z-max selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.

Parameter	*Validity*	*Default*	*Description*
Z-max[I]*	0..max Z-Range set by **SRZ** cmd or 32767	1000	Set Z-axis max in 1/10 mm.
Error	(3) Invalid operand.		

SBL Set Individual Submerge for Liquid Search Commands:

SBL Submerge1*.. Submerge8*

This command sets the individual submerge distance for all Z-axis. These parameters are used by the **MDT** and **MET** command if no global submerge is selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.

Parameter	*Validity*	*Default*	*Description*
Submerge [I]*	-1000..max Z-Range set by **SRZ** cmd or 32767	0	Set Z-axis submerge distance in 1/10 mm.
Error	(3) Invalid operand.		

SDL Set Individual Safe Detection Retract Distance for Liquid Search Cmd:

SDL SafeDetRetractDist 1*.. SafeDetRetractDist 8*			
This command sets the individual safe detection retract distance for all Z-axis. These parameters are used by the **MDT** and **MET** commands. Also is this value responsible for the double detection window (SafeDetRetractDist * 0.5). In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
SafeDetRetractDist1 [I]*	0..max Z-Range set by **SRZ** cmd or 32767	50	Set Z-axis safe detection retract distance in 1/10 mm.
Error	(3) Invalid operand.		

SDR Set Individual Retract Distance for Clot Detection Commands:

SDR RetractDist1*.. RetractDist8*			
This command sets the individual retract distance for all Z-axis. These parameters are used by the **MCT** command if no global retract distance is selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
RetractDist [I]*	0..max Z-Range set by **SRZ** cmd or 32767	50	Set Z-axis retract distance in 1/10 mm.
Error	(3) Invalid operand.		

SSR Set Individual Retract Speed for Clot Detection Commands:

SSR RetractSpeed1*.. RetractSpeed8*			
This command sets the individual retract speed for all Z-axis. These parameters are used by the **MCT** command if no global retract speed is selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
Retract Speed [I]*	1..1500	200	Set the retract speed in 1/10 mm/s.
Error	(3) Invalid operand.		

SLR Set Individual Limit for Clot Detection Commands:

SLR Limit1*.. Limit8*			
This command sets the individual limit within the clot must be detected without generating an error for all Z-axis. These parameters are used by the **MCT** command if no global limit is selected. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored.			
Parameter	***Validity***	***Default***	***Description***
Limit [I]*	0..RetractDist	40	Set the limit distance in 1/10 mm.
Error	(3) Invalid operand.		

© Copyright by Tecan Schweiz AG

SDM Set Liquid Detection Mode:

SDM DetProc*, Sense*

This command sets the different liquid detection procedures (DetProc) and detection modes for the liquid detection commands **MDT** and **MET**. There are nine different standard capacitive detection procedures available. Supplementary there are seven pressure detection modes available, which are only selectable if a PMP module is connected.

Capacitive modes:

0) The **cLLD Common Proc** detects liquid with all selected tips simultaneously.
1) The **cLLD Common Safe Proc** detects liquid with all selected tips simultaneously. After a successful first detection, the position where liquid was detected is stored and the tips will be retracted with the distance defined by the **SDL** command. Then a second detection will be started. The second detection must be within a window (+/- 50% **SDL** dist.) to accept the detection. If the second capture position is out of window range a further detection will be started at this point. After four-failed detection's the procedure responds with an error message.
2) The **cLLD Semi Proc** detects first with all odd selected tips, then with all even selected tips. The detection itself is like the Common Proc.
3) The **cLLD Semi Safe Proc** detects first with all odd selected tips, then with all even selected tips. The detection itself is like the Common Safe Proc.
4) The **cLLD Full Proc** detects liquid tip after tip with a Common Proc.
5) The **cLLD Full Safe Proc** detects liquid tip after tip with a Common Safe Proc.
6) The **cLLD Delay Proc** detects liquid tip after tip with a delay of 80ms with a single detection Common Proc.
7) The **cLLD Trough1 Proc** detects liquid tip after tip with a Common Safe Proc. If a tip detects liquid, it will be retracted out of liquid 10 mm immediately. When all tips have done the same detection, they will be moved into liquid again with default submerge of 1 mm. The individual submerge distance is added after the default submerge.
8) The **cLLD Trough2 Proc** has the same functionality as the Trough1 procedure, except that there is no extra submerge of 1mm.

Pressure and mixed modes:

10) The **pLLD Common Proc** detects liquid with all selected tips simultaneously. After the detection the tips will be retracted by a certain distance and afterwards lowered again to the liquid surface respectively lowered into the liquid with the given submerge value.
11) The **pLLD or cLLD Common Proc** detects liquid by either pressure or capacitive method, where the first of the two signals is responsible for the detection. The detection procedure is the same as the pLLD Common Proc.
12) The **pLLD or cLLD Semi Proc** detects liquid by either pressure or capacitive method, where the first of the two signals is responsible for the detection. The detection will be started with all odd selected tips, then with all even selected tips. The rest of the detection procedure is the same as the pLLD Common Proc.
13) The **pLLD or cLLD Full Proc** detects liquid by either pressure or capacitive method, where the first of the two signals is responsible for the detection. The detection will be handled tip after tip sequentially. The rest of the detection procedure is the same as the pLLD Common Proc.
14) The **pLLD and cLLD Common Proc** detects liquid by pressure and capacitive method with all selected tips simultaneously.
15) The **pLLD and cLLD Semi Proc** detects liquid by pressure and capacitive method with all odd selected tips, then with all even selected tips.
16) The **pLLD and cLLD Full Proc** detects liquid by pressure and capacitive method tip after tip sequentially.

The clot detection command **MCT** interprets the DetProc the following way:

- 0, 1, 10, 11, 14 belongs to **cLLD Common Proc**
- 2, 3, 12, 15 belongs to **cLLD Semi Proc**
- 4, 5, 7, 8, 13, 16 belongs to **cLLD Full Proc**
- 6 belongs to **cLLD Delay Proc**

Parameter	*Validity*	*Default*	*Description*
DetProc*	0		cLLD Common Proc (single detection all)

	1	1	cLLD Common Safe Proc (double Detection all)
	2		cLLD Semi Proc (single detection odd/even)
	3		cLLD Semi Safe Proc (double detection odd/even)
	4		cLLD Full Proc (single detection sequential)
	5		cLLD Full Safe Proc (double detection sequential)
	6		cLLD Delay Proc (trough, first tip single detection)
	7		cLLD Trough 1 Proc (trough, double detection sequential with retract and extra submerge 1mm)
	8		cLLD Trough 2 Proc (trough, double detection sequential with retract and no extra submerge)
	10		pLLD Common Proc (all with retract)
	11		pLLD or cLLD Common Proc (all with retract)
	12		pLLD or cLLD Semi Proc (odd/even with retract)
	13		pLLD or cLLD Full Proc (sequential with retract)
	14		pLLD and cLLD Common Proc (all with retract)
	15		pLLD and cLLD Semi Proc (odd/even with retract)
	16		pLLD and cLLD Full Proc (sequential with retract)
Sense*	0	0	Standard. (Not valid for pLLD)
	1		High.
	2		Very high.
	3		Shorted to earth.
Error	(3) Invalid operand, (5) Device not implemented.		

SLA Set Liquid Detection Acceleration:

SLA Accel*

This command sets the acceleration in Z-axis for liquid detection. This parameter is only active while searching for liquid with the **MDT** and **MET** command. After completion of liquid detection, the normal acceleration, set by the **SFZ** command, is in use. This value can be stored in non-volatile memory by the **AWE** command.

Parameter	*Validity*	*Default*	*Description*
Accel*	250..7500	2000	Set acceleration in 0.1 mm/s$^{2.}$
Error	(3) Invalid operand.		

SFX Set X-Move Parameters:

SFX EndSpeed*, Accel*

This command sets the X-axis DC-Servo move settings in volatile RAM. With the **AWE** command, the values can be stored in the non-volatile memory.
CAUTION! Wrong usage of this command can damage the instrument.

Parameter	*Validity*	*Default*	*Description*
EndSpeed*	50..11250	10000	Set end speed in 1/10mm/s.
Accel*	380..11250	1600	Set acceleration in 1/10mm/s$^{2.}$
Error	(3) Invalid operand.		

SFY Set Y-Move Parameters:

SFY EndSpeed*, Accel*

This command sets the Y and Y-space axis DC-Servo move settings in volatile RAM. With the **AWE** command, the values can be stored in the non-volatile memory.

Parameter	*Validity*	*Default*	*Description*
EndSpeed*	50..12500	3500	Set speed in 0.1 mm/s.
Accel*	430..12500	2400	Set acceleration in 0.1 mm/s$^{2.}$
Error	(3) Invalid operand.		

SFZ Set Z-Move Parameters:

SFZ EndSpeed*, Accel*			
This command sets all the Z-axis DC-Servo move settings in volatile RAM. With the **AWE** command, the values can be stored in the non-volatile memory.			
Parameter	***Validity***	***Default***	***Description***
EndSpeed*	50..7500	4000	Set speed in 0.1 mm/s.
Accel*	250..7500	2000	Set acceleration in 0.1 mm/s$^{2.}$
Error	(3) Invalid operand.		

SOX Set Initialization Offset for X-Axis:

SOX InitOffset*, Displacement*			
This command sets the initialization offset and the displacement offset for the X-axis to the entered values. Both parameter entered are in action immediately after this command is given. They can be stored in non-volatile memory by the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
InitOffset*	10..X-Range + X-InitOffset or 32767	150	Set X-axis initialization offset in 1/10 mm.
Displace-ment*	-250.. 32767	0	Set X-axis displacement offset in 1/10 mm.
Error	(3) Invalid operand.		

SOY Set Initialization Offset for Y-Axis:

SOY InitOffset*, Displacement*			
This command sets the initialization offset and the displacement offset for the Y- and Ys- (if available) to the entered values. Both parameter entered are in action immediately after this command is given. They can be stored in non-volatile memory by the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
InitOffset*	10..Y-Range + Y-InitOffset or 32767	10	Set Y-axis initialization offset in 1/10 mm.
Displace-ment*	-1000 - 0	-887	Set Y-axis displacement offset in 1/10 mm.
Error	(3) Invalid operand.		

SOZ Set Initialization Offset for Z-Axis:

SOZ InitOffset1*..InitOffset8*			
This command sets the initialization offset to the entered parameter for the given Z-axis. The offset parameter entered is in action immediately after this command is given. These parameters can be stored in non-volatile memory by the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
InitOffset [I]*	10..1000	85	Set Z-axis initialization offset in 1/10 mm.
Error	(3) Invalid operand.		

SAX Set Scale Adjust Factor for X-Axis:

SAX ScaleAdjust*			
This command redefines the scale adjust factor of the X axis within a defined range. Default scale adjust is 10000. This value can be stored in non-volatile memory with the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Scale Adjust	9500..10500	10000	Set X-axis scale factor.
Error	(3) Invalid operand.		

SAY Set Scale Adjust Factor for Y-Axis:

SAY ScaleAdjust*			
This command redefines the scale adjust factor of the Y and Y-space axis within a defined range. Default scale adjust is 10000. This value can be stored in non-volatile memory with the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Scale Adjust	9500..10500	10000	Set Y-axis scale factor.
Error	(3) Invalid operand.		

SAS Set Scale Adjust Factor for Y-Space Axis Only:

SAS ScaleAdjust*			
This command redefines the scale adjust factor of the Y-space axis within a defined range. Default scale adjust is 10000. This value can be stored in non-volatile memory with the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Scale Adjust	9500..10500	10000	Set Y-axis scale factor.
Error	(3) Invalid operand.		

SSM Set X-Axis Smooth Move Mode:

SSM Mode*			
This command sets the X-axis smooth move mode. By default the smooth move mode is active. In this case the acceleration and speed parameters will be recalculated depending on the distance to move. When selecting mode 1, the original acceleration and speed parameters set by the **SFX** command are in use. The mode parameter can be stored in the non-volatile memory with the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Mode	0	0	Smooth move active.
	1		Normal acceleration and speed parameter set by the **SFX** command are in use.
Error	(3) Invalid operand.		

SLX Set New X-Axis Scaling Factor and Motion Direction:

SLX Xscale*			
With this command, it's possible to redefine the X-axis scale factor. In some special applications it's maybe useful to redefine this value. Inverting the sign of the scale factor can change the motor rotation direction. This value can't be stored in non-volatile memory. CAUTION! This command should never be used in the normal operation with an instrument. Wrong definition causes malfunction and could destroy the instrument!			
Parameter	***Validity***	***Default***	***Description***
XScale*	-32768..32767	-1250	Set scale factor for X-axis.
Error	(3) Invalid operand.		

SLY Set New Y-Axis Scaling Factor and Motion Direction:

SLY YScale*, YsScale*			
With this command, it's possible to redefine the Y and Ys-axis scale factor. In some special applications it's maybe useful to redefine this value. Inverting the sign of the scale factor can change the motor rotation direction. This value can't be stored in non-volatile memory. CAUTION! This command should never be used in the normal operation with an instrument. Wrong definition causes malfunction and could destroy the instrument!			
Parameter	***Validity***	***Default***	***Description***
YScale*	-32768..32767	1389	Set scale factor for Y-axis.
YsScale*	-32768..32767	1389	Set scale factor for Ys-axis.
Error	(3) Invalid operand.		

SLZ Set New Z-Axis Scaling Factor and Motion Direction:

SLZ Zscale1*, Zscale8*			
With this command, it's possible to redefine the Z-axis scale factor. In some special applications it's maybe useful to redefine this value. Inverting the sign of the scale factor can change the motor rotation direction. This value can't be stored in non-volatile memory. CAUTION! This command should never be used in the normal operation with an instrument. Wrong definition causes malfunction and could destroy the instrument!			
Parameter	***Validity***	***Default***	***Description***
ZScale[I]*	-32768..32767	+/-782	Set scale factor for Z-axis.
Error	(3) Invalid operand.		

SMC Set all LIHA Axis Move Counter to Zero:

SMC Key			
This command sets the entire LIHA move counter, reportable with the **RDX/Y/Z selector 5** command to zero. The value of the counter that can be reported by the **RDX/Y/Z selector 0** command remains at the same value as before.			
Parameter	***Validity***	***Default***	***Description***
Key	xxxxx		Secret. (source code LiHa. File: globs.h)
Error	(3) Invalid operand.		

SHS Set Enhanced Speed Setting for EVO75:

SHS Mode*			
This command enables the enhanced speed settings for the EVO75 (App. Switch 3, 4 & 5). The mode can be stored in non-volatile memory with the **AWE** command. After setting a new mode, either default or enhanced, the instrument must be turned off and on before the new settings are in use. The **SHS** command changes automatically the **SSM** setting (default EVO75 speed settings -> Smooth Mode ON; enhanced speed stettings -> Smooth Mode OFF).			
Parameter	***Validity***	***Default***	***Description***
Mode	0..1	0	0 = default speed setting, 1 = enhanced speed setting for EVO75.
Error	(3) Invalid operand, (29) Application and axes mismatch		

SXT Set Discard Offset (8+1):

SXT Offset 1*, Offset 2*, Offset 3*			
This command is used only for an 8+1 LIHA. It sets the discard offset 1, 2 and 3. These offsets are used to set a different discard start position from Tip 1 and the other Tips. The offset 1 and 2 is used with the **AXT** command. The offset 3 is used with the **AST** command. The offsets can be stored in non-volatile memory with an **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Offset1	0..60	30	Value for Discard Offset 1 in 1/10 mm.
Offset2	90..130	110	Value for Discard Offset 2 in 1/10 mm.
Offset3	-20..40	10	Value for Discard Offset 3 in 1/10 mm.
Error	(3) Invalid operand.		

SBK Set Z Drive Brake On or Off (only 8 + 1 Configuration):

SBK OnOff			
This command can be used to turn on or off the Z-drive brake. In normal operation, the brake will be controlled by the moving commands. There is no need to control the brake manually, except for service purposes. This function is only valid for the 8+1 configuration (App. Switch 5).			
Parameter	***Validity***	***Default***	***Description***
OnOff	0..1	0	0 = break active (power off), 1 = break released (power on).
Error	(3) Invalid operand, (5) Device not implemented.		

4.8 Set Commands (Dilutor Specific Functionality)

SEP Set End Speed for Plungers:

SEP Plunger1*..Plunger8*			
This command sets the plunger end speed in half step per second for all connected plungers. For detailed information refer to the corresponding command in the XP2000 Command Set. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000*			
Parameter	***Validity***	***Default***	***Description***
Plunger [I]*	5..6000	1400	Set plunger end speed in half step per second.
Error	(28) Subdevice error.		

SPP Set Stop Speed for Plungers:

SPP Plunger1*..Plunger8*			
This command sets the plunger stop speed in half step per second for all connected plungers. For detailed information refer to the corresponding command in the XP2000 Command Set. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000*			
Parameter	***Validity***	***Default***	***Description***
Plunger [I]*	50..2700	900	Set plunger stop speed in half step per second.
Error	(28) Subdevice error.		

STP Set Start Speed for Plungers:

STP Plunger1*..Plunger8*			
This command sets the plunger start speed in half step per second for all connected plungers. For detailed information refer to the corresponding command in the XP2000 Command Set. In case of an 8+1 configuration (App. Switch 5), the first parameter sets all 8 tips and all other parameters will be ignored. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000*			
Parameter	***Validity***	***Default***	***Description***
Plunger [I]*	50..1000	900	Set plunger start speed in half step per second.
Error	(28) Subdevice error.		

4.9 Set Commands (PMP Specific Functionality)

SAP Set Pressure LLD Parameter (Aspirate Part):

SAP AspSpeed*, AspDelay*, AspRelDist*, AspAfterLLD*			
This command sets the different pressure LLD parameters of the aspiration LLD part used for the detection modes 10 to 16 selected by the **SDM** command. The first three parameters are used for determining the aspiration speed, the delay in between starting the plunger aspiration move and activating the pressure LLD and the maximal aspiration distance. The forth parameter is used to define the relative aspiration distance, which is active after a pressure LLD.			
Parameter	***Validity***	***Default***	***Description***
AspSpeed*	5.6000	300	Set plunger speed in half step per second.
AspDelay*	0..5000	350	Set delay between plunger start and pLLD start in ms.
AspRelDist*	0..3000	600	Set relative Aspiration Distance in plunger steps.
AspAfter LLD*	0..60	0	Set relative Aspiration Distance after pLLD in plunger steps.
Error	(3) Invalid operand, (5) Device not implemented.		

SDP Set Pressure LLD Parameter (Dispense Part):

SDP Disp1Retract*, Disp1Speed*, Disp1RelDist*, DispDelay*, Disp2Retract*, Disp2Speed*

This command sets the different pressure LLD parameters of the dispense LLD part used for the detection modes 10 to 16 selected by the **SDM** command. The dispense part is splitted into two parts. The first dispense cycle can be parameterized by a retract distance of the tips, a dispense speed of the plunger and a relative dispense distance of the plunger. This relative dispense distance can't be higher then the origin position of the plunger before the LLD. The second part can be defined by a further retract distance of the tip and a dispense speed of the plunger. The plunger will be moved in this second part to the origin position before the LLD. In between the first part and the second part, a delay can be defined. A complete cycle can be disabled, when setting the dispense retract parameter to zero.

Parameter	*Validity*	*Default*	*Description*
Disp1-Retract *	0..1000	15	Set retract distance of first dispense cycle in 1/10 mm relative above LLD.
Disp1-Speed *	5..6000	50	Set plunger speed in half step per second of first dispense cycle.
Disp1RelDist*	0..3000	20	Set relative dispense distance of plunger in steps of first dispense cycle.
DispDelay*	0..1000	200	Set delay between dispense cycle 1 and cycle 2 in ms.
Disp2-Retract *	0..1000	40	Set retract distance of second dispense cycle in 1/10 mm relative above LLD.
Disp2-Speed *	5..6000	1200	Set plunger speed in half step per second of second dispense cycle.
Error	(3) Invalid operand, (5) Device not implemented.		

SVP Set Delta Pressure Overrun Limit:

SVP Limit *

This command sets the pressure-overrun limit used by the pLLD. The limit will be used to compare the pressure values before and after the liquid detection. In case of exceeding the limit, the affected tips will be marked with a "delta pressure overrun" error. A value of zero will disable the pressure comparison. The value set by the **SVP** command can be reported by the **RVP2** command.

Parameter	*Validity*	*Default*	*Description*
Limit*	0..255	0	0 = disables the pressure compare. 1..255 = delta pressure limit in 1/10 mBar.
Error	(3) Invalid operand, (5) Device not implemented.		

SPE Set PMP Error Handling:

SPE OnOff

This command activates or deactivates the PMP Error test.

The PMP Error test checks the status of PmP at the end of the commands MET, MDT, PPA, PPR and MTR. If the test is not in use, the commands do not report a subdevice error even if PmP has an error. If the test is active a subdevice error will be reported if a PmP error occurred (for example a pressure out of range with dilutor stop).

CAUTION! The state is volatile and therefore deactivated after each startup of the LIHADCU firmware.

Parameter	*Validity*	*Default*	*Description*
OnOff	0, 1	0	0 = deactivate test. 1 = activate test.
Error	(3) Invalid operand, (5) Device not implemented.		

4.10 Action Commands (Base Functionality)

AWE Write System Parameters to FLASH-EPROM:

AWE			
This command writes all parameters set by the following commands to the Flash-EPROM (non-volatile memory). **SFV** Set Serial Number. **SGD** Set Global Data. **SED** Set Flash Data. **SRX/Y/Z** Absolute Range. **SOX/Y/Z** Initialization Offset and Displacement. **SFX/Y/Z** Fast Speed and Acceleration. **SAX/Y** Scale Adjusts. **SSM** Smooth Move Mode. **SYB** Set Y Backlash and Z Positioning Parameter. **SYS** Set Minimum Y-Space Distance. **SST** Set Lower Diti Eject Logical Position. **SLA** Set Liquid Detection Acceleration. **SHS** Set Enhanced Speed Setting for EVO75. **SXT** Set Discard Offset. **PTG 99..101** evaluated calibration value.			
Parameter	***Validity***	***Default***	***Description***
Error	(13) No Flash access.		

ARE Read System Parameters to FLASH-EPROM:

ARE			
This command reads all parameters set by the following commands from the Flash-EPROM (non-volatile memory) into the working memory (volatile memory). **SFV** Set Serial Number. **SGD** Set Global Data. **SED** Set Flash Data. **SRX/Y/Z** Absolute Range. **SOX/Y/Z** Initialization Offset and Displacement. **SFX/Y/Z** Fast Speed and Acceleration. **SAX/Y** Scale Adjusts. **SSM** Smooth Move Mode. **SYB** Set Y Backlash and Z Positioning Parameter. **SYS** Set Minimum Y-Space Distance. **SST** Set Lower Diti Eject Logical Position. **SLA** Set Liquid Detection Acceleration. **SHS** Set Enhanced Speed Setting for EVO75. **SXT** Set Discard Offset. **PTG 99..101** evaluated calibration value.			
Parameter	***Validity***	***Default***	***Description***
Error	(13) No Flash access.		

ACW Erase all Setup Data in the Flash:

ACW Key			
Erases all data in the Flash this includes Diagnose- and Parameter Data. The default data will be stored. NOTE! This command is for service purposes only. CAUTION! Inappropriate usage of this command causes damages to the instrument!			
Parameter	***Validity***	***Default***	***Description***
Key	xxxxx	-	Secret.
Error	(3) Invalid operand.		

Txx Pipeline to Slave Device:

T Layer Device Cmd			
Transparent Pipeline Command to Slave Devices. It is possible to communicate with subdevices or sub-subdevices. EXAMPLE: #C5T31RFV2 Send the command RFV2 (Report Serial number) to the device C5. The command goes through the C5 device. And goes to O1 and read the Serial string number (layer 3 means 'O') If you would connect this device to H-CAN, the address and command would be 'O1RFV2'.			
Parameter	***Validity***	***Default***	***Description***
Layer	0..7	0	Layer number coded in alpha characters (A,D,Q,O..).
Device	0..F	0	Device number, HEX format.
Cmd	Depends of CS		Command of Subdevice.
Error	(3) Invalid operand.		

4.11 Action Commands (LIHA Specific Functionality)

PIA Position Initialization X/Y/Z – Axis:

PIA Selector			
This is the command, to initialize the arm X/Y/Z-axis and the optional tip guard drive. No movement command for the arm will be accepted before the arm is initialized. When the **PIA** command is entered, the X/Y/Z-axis and the optional tip guard moves to their initialization positions with a default init speed. With the selector it is possible to disable the X-axis. This is useful after a pre initialization with **PIB** command. When the init position of each axis has been detected, they move to an initial offset position. There are two different init procedures possible. **First init**: First all Z-axis will be initialized at the current X and Y position. Then the Y and Y- space will be initialized. After that, the X-axis will be initialized and finally the Z-axis will be initialized once again. **Further init**: Further init: First all Z-axis move upwards to initialization position. Then the Y and Y- space axis will be initialized. After that, the X-axis will be initialized and finally the Z-axis will be initialized.			
Parameter	***Validity***	***Default***	***Description***
Selector	0	0	Normal initialization.
	1		X-axis not participates.
Error	(1) Initialization failed, (3) Invalid operand, (5) Device not implemented, (29) Application and axes mismatch, (30) Wrong DC-Servo Type.		

PIB Position Pre Initialization:

PIB

The **PIB** command is used to perform a pre initialization of the arm. This is to prevent a collision with an obstacle in the rear part of the instrument while initialization. After performing the **PIB**, normally a **PIA** without X-axis will be performed. The goal of this command is to bring the Y-axis to the front of the instrument. After doing a **PIB**, all axis except the X drive have a not initialized status.

Parameter	*Validity*	*Default*	*Description*
Error	(1) Initialization failed, (29) Application and axes mismatch.		

PIF Fake Initialization X/Y/Z – Axis:

PIF

The **PIF** command tells the firmware that all axis have been initialized, however, no mechanical initialization is executed. The current position coordinate of each axis is still valid, except if it is not initialized. In case of a not initialized axis, the position will be set to zero or maximal range.
CAUTION! Incorrect usage of this command may damage the instrument.

Parameter	*Validity*	*Default*	*Description*
Error	(30) Wrong DC-Servo Type.		

PIX Position Initialization X-Axis:

PIX InitSpeed*, (Range, Offset)

This function reinitializes only the X-axis of the LIHA. An override motor speed for axis initialization may be placed at the end of the command. A command without any parameter uses the default speed to initialize.
In case of failed initialization (rc = 1) the position will be lost and the axis is not anymore initialized.
CAUTION! Parameters in brackets are for TECAN internal use only. Incorrect usage of this command may damage the instrument.

Parameter	*Validity*	*Default*	*Description*
InitSpeed	5..1500	400	Set individual initialization speed in 1/10 mm/s.
Range	+/-1’000’000	SRX	Range in 0.1 mm.
Offset	-1000..1000	SOX	Offset in 0.1 mm.
Error	(1) Initialization failed, (3) Invalid operand, (29) Application and axes mismatch, (30) Wrong DC-Servo Type.		

PIY Position Initialization Y-Axis:

PIY InitSpeed*, (Range, Offset)

This function reinitializes the Y and Y-space axis on the arm. An override motor speed for axis initialization may be placed at the end of the command. A command without any parameter uses the default speed to initialize.
If the Y and Ys axis are already initialized the Y and Ys axis will move near the init position and start there the initialization.
In case of failed initialization (rc = 1) the position will be lost and the axis is not anymore initialized.
CAUTION! Parameters in brackets are for TECAN internal use only. Incorrect usage of this command may damage the instrument.

Parameter	*Validity*	*Default*	*Description*
InitSpeed	5..1500	350	Set individual initialization speed in 1/10 mm/s.
Range	+/-1’000’000	SRY	Range in 0.1 mm.
Offset	-1000..1000	SOY	Offset in 0.1 mm.
Error	(1) Initialization failed, (3) Invalid operand, (29) Application and axes mismatch, (30) Wrong DC-Servo Type.		

PIZ Position Initialization Z-Axis:

PIZ TipSelect*, InitSpeed*, (Range)

This function reinitializes all installed Z-drives on the arm. If single tip initialization is required, the binary value of TipSelect selects the corresponding Z-drive. An override motor speed for axis initialization may be placed at the end of the command. A command without any parameters uses the default speed and all tips to initialize. The init position of the Z drives is the range position set by the **SRZ** command. That means that Z-zero position must be somewhere near the worktable.
In case of failed initialization (rc = 1) the position will be lost and the axis is not anymore initialized.
CAUTION! Parameters in brackets are for TECAN internal use only. Incorrect usage of this command may damage the instrument.

Parameter	*Validity*	*Default*	*Description*
TipSelect*	1..255	255	Binary coded tip select.
InitSpeed*	5..1500	270	Speed in 0.1 mm/s.
Range	+/-1'000'000	SRZ	Range in 0.1 mm.
Error	(1) Initialization failed, (3) Invalid operand, (29) Application and axes mismatch, (30) Wrong DC-Servo Type.		

PAA Position Absolute for All Axis:

PAA X*, Y*, Ys*, Z1*, Z2*, Z3*, Z4*, Z5*, Z6*, Z7*, Z8*

The **PAA** command moves the X/Y/Z-axis to the entered coordinates in the absolute field. After using this command, the individual Z-travel height, set with the **SHZ** command, is in effect. If no Z-travel is set by **SHZ** command the Z-drives move to init position before traveling. The number of Z-parameters depends on the number of installed tips. In case of a fixed space LIHA, the Ys parameter will be ignored. The speeds defined by the **SFX**, **SFY**, **SFZ** and **SSM** commands are in use for this command.
Exception: space of 2 tip LiHa, see chapter 3.7.3

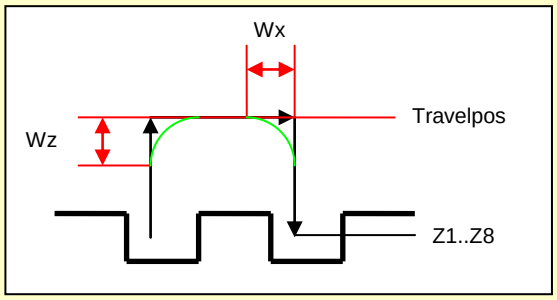
Parameter	*Validity*	*Default*	*Description*
X*	allowed X-Range	Last pos.	Absolute position in 1/10 mm.
Y*	Allowed Y-Range	Last pos.	Absolute position in 1/10 mm.
Ys*	90..380	Last pos.	Absolute position in 1/10 mm.
Z[1..8*]	allowed Z-Range	Travel pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PXZ Fast Positioning Absolute for X and Z Axis:

PXZ X*, Wx, Wz, Z1*, Z2*, Z3*, Z4*, Z5*, Z6*, Z7*, Z8*

The **PXZ** command moves the X and Z-axis to the entered coordinates in the absolute field with the same roles as they are used by the regular **PAA** command. The Y movements are explicitly excluded by the **PXZ** command. To reach a higher movement performance, a separate positioning window can be given to the X and Z drives. The window defines the point where a drive accepts a new position, before the preceding one reaches the target position.

Parameter	*Validity*	*Default*	*Description*
X*	allowed X-Range	Last pos.	Absolute position in 1/10 mm.
Wx	0..100	0	Window size in 1/10 mm.
Wz	0..100	0	Window size in 1/10 mm.
Z[1..8*]	allowed Z-Range	Travel pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		



PAX Position Absolute X-Axis:

PAX X*			
Moves the X-axis to an absolute position, leaving the other axis positions unchanged. The movement will be performed with the speed and acceleration setting done by the **SFX** and **SSM** command.			
Parameter	***Validity***	***Default***	***Description***
X*	allowed X-Range	Last pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PAY Position Absolute Y-Axis:

PAY Y*, Ys*			
Moves the Y and Ys-space axis to an absolute position, leaving the other axis position unchanged. The Y-space axis parameter is the distance from tip to tip. In case of a fixed space LIHA, the Ys parameter will be ignored. The movement will be performed with the speed and acceleration setting done by the SFY command. In case of spacing 90 the pressure movement will be done with slow speed settings. The **PAY** command can be used for 1536 microplate pipetting, with spacing 90. There is a special Y-pressure algorithm. Settings can be done by **SYB** command. Exception: space of 2 tip LiHa, see chapter 3.7.3			
Parameter	***Validity***	***Default***	***Description***
Y*	allowed Y-Range	Last pos.	Absolute position in 1/10 mm.
Ys*	0, 90..380 (0 = 90)	90	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PSY Y-Spacing Of Tips:

PSY Ys			
Space the tips in Y-direction. Tip number one remains at the same position. The Y-space axis parameter is the distance from tip to tip. In case of a fixed space LIHA, this command has no function. Exception: space of 2 tip LiHa, see chapter 3.7.3			
Parameter	***Validity***	***Default***	***Description***
Ys	0, 90..380 (0 = 90)	90	Absolute position from tip to tip in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PAZ Position Absolute Z-Axis:

PAZ Z1*.. Z8*			
Move all installed tips individually to an absolute position, leaving the X and Y-axis position unchanged. The init position is equal to the range set by the **SRZ** command. The zero position is somewhere near the worktable. The number of Z-parameters depends on the number of installed tips. If the movement goes upwards a Z-overdrive movement set by the **SYB** command will be performed.			
Parameter	***Validity***	***Default***	***Description***
Z[I]*	allowed Z-Range	Last pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load, (22) Tip Guard in wrong position.		

PRX Position Relative for X-Axis:

PRX +/-X			
Moves X-axis relative to its actual position. All other positions remain unchanged. The movement will be performed with the speed and acceleration setting done by the **SFX** and **SSM** command.			
Parameter	***Validity***	***Default***	***Description***
+/-X	X-LowerLimit-actual Pos..X-Upperlimit-actual Pos	0	Relative distance in 1/10mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PRY Position Relative Y-Axis:

PRY +/-Y			
Moves the Y-axis relative to its actual position, leaving the other axis positions unchanged. The movement will be performed with the speed and acceleration setting done by the SFY command.			
Parameter	***Validity***	***Default***	***Description***
+/-Y	Y-LowerLimit-actual Pos..Y-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PRZ Position Relative Z-Axis:

PRZ +/-Z1*..+/-Z8*			
Move all installed tips individually in the Z-axis to positions relative to their present positions, leaving the other axis unchanged. The init position is equal to the range set by the **SRZ** command. The zero position is somewhere near the worktable. The number of Z-parameters depends on the number of installed tips. The movement will be performed with the speed and acceleration setting done by the **SFZ** command. If the movement goes upwards a Z-overdrive movement set by the **SYB** command will be performed.			
Parameter	***Validity***	***Default***	***Description***
+/-Z[I]	Z-LowerLimit-actual Pos..Z-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

PCX Position Relative in Increment Resolution for X-Axis:

PCX +/-Xincs			
Moves the X-axis, with slow speed, relative to its actual position in increment resolution. This feature is useful when the normal resolution of 1/10mm is too high. CAUTION! This command does not check any ranges and does not support any collision avoidance. Improper usage of this command can destroy the instrument.			
Parameter	***Validity***	***Default***	***Description***
+/-Xincs	-10000..10000	0	Relative distance in increments.
Error	(3) Invalid operand.		

PCY Position Relative in Increment Resolution for Y-Axis:

PCY +/-Yincs			
Moves the Y and Y-space axis with slow speed relative to its actual position in increment resolution. This feature is useful when the normal resolution of 1/10mm is too high. CAUTION! This command does not check any ranges and does not support any collision avoidance. Improper usage of this command can destroy the instrument.			
Parameter	***Validity***	***Default***	***Description***
+/-Yincs	-10000..10000	0	Relative distance in increments.
Error	(3) Invalid operand.		

PTG Position Logic for Optional Tip Guard Drive:

PTG LogPos			
This command moves the optional tip guard drive to a logical position. A zero releases the tip guard, which is the same position as after an initialization with the **PIA** command. A one closes the tip guard underneath the tips. Caution must be taken, that the tips are in save position, before closing the tip guard. Additionally a calibration of the Tip Guard can be done with the LogPos 99 to 101. A 99 corrects the Tip Guard to the left side, a 101 correct the position to the right side. The default position and value can be restored by a **PTG100**. The calibration can only be done with a previously activated Tip Guard with **PTG1**. After successful calibration procedure, the evaluated position can be stored in non volatile memory by the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
LogPos	0..1, 99..101	0	0 = released tip guard. 1 = active tip guard. 99 = calibration to the left. 100 = calibration position to default. 101 = calibration to the right.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load, (22) Tip Guard in wrong position.		

MAX Position Absolute with Slow Speed X-Axis:

MAX X*, Speed*			
Moves the X-axis with selected slow speed to an absolute position, leaving the other axis positions unchanged.			
Parameter	***Validity***	***Default***	***Description***
X*	allowed X-Range	Last pos.	Absolute position in 1/10 mm.
Speed*	1..4000	SSX	Set X-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MAY Position Absolute with Slow Speed Y-Axis:

MAY Y*, Ys*, Speed*

Moves the Y and Y-space axis with a slow speed to an absolute position, leaving the other axis positions unchanged. The Y-space axis parameter is the distance between the tips. In case of a fixed space LIHA, the Ys parameter will be ignored.
Exception: space of 2 tip LiHa, see chapter 3.7.3

Parameter	*Validity*	*Default*	*Description*
Y*	allowed Y-Range	Last pos.	Absolute position in 1/10 mm of tip 1.
Ys*	0, 90..380 (0 = 90)	90	Absolute position in 1/10 mm.
Speed*	0, 1..4000 (0=SSY)	SSY	Set Y-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MAZ Position Absolute with Slow Speed Z-Axis:

MAZ Z1*,.. Z8*, Speed*

Move all installed tips with slow speed individually to absolute position, leaving the other axis positions unchanged. The init position is equal to the range set by the **SRZ** command. The zero position is somewhere near the worktable. The number of Z-parameters depends on the number of installed tips. In case of an 8+1 configuration (App. Switch 5), the number of tips is always eight.
If the movement goes upwards a Z-overdrive movement set by the **SYB** command will be performed.
Liquid level signal will be recorded during movement. Get result with **RVZ**.

Parameter	*Validity*	*Default*	*Description*
Z[I]*	allowed Z-Range	Last pos.	Absolute position in 1/10 mm.
Speed*	1..4000	SSZ	Set Z-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MAA Position Absolute for all Axis with Slow Speed:

MAA X*, Y*, Ys*, Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8

The **MAA** command moves the X/Y/Z-axis to the entered coordinates in the absolute field. After using this command, the individual Z-travel height, set with the **SHZ** command, is in effect. If no Z-travel is set by **SHZ** command the Z-drives move to init position before traveling. The number of Z-parameters depends on the number of installed tips. In case of a fixed space LIHA, the Ys parameter will be ignored. The speeds defined by the **SSX**, **SSY**, **SSZ** and **SSM** commands are in use for this command.
Exception: space of 2 tip LiHa, see chapter 3.7.3

Parameter	*Validity*	*Default*	*Description*
X*	allowed X-Range	Last pos.	Absolute position in 1/10 mm.
Y*	allowed Y-Range	Last pos.	Absolute position in 1/10 mm.
Ys*	90..380	Last pos.	Absolute position in 1/10 mm.
Z[I]	allowed Z-Range	Travel pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MRX Position Relative with Slow Speed X-Axis:

MRX +/-X, Speed*			
Moves the X-axis with selected slow speed relative to its actual position, leaving the other axis positions unchanged.			
Parameter	***Validity***	***Default***	***Description***
+/-X	X-LowerLimit-actual Pos..X-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Speed*	1..4000	SSX	Set X-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MRY Position Relative with Slow Speed Y-Axis:

MRY +/- Y*, Speed*			
Moves the Y-axis with selected slow speed relative to its actual position, leaving the other axis positions unchanged.			
Parameter	***Validity***	***Default***	***Description***
+/-Y*	Y-LowerLimit-actual Pos..Y-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Speed*	0, 1..4000 (0=SSY)	SSY	Set Y-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

MRZ Position Relative with Slow Speed Z-Axis:

MRZ +/-Z1*..+/-Z8*, Speed*			
Move all installed tips individually in the Z-axis to positions relative to their present position, leaving the other axis unchanged. The init position is equal to the range set by the **SRZ** command. The zero position is somewhere near the worktable. The number of Z-parameters depends on the number of installed tips. If the movement goes upwards a Z-overdrive movement set by the **SYB** command will be performed.			
Parameter	***Validity***	***Default***	***Description***
+/-Z[1..8]*	Z-LowerLimit-actual Pos..Z-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Speed*	1..4000	SSZ	Set Z-axis slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) Drive no load.		

© Copyright by Tecan Schweiz AG

MDT Move Tip, Detect Liquid, Submerge:

MDT TipSelect, Submerge, Z-start, Z-max, Z-add1..Z-add8

The **MDT** command moves the selected tips to Z-start and then searches downward until they detect liquid or reach Z-max. If no liquid is detected, the tips will move back to their Z-travel position and an error code will be generated. If liquid is detected, the tips will be lowered by the specified Submerge distance and verify that another Add distance can be lowered before reaching Z-max. If this is not possible, an error code is generated. If no tips are mounted the Z-axis will move to Z-Start and returns an error code 24. The additional distance will only be tested if Z-max is lower then Z-start (Dip In Detection). If the parameter TipSelect is not defined, all possible tips are used to detect liquid. If the parameters Submerge, Z-start or Z-max are not defined, the **MDT** command is using the individual position values. Those values can be set for each axis separately by the following commands: **SBL** (set submerge distance), **STL** (set Z-start position), **SML** (set Z-max position), **SLA** (set search acceleration), **SSL** (set search speed) and **SDL** (set safe detection retract distance). The **MDT** command can handle also different capacitive and pressure detection procedures and modes, which can be set by the **SDM** (set detection mode) command. A Dip out detection is not possible for all pressure detection modes. The number of Z-add parameters depends on the number of installed tips. In case of an 8+1 configuration (App. Switch 5), the TipSelect parameter is always set to 1.

Parameter	***Validity***	***Default***	***Description***
TipSelect	1..255	255	Binary coded tip select.
Submerge	-1000.. Z-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Z-start	allowed Z-Range	2100	Absolute position in 1/10 mm.
Z-max	allowed Z-Range	1000	Absolute position in 1/10 mm.
Z-add[I]	0..(Z-start – Z-max)	0	Relative distance in 1/10 mm Required distance to travel downwards before reaching Z-Max. The calculation for enough liquid includes the driven submerge.
Error	(3) Invalid operand, (9) No liquid detected, (10) Drive no load, (11) Not enough liquid MDT, (20) No liquid exit detected, (21) Delta pressure overrun, (22) Tip Guard in wrong position, (23) Not yet moved or move aborted, (24) Pulse Ilid, (28) Subdevice error.		

MET Move Tip, Detect Liquid, Submerge:

MET TipSelect, Submerge, Z-start, Z-max, Z-add1..Z-add8

The **MET** is the same as **MDT** command, except the tips will remain at Z-max upon error.

Parameter	***Validity***	***Default***	***Description***
TipSelect	1..255	255	Binary coded tip select.
Submerge	-1000.. Z-Upperlimit-actual Pos	0	Relative distance in 1/10 mm.
Z-start	allowed Z-Range	2100	Absolute position in 1/10 mm.
Z-max	allowed Z-Range	1000	Absolute position in 1/10 mm.
Z-Add[i]	0 – (Z-start – Z-max)	0	Relative distance in 1/10 mm. Required distance to travel downwards before reaching Z-Max.
Error	(3) Invalid operand, (9) No liquid detected, (10) Drive no load, (12) Not enough liquid MET, (20) No liquid exit detected, (21) Delta pressure overrun, (22) Tip Guard in wrong position, (23) Not yet moved or move aborted, (24) Pulse Ilid, (28) Subdevice error.		

MCT Check for Clot on Selected Tips:

MCT TipSelect, RetractDist, RetractSpeed, Limit

This command retracts the selected tips out of liquid with the specified distance and speed. Then it checks if the exit signal (dip out) is within a defined limit. If the exit signal is not within the limit, a Clot Limit error will be generated. If no exit signal can be detected, a Clot no Exit error is generated. If no tips are mounted the Z-axis will move to Z-Start and returns an error code 24. If the parameter TipSelect is not defined, all possible tips are used for Clot detection. If the parameters RetractDist, RetractSpeed or Limit are not defined, the **MCT** command is using the individual retract values. These values can be set for each axis separately by the following commands: **SDR** (set retract distance), **SSR** (set retract speed) and **SLR** (set limit). The **MCT** command can also handle different detection procedures and modes, which can be set by the **SDM** (set detection mode) command. The LLD position can be reported with **RVZ** command. In case of an 8+1 configuration (App. Switch 5), the TipSelect parameter is always set to 1.

Parameter	*Validity*	*Default*	*Description*
TipSelect	1..255	255	Binary coded tip select.
RetractDist	allowed Z-Range	50	Relative distance in 1/10 mm. RetractDist must be > Limit.
Retract Speed	1..1500	200	Speed in 1/10mm/s.
Limit	0..RetractDist-1	40	Relative distance in 1/10 mm.
Error	(3) Invalid operand, (10) Drive no load, (18) Clot limit, (19) Clot no exit, (22) Tip Guard in wrong position, (23) Not yet moved or move aborted, (24) Pulse Ilid.		

APT Pierce With Tip:

APT TipSelect*, Z-start, Z-max

The **APT** command moves the selected tips to Z-start and then pierces downwards until the tips reach Z-max. The parameters Z-start and Z-max must be given, otherwise no move will be performed.
Appertaining other commands are **SPS**, **RGZ0, RDZ**.
CAUTION! This command can destroy Z-axis by using high current limit.

Parameter	*Validity*	*Default*	*Description*
TipSelect*	1..255	255	Binary coded tip select.
Z-start	allowed Z-Range	Last pos.	Absolute position in 1/10 mm.
Z-max	allowed Z-Range	Last pos.	Absolute position in 1/10 mm.
Error	(3) Invalid operand, (10) Drive no load, (22) Tip Guard in wrong position.		

AGT Get Disposable Tip:

AGT TipSelect*, Z-start, SearchDist, GetMode, Retract

This function picks up the number of disposable tips set by TipSelect from the current position. If no tip is selected, all channels are searching for a disposable tip. Z-start is the position where searching begins and the SearchDist defines the range within a tip must be found. Pick force and speed can be adapted by the **SSP** command. Alternatively to the default sequential mode, an all together respectively an even/odd mode can be selected for tip fetching procedure by the GetMode selector. At least, the retract movement can be selectively selected. Per default the tips will be retracted to max Z-Range. Alternatively by disabling the retract switch, the tip will be left at Z-Start after the tip fetch procedure. In case of an 8+1 configuration (App. Switch 5), only tip number 1 is able to take care of the tip presence.

Parameter	*Validity*	*Default*	*Description*
TipSelect*	1..255	255	Binary coded tip select.
Z-start	allowed Z-Range	-	Absolute position in 1/10 mm.
SearchDist	0 - Z-start	0	Relative distance in 1/10 mm.
GetMode	0..2	0	0 = default sequential, 1 = all parallel, 2 = even / odd.
Retract	0..1	0	0 = retract move to Z-Range. 1 = retract disabled, leave Tips at Z-Start after tip fetch.

Error	(3) Invalid operand, (10) Drive no load, (22) Tip Guard in wrong position, (25) Tip not fetched, (26) Tip not mounted, (27) Tip mounted.

ADT Discard Disposable Tip:

ADT TipSelect*

This function discards the number of disposable tips set by TipSelect. If no tip is selected, all tips will be discarded. The tips will be thrown off by moving up to initialization position of the Z-axis. Additionally to this standard discard procedure, an aspiration move while throwing off the disposable tips can be activated by the **SDT** command. This can be useful to reduce contamination of the tip cone. In case of an 8+1 configuration (App. Switch 5), the TipSelect parameter is always set to 1.

Parameter	***Validity***	***Default***	***Description***
TipSelect*	1..255	255	Binary coded tip select.
Error	(1) Initialization failed, (3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (22) Tip Guard in wrong position, (27) Tip mounted, (28) Subdevice error.		

AST Discard Disposable Tip with Lower Diti Eject Option:

AST TipSelect*, LogPos*

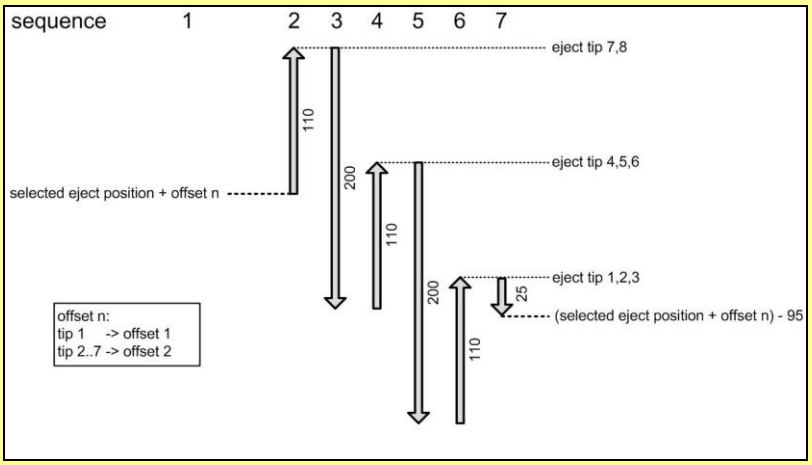
This function discards the number of disposable tips set by TipSelect. If no tip is selected, all tips will be discarded. Unselected tips remain at the actual position. The selected tips go to a start position and from there they move the DiscardDist upwards to throw off the tips. In case of an 8+1 configuration the start position is *selected LogPos - 100 + Offset3* (**SXT**), at all other configurations the start position is *selected LogPos* (**SST**). LogPos defines the logical position where the tips must be thrown off. The logical positions can be calibrated automatically by the **CST** command or set manually by the **SST** command. The presence of the lower diti eject mechanism can be reported by the **RSD** command. The **AST** command is operational too if there is no standard lower diti eject mechanism installed. Additionally to this standard discard procedure, an aspiration move while throwing off the disposable tips can be activated by the **SDT** command. This can be useful to reduce contamination of the tip cone. In case of an 8+1 configuration (App. Switch 5), the TipSelect parameter is always set to 1.

Parameter	***Validity***	***Default***	***Description***
TipSelect*	1..255	255	Binary coded tip select.
LogPos*	0	0	Higher discard position.
	1		Lower discard position.
Error	(1) Initialization failed, (3) Invalid operand, (7) Device not initialized, (10) drive no load, (22) Tip Guard in wrong position, (27) tip mounted, (28) Subdevice error.		

AXT Discard Disposable Tip with Lower Diti Eject Option (only 8 + 1 Configuration):

AXT LogPos*

This function is only valid for the 8+1 configuration (App. Switch 5). It discards all 8 disposable tips at a time. Discarding only the first tip must be performed with the **AST** command. The LogPos parameter defines the logical position where the tips must be thrown off. The logical positions can be calibrated automatically by the **CST** command or set manually by the **SST** command. An aspiration move while throwing off the disposable tips is not possible with this command.



Parameter	*Validity*	*Default*	*Description*
LogPos*	0	0	Higher discard position.
	1		Lower discard position.
Error	(1) Initialization failed, (3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (10) drive no load, (27) tip mounted.		

BMX Stop X Drive Movement Immediately:

BMX Selector

This function stops the movement of the commands **PAX**, **PRX**, **MAX**, **MRX** immediately either with normal deceleration or with an emergency break. Additionally the axis can be powered down for position evaluation. After breaking a movement, a new positioning command can be send. The drive doesn't lose the position.
Recommendation: After using BMX 2 start an initialization of the X axis to power up the X axis.

Parameter	*Validity*	*Default*	*Description*
Selector	0	0	Normal deceleration.
	1		Emergency break.
	2		Power down axis (sets status error 10).
Error	(3) Invalid operand.		

BMY Stop Y Drive Movement Immediately:

BMY Selector			
This function stops the movement of the commands **PAY**, **PRY**, **MAY**, **MRY** immediately either with normal deceleration or with an emergency break. Additionally the axis can be powered down for position evaluation. After breaking a movement, a new positioning command can be send. The drive doesn't lose the position. *Recommendation: After using BMY 2 start an initialization of the Y axis to power up the X axis.*			
Parameter	***Validity***	***Default***	***Description***
Selector	0	0	Normal deceleration, move to the last space position.
	1		Emergency break.
	2		Power down axis (sets status error 10).
Error	(3) Invalid operand.		

BMZ Stop Z Drive Movement Immediately:

BMZ TipSelect*, Selector*			
This function stops the movement of the commands **PAZ**, **PRZ**, **MAZ**, **MRZ** immediately either with normal deceleration or with an emergency break. Additionally the axis can be powered down for position evaluation. After breaking a movement, a new positioning command can be send. The drive doesn't lose the position. *Recommendation: After using BMZ 2 start an initialization of the Z axis to power up the Z axis.*			
Parameter	***Validity***	***Default***	***Description***
TipSelect*	1..255	255	Binary coded tip select.
Selector*	0	0	Normal deceleration.
	1		Emergency break.
	2		Power down axis (sets status error 10).
Error	(3) Invalid operand, (5) Device not implemented.		

BMA Stop all Axis Immediately:

BMA Selector			
This function stops the movement of **all** commands e.g. **PAA**, **MAA, PIA** immediately either with normal deceleration or with an emergency break. Additionally the axis can be powered down for position evaluation. After breaking a movement, a new positioning command can be send. The drive doesn't lose the position. *Recommendation: After using BMA 2 start an initialization of all axes to power up all axes.*			
Parameter	***Validity***	***Default***	***Description***
Selector	0	0	Normal deceleration.
	1		Emergency break.
	2		Power down axis (sets status error 10).
Error	(3) Invalid operand.		

CST Calibrate Automatically Lower Diti Eject Logical Positions:

CST			
This command searches automatically the lower diti eject logical positions. First the lower eject position will be evaluated, then the higher one. The determined range value can be stored into the non-volatile memory with the **AWE** command. In case of an 8+1 configuration (App. Switch 5), tip number 2 will be used for calibration. *Attention: Use this command only when no tips are mounted!*			
Parameter	***Validity***	***Default***	***Description***
Error	(1) Initialization failed, (5) Device not implemented, (22) Tip Guard in wrong position, (29) Application and axes mismatch.		

ARX Auto Range X-Axis:

ARX Scale, Offset*			
This command moves to the right and then to the left stopper of the X-axis and sets the X-range. After completion of the ranging movement either the standard offset or the offset given by the second parameter will be performed. The scale adjust value can be set to 10000, when using the selector one. The determined range value can be stored into the non-volatile memory with the **AWE** command.			
Parameter	***Validity***	***Default***	***Description***
Scale*	0..1	0	0 = use original scale adjust. 1 = reset scale adjust to 10000.
Offset*	0..X-Offset set by **SOX**	SOX	Set alternative initialization offset in 1/10 mm.
Error	(1) Initialization failed, (3) Invalid operand. (5) Device not implemented.		

ARY Auto Range Y-Axis:

ARY Scale, Offset*			
This command moves to the front and the back stopper of the Y-axis and sets the Y-range. The scale adjust value can be set to 10000, when using the selector one. The determined value can be stored into the non-volatile memory with the **AWE** command. The measured range will be reduced by either 2mm or by the Y-Backlash Distance set by the **SYB** command if it's size is larger then 2mm. The 2mm distance is required, when moving with a 9mm space in Y-direction.			
Parameter	***Validity***	***Default***	***Description***
Scale*	0..1	0	0 = use original scale adjust. 1 = reset scale adjust to 10000.
Offset*	0..Y-Offset set by **SOY**	SOY	Set alternative initialization offset in 1/10 mm.
Error	(1) Initialization failed, (3) Invalid operand. (5) Device not implemented.		

ARZ Auto Range Z-Axis:

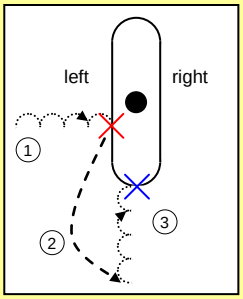
ARZ TipSelect			
This command moves with the selected reference tip from top downwards onto the table and back to the initialization position. Only one tip can be selected to evaluate the range at a time. For correct ranging a TECAN reference tip must be mounted. The determined value can be stored into the non-volatile memory with the **AWE** command. Caution: In case of an 8+1 configuration release the Z-Break before using the ARZ command for tip 2. This could be done either with the SBK command or an initialization of the Z axis.			
Parameter	***Validity***	***Default***	***Description***
TipSelect	1, 2, 4, 8, 16, 32, 64 or 128	0	Binary coded tip select.
Error	(1) Initialization failed, (3) Invalid operand. (5) Device not implemented.		

NOC Automatic Reference Pin Coarse Detection:

NOC TipSelect

This function is used for coarse finding the reference pin with the hole in the middle. After once detected the pin, the hole inside can be found with the **NOK** command precisely. For further information about the function of this command, please contact TECAN.
CAUTION! Only one tip can be selected. Wrong usage of this command can damage the instrument.

Parameter	*Validity*	*Default*	*Description*
TipSelect	1, 2, 4, 8, 16, 32, 64 or 128	-	Binary coded tip select.



1: Start from achieved X/Y/Z position to approach the grid in 0.1mm steps until Z detects grid height.

2: Move X/Y/Z in middle/front of grid

3: Approach in 0.1mm steps until grid height is detected

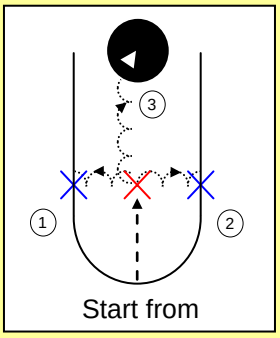
Error (1) Initialization failed, (3) Invalid operand, (7) Device not initialized

NOK Automatic Reference Hole Detection:

NOK TipSelect

This function can be used to find a reference hole automatically. For further information about the function of this command, please contact TECAN.
CAUTION! Only one tip can be selected. Wrong usage of this command can damage the instrument.

Parameter	*Validity*	*Default*	*Description*
TipSelect	1, 2, 4, 8, 16, 32, 64 or 128	-	Binary coded tip select.



1.: Achieve start position (NOC endposition -5mm in Y) to approach the left grid border in 0.1mm steps until Z detects no grid height anymore.
Then move X/Y/Z to the middle of the grid.

2.: Approach the right grid border in 0.1mm steps until Z detects no grid height anymore.

3.: Search the grid reference hole in the middle of the grid, backward direction in 0.1mm steps

Error (1) Initialization failed, (3) Invalid operand, (7) Device not initialized

MSD X/Y/Z-Spiral Move with Dilutor Tracking:

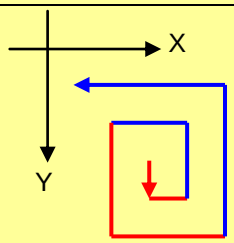
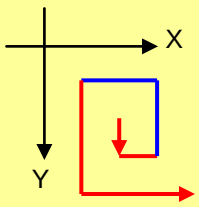
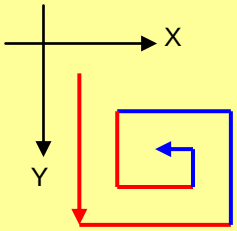
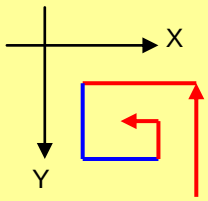
MSD XDeltaDistance, YDeltaDistance, NrOfHalfSpirals, TipSelect, DilutorDistance, ZTrackingDistance, XYSpeed, XYAcceleration

This command starts a square or rectangle spiral form move with the X-, Y- and Z-axis while relative moving the selected dilutors.
A spiral consists of several single X- Y-, and Z-moves. Using equal values for X/YDeltaDistance will result in a square spiral move; this form can be changed to rectangle using different X/YDeltaDistance parameters. If X/YDeltaDistance are positive an opening spiral move is done. If the X/YDeltaDistance are negative a closing spiral move is done. The first move of an opening spiral is always a positive Y-move. The first move of a closing spiral depends on the number of half-spirals. If NrOfHalfSpirals is even, the first Y-move is positive; if it is odd the move is negative. The reason for this behavior is that the closing spiral move ends at the position where the corresponding opening move (same absolute value of X/YDeltaDistance and same NrOfHalfSpirals) started.
If ZTrackingDistance in not 0, a Z-move is done after each half spiral except for the last one. Only the Z-axes which are selected with the TipSelect parameter perform these movements. The unit is 1/100mm. *Be aware that resolution and the mechanical accuracy of the Z-Axis is too small to guarantee such a exact positioning accuracy!*
Speed and acceleration must be set with XYSpeed and XYAcceleration. The Z-move uses the current set fast speed and acceleration. (see **SFZ**)The speeds for the dilutors must be set previously with the SEP, SPP and STP commands.

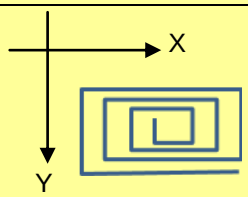
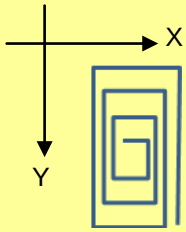
Caution on error handling:
Error messages can be initiated either by the plunger, the X-, Y- or the Z-drive. If an X-, Y- or Z-drives value is invalid, this command will return an error 3 and no move will be performed. In case of an invalid plunger value, the X-, Y- and Z-drives will start to move. The dilutors with no error will also start to move except the invalid Dilutor. At the end of such an occurrence, an error 28 will be returned. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PPA** or **PPD** command in the XP2000 Command Set.
If a crash occurs during a move on the X- Y- or Z- drive all moving parts will stop. If a crash occurs on a dilutor, only the dilutor stops while the X- Y- and Z-move continue.

Valid XDeltaDistance, YDeltaDistance, ZTrackingDistance and *NrOfHalfSpirals*:
- All moves must be within the movable range of the X-, Y- and Z-axis.
- *XDeltaDistance and YDeltaDistance* must not be 0.
- *XDeltaDistance and YDeltaDistance* must have same polarity (+ or -).

Square spirals (XDeltaDistance =YDeltaDistance):

	even NrOfHalfSpirals	odd NrOfHalfSpirals
open spiral, X/YDeltaDistance > 0		
closing spiral, X/YDeltaDistance < 0		

Rectangle spirals (XDeltaDistance ≠ YDeltaDistance):

XDeltaDistance > YDeltaDistance	 Example of an open spiral
XDeltaDistance < YDeltaDistance	 Example of a closing spiral

Attention:
Because of the backlash compensation the Ys-Axis should be opened at least 0.6mm.
8+1 LiHa uses one XP6000 instead of XP2000.

Parameter	***Validity***	***Default***	***Description***
XDeltaDistance	see text above	-	Minimal X move distance in 1/10 mm.
YDeltaDistance	see text above	-	Minimal Y move distance in 1/10 mm.
NrOfHalfSpirals	see text above	-	Number of half spirals to move
TipSelect	0..255	-	Binary coded Dilutor and Z-Axis select. If 0, no Dilutor or Z-Move will be done.
DilutorDistance	-3150..3150	-	Relative position in full steps. If 0, no dilutor movement will be done.
ZTrackingDistance	0..see text above	-	Distance of Z-Move after each half spiral (except the last one) in 1/100mm. If 0, no Z-Move will be done. Move is always downwards.
XYSpeed	1..4000	-	End speed in 1/10 mm/s
XYAcceleration	430..11250	-	Acceleration in 1/10 mm/s^2
Error	(3) Invalid operand, (5) Device not implemented, (10) Drive no load, (28) Subdevice error.		

4.12 Action Commands (Dilutor Specific Functionality)

PPR Move Plunger Relative:

PPR PlungerRel1*.. PlungerRel8*			
This command moves the plunger drives relative upwards for dispensing and relative downwards for aspiration. A negative value represents a dispense cycle (XP2000 Command **PPD**) and a positive value an aspiration (XP2000 command **PPP**). The validity of the entered relative position will be tested in the pump itself. So if one of the eight positions is out of range, this command is responding with an error code 28, but all other values will be accepted and those movements will be performed. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PPD** and **PPP** command in the XP2000 Command Set. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000.*			
Parameter	***Validity***	***Default***	***Description***
PlungerRel [I]*	-3150..3150	0	Relative position in full steps.
Error	(5) Device not implemented, (28) Subdevice error.		

PPA Move Plunger to Absolute Position:

PPA PlungerAbs1*.. PlungerAbs8*			
This command moves the plunger to an absolute position (XP2000 command **PPA**). The validity of the entered absolute position will be tested in the pump itself. So if one of the eight positions is out of range, this command is responding with an error code 28, but all other values will be accepted and those movements will be performed.In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PPA** command in the XP2000 Command Set. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000.*			
Parameter	***Validity***	***Default***	***Description***
PlungerAbs[I]*	0..3150	Last pos.	Absolute position in full steps.
Error	(5) Device not implemented, (28) Subdevice error.		

MTR Move Tracking Relative:

MTR PlungerRel1*.. PlungerRel8*

This command starts the Z-drives and dilutors simultaneously to achieve a synchronous tracking movement. The plungers are moving relative upwards (dispense) or relative downwards (aspirate) with the given “PlungerRel” parameter. The Z-drive relative tracking distance must be previously defined by the **STZ** command. Also the speed used for the Z-drive tracking must be set by the **SSZ** command. A **MTR** command without any plunger parameter is performing neither a plunger nor a tip movement. In case of an 8+1 configuration (App. Switch 5), only the first PlungerRel parameter is relevant, all others will be ignored.

Caution on error handling:
Error messages can be initiated either by the plunger or the Z-drive. If a Z-drive value is invalid, this command will return an error 3 and no move will be performed. In case of an invalid plunger value, both, the Z-drive and plunger will start to move except the invalid channel (tip and plunger). At the end of such an occurrence, an error 28 will be returned. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PPA** or **PPD** command in the XP2000 Command Set.
Attention: 8+1 LiHa uses one XP6000 instead of XP2000.

Parameter	*Validity*	*Default*	*Description*
PlungerRel [I]*	-3150..3150	0	Relative position in full steps.
Error	(3) Invalid operand, (5) Device not implemented, (10) Drive no load, (28) Subdevice error.		

PID Initialize Plunger and Valve Drive (Reverse Polarity):

PID DilutorSelect

This command initializes the plunger and the valve drive. The valve drive direction has reverse polarity. After initialization, all the speed and ramp settings will be set to default again. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PIY** command in the XP2000 Command Set. In case of an 8+1 configuration (App. Switch 5), the DilutorSelect parameter is always set to 1.
Attention: 8+1 LiHa uses one XP6000 instead of XP2000.

Parameter	*Validity*	*Default*	*Description*
Dilutor Select	1..255	255	Binary coded dilutor select.
Error	(3) Invalid operand, (5) Device not implemented, (28) Subdevice error.		

PVL Position Valve Logical:

PVL PositionValve1*.. PositionValve8*

This command turns the valves to the selected position. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the **PVO**, **PVI** and **PVB** command in the XP2000 Command Set.
Attention: 8+1 LiHa uses one XP6000 instead of XP2000.

Parameter	*Validity*	*Default*	*Description*
PositionValve	0	Last Position	Turns the valve to outlet port.
	1		Turns the valve to inlet port.
	2		Turns the valve to bypass port.
Error	(3) Invalid operand, (5) Device not implemented, (28) Subdevice error.		

AHS Start Hit Pinch Valve Solenoids:

AHS DilutorSelect			
This command starts the hit pinch valve solenoid sequence. The timing for this sequence is given by the time before, while and after parameter, which can be defined by the XP2000 commands **SBH**, **STH** and **SAH**. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the corresponding command in the XP2000 Command Set. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000.*			
Parameter	***Validity***	***Default***	***Description***
Dilutor Select	1..255	255	Binary coded dilutor select.
Error	(3) Invalid operand, (5) Device not implemented, (28) Subdevice error.		

APS Start Piezo Pump for N Drops:

APS DilutorSelect			
This command sets the relay to Piezo position, starts the micro pump for the number of pulses set by the **SPN** command and afterwards, it sets the relay back to liquid level detection position. Values set by XP2000 commands **SPV**, **SPF** and **SPW** are in use. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the corresponding command in the XP2000 Command Set. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000.*			
Parameter	***Validity***	***Default***	***Description***
Dilutor Select	1..255	255	Binary coded dilutor select.
Error	(3) Invalid operand, (5) Device not implemented, (28) Subdevice error.		

ADV Dispense Volume:

ADV DilutorSelect			
This command calculates the pump dilutor parameters, sets the relay to Piezo position, starts the micro pump and sets the relay back to LLD position after pump stop. Values set by the XP2000 commands **SPV**, **SPF**, **SPW**, **SOV**, **SDV**, **SYV** are in use. The syringe size for this command must be between 10 and 1000 micro liters. In case of a Subdevice error message use the **RDS** command to get the origin source of the problem. For detailed information refer to the corresponding command in the XP2000 Command Set. *Attention: 8+1 LiHa uses one XP6000 instead of XP2000.*			
Parameter	***Validity***	***Default***	***Description***
Dilutor Select	1..255	255	Binary coded dilutor select.
Error	(3) Invalid operand, (5) Device not implemented, (28) Subdevice error.		

4.13 Action Commands (TePS Specific Functionality)

ATP Auto Tip Step Positioning:

ATP AxisSelect, CountOfSteps*, StepWidth*, SensorLimit*, SensorChannel*

This command moves from left to the right, from back to the front or from up to down. Steps will do the movement. The tips have to be at start position. The tip will move through the measure gap of the TePS, until sensor 1 or sensor 2 limits are reached.
The TePS module measures the arriving tip. If the sensor level limit is reached, the movement will stop.
The corresponding report command is **RPX0, RPY0** and **RPZ0**.

Tips should be mounted before this command is used.

CAUTION! This command uses the external TePS module. To get a result from the TePS module turn the sensors ON and OFF with **ASM** and **AFM** commands.
For more information see the CS of the TePS module.

Parameter	*Validity*	*Default*	*Description*
AxisSelect	0..9	0	0 = X-axis, 1= Y-axis, 2 = Z1, 3 = Z2, 4=Z3, 5=Z4, 6=Z5, 7=Z6, 8=Z7, 9=Z8.
CountOf Steps	1..200	100	Count of Steps times Step width gives the relative movement in 1/10mm.
StepWidth	-10..10	1	Relative distance in 1/10mm.
Sensor Limit	-99..99	50	Sensor limit in %. Positive values entering in sensor beam. Negative values leaving sensor beam.
Sensor Channel	1, 2	1	Sensor channel 1 or 2 of TePS module
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (17) Measurement failed, (28) Subdevice error.		

AAZ Auto Adjustment Z-Axis direction:

AAZ TipSelect, RelDistance, Speed*

This command moves with the selected tip from actual position, down to end position. As soon as sensor 1 from the TePS module detects the selected tip, an interrupt will send to the LiHa CU. The actual tip position will recorded. Use the **RAZ** command to get results.
The Z movement has to go trough sensor 1!

Tips should be mounted before this command is used.

CAUTION! The sensor limit can be set by the **STC** command of the TePS.
This command uses the external TePS commands: **AAS, SIM, AER, ASM, AFM**
For more information see the CS of the TePS module.

Parameter	*Validity*	*Default*	*Description*
TipSelect	1, 2, 4, 8, 16, 32, 64 or 128		Binary coded tip select.
RelDistance	Allowed Z Range	100	Relative distance in 1/10mm.
Speed*	1..1000	350	Move with slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (17) Measurement failed, (28) Subdevice error.		

AAT Auto Adjustment X- and Y-Axis direction:

AAT AxisSelect, CountOfTips, RelDistance, Speed*

X-Axis selection is for future use.
With Axis selection Y the LiHa moves from back to the front. The tips have to be at start position and move with selected speed to the end position. The tips have to move through the measure gap of the TePS, crossing both sensor beams.

The TePS measure with a laser diode the crossing sensor beams and sends interrupts to the LiHa DCU. These interrupts give the signals to the LiHa DCU to record the actual position in Y-direction. If no interrupt occurs, a timeout of 2 second is set.

It is possible to record all 8 tips in one cycle. The corresponding report command is **RAT**.

Tips should be mounted before this command is used.

CAUTION! The sensor limit can be set by the **STC** command of the TePS.
This command uses the external TePS commands: **AAS, SIM, ASM, AFM**
For more information see the CS of the TePS module.

Parameter	*Validity*	*Default*	*Description*
AxisSelect	0..1	-	0 = X-axis, 1= Y-axis.
CountOf-Tips	1..8	-	Count of tips, which go through the measure gap.
RelDistance	Allowed X- respectively Y- Range	0	Relative distance in 1/10mm.
Speed	1..1000	100	Move with slow speed in 1/10 mm/s.
Error	(3) Invalid operand, (5) Device not implemented, (7) Device not initialized, (17) Measurement failed, (28) Subdevice error.		

4.14 Broadcast Messages

Broadcast messages			
The LIHA device CU will do some action (also to the subdevices) to the following broadcast message numbers:			
Parameter	***Validity***	***Default***	***Description***
	0		SW Reset.
	4		Normal Break.
	5		Emergency Break.
	32		Keep Alive Message On.
	33		Keep Alive Message Off.

5 Error Codes

LIHA Errors Codes		
Code	***Description***	***Source***
1	Initialization failed.	Initialization commands i.e. PIX, PIA.
2	Invalid command.	Not available commands.
3	Invalid operand.	Parameter out of range.
4	CAN acknowledge problems.	Communication to local CAN bus.
5	Device not implemented.	Device connected to local CAN bus missing.
6	CAN answer timeout.	Communication to local CAN bus.
7	Device not initialized.	Move commands i.e. PAX, PAA.
8	Command overflow of TeCU	Communication pipeline PC – CU overflow.
9	No liquid detected	MDT, MET command.
10	Drive no load.	Crash detected.
11	Not enough liquid	MDT command.
12	Not enough liquid	MET command.
13	No Flash access	Hardware problem.
15	Command overflow of Subdevice	Second Action task is started.
17	Measurement failed	ATP, AAT, AAZ commands.
18	Clot limit passed	MCT command.
19	No clot exit detected	MCT command.
20	No liquid exit detected	MET, MDT command.
21	Delta pressure overrun (pLLD)	MET, MDT command.
22	Tip Guard in wrong position	PAZ, PTG, MDT, MET, MCT, APT, AGT, ADT, AST, CST
23	Not yet moved or move aborted	MET, MDT command.
24	Ilid pulse error	MCT, MET, MDT command.
25	Tip not fetched	AGT, ADT, AST command.
26	Tip not mounted	AGT, ADT, AST command.
27	Tip mounted	AGT, ADT, AST command.
28	Subdevice error	MDT, MET, ADV, APS, AHS, AAT, AAZ, ATP commands. SEP, SPP, STP, PID, PVL, PPR, PPA, MTR commands.
29	Application switch and axes mismatch	PIA, PIX, PIY, PIZ, PIB, REE, SHS command.
30	Wrong DC-Servo Type	PIA, PIX, PIY, PIZ, REE command.
31	Virtual Drive	REE (only 8+1 configuration)

The following error messages may occur in all commands.

Code	Error message
2	Invalid command
3	Invalid operand
4	CAN acknowledge problems
5	Device not implemented
6	CAN answer timeout
7	Device not initialized
8	Command overflow of TeCU
15	Command overflow of subdevice

6 Traceability

6.1 Requirement Downwards Traceability

FRS	FCS (3letter Cmd)	Description (FCS)
7.1	RKA	Report Keep Alive Function
	SKA	Set Keep Alive Function
	SRS	Reset System (Whole System inclusive this CU)
	SBC	Send Broadcast to all Subdevice
	SCC	Send Broadcast to Device:
7.2	RNT	Report Number Of Tips On Arm
	RFV	Report Firmware Version
7.2.1	RSL	Report Second LIHA
7.3	RDF	Report Diagnostic Functions
	RGD	Report Global Data
	RED	Read FLASH-EPROM Data
	RDA	Report Device Allocation Array of Subdevice
	RSU	Report Stack Usage
	RBT	Report Board Temperature
	RDX	Report Diagnostic Functions for the X-Axis
	RDY	Report Diagnostic Functions for the Y-Axis
	RDZ	Report Diagnostic Functions for the Z-Axis
	SFV	Set Serial Number
	SGD	Set Global Data
	SED	Set FLASH-EPROM Data
	SMC	Set All LIHA Axis Move Counter To Zero
	ACW	Erase all Setup Data in the FLASH-EPROM
	AWE	Write System Parameters to FLASH-EPROM
	ARE	Read System Parameters to FLASH-EPROM
7.4	SOF	Firmware Download
7.5.1	PIA	Position Initialization X/Y/Z - Axis
	PIB	Position Pre Initialization
	PIF	Fake Initialization X/Y/Z - Axis
	PIX	Position Initialization X-Axis
	PIY	Position Initialization Y-Axis
	PIZ	Position Initialization Z-Axis
7.5.2	RYS	Report Minimum Y Space Distance
	RYB	Report Y Backlash and Z Positioning Parameter
	RPX	Report Current Parameter For X-Axis
	RPY	Report Current Parameter For Y-Axis
	RPZ	Report Current Parameter For Z-Axis
	RSM	Report X-Axis Smooth Move Mode
	REE	Report Extended Error Code or Axis Configuration String
	RVZ	Report Z-Axis Values And Parameters
	RGZ	Report Global Z-Axis Values And Parameters
	RHS	Report Enhanced Speed Setting for EVO75
	SRX	Set X-Axis Range

© Copyright by Tecan Schweiz AG

7.5.2 (cont.)	SRY	Set Y-Axis Range
	SRZ	Set All Z-Axis Range
	SYS	Set Minimum Y-Space Distance
	SYB	Set Y Backlash and Z Positioning Parameter
	SHZ	Set Individual Z-Travel Height
	SSX	Set Slow Speed for X-Axis
	SSY	Set Slow Speed for Y-Axis
	SSZ	Set Individual Slow Speed For Z1..Z8
	SFX	Set X-Ramp Parameters
	SFY	Set Y-Ramp Parameters
	SFZ	Set Z-Ramp Parameters
	SOX	Set Initialization Offset For X-Axis
	SOY	Set Initialization Offset For Y-Axis
	SOZ	Set Initialization Offset For Z-Axis
	SAX	Set Scale Adjust Factor For X-Axis
	SAY	Set Scale Adjust Factor For Y-Axis
	SAS	Set Scale Adjust Factor For Y- Space Axis Only
	SSM	Set X-Axis Smooth Move Mode
	SMS	Stop “Move on Start Signal”
	SLX	Set New X-Axis Scaling Factor And Motion Direction
	SLY	Set New Y-Axis Scaling Factor And Motion Direction
	SLZ	Set New Z-Axis Scaling Factor And Motion Direction
	SHS	Set Enhanced Speed Setting for EVO75
	SBK	Set Z Drive Brake On or Off (only 8 + 1 Configuration)
	RBK	Report Z Drive Brake Status (only 8 + 1 Configuration):
	PAA	Position Absolute For All Axis
	PXZ	Fast Positioning Absolute for X and Z Axis
	PAX	Position Absolute X-Axis
	PAY	Position Absolute Y-Axis
	PSY	Y-Spacing Of Tips
	PAZ	Position Absolute Z-Axis
	PRX	Position Relative For X-Axis
	PRY	Position Relative Y-Axis
	PRZ	Position Relative Z-Axis
	PCX	Position Relative In Increment Resolution For X-Axis
	PCY	Position Relative In Increment Resolution For Y-Axis
	MAX	Position Absolute with Slow Speed X-Axis
	MAY	Position Absolute with Slow Speed Y-Axis
	MAZ	Position Absolute with Slow Speed Z-Axis
	MAA	Position Absolute For All Axis with Slow Speed
	MRX	Position Relative with Slow Speed X-Axis
	MRY	Position Relative with Slow Speed Y-Axis
	MRZ	Position Relative with Slow Speed Z-Axis
	MSD	X/Y/Z-Spiral Move with Dilutor Tracking
	PTG	Position Logic for Optional Tip Guard Drive
	RTG	Report Optional Tip Guard Status
7.5.3	RTL	Report Individual Z-Start For Liquid Search Commands
	RML	Report Individual Z-Max For Liquid Search Commands
	RBL	Report Individual Submerge For Liquid Search Commands
	RDL	Report Individual Safe Detection Retract Distance For Liquid Search
	RDM	Report Liquid Detection Mode

7.5.3 (cont.)	RLA	Report Liquid Detection Acceleration
	RAP	Report Pressure LLD Parameter (Aspirate Part)
	SAP	Set Pressure LLD Parameter (Aspirate Part)
	RDP	Report Pressure LLD Parameter (Dispense Part)
	SDP	Set Pressure LLD Parameter (Dispense Part)
	RVP	Report PMP Pressure Value Before And After Detection
	SVP	Set Delta Pressure Overrun Limit
	SSL	Set Search Speed For Liquid Search Commands
	STL	Set Individual Z-Start For Liquid Search Commands
	SML	Set Individual Z-Max For Liquid Search Commands
	SBL	Set Individual Submerge For Liquid Search Commands
	SDL	Set Individual Safe Detection Retract Distance For Liquid Search Cmd
	SDM	Set Liquid Detection Mode
	SLA	Set Liquid Detection Acceleration
	MDT	Move Tip, Detect Liquid, Submerge
	MET	Move Tip, Detect Liquid, Submerge
7.5.4	RDR	Report Individual Retract Distance For Clot Detection
	RSR	Report Individual Retract Speed For Clot Detection
	RLR	Report Individual Retract Limit For Clot Detection
	SDR	Set Individual Retract Distance For Clot Detection Commands
	SSR	Set Individual Retract Speed For Clot Detection Commands
	SLR	Set Individual Limit For Clot Detection Commands
	MCT	Check For Clot On Selected Tips
7.5.5	RTZ	Report Z-Axis relative tracking Values
	STZ	Set Z-Axis Relative Value
	MSD	X/Y/Z-Spiral Move with Dilutor Tracking
	MTR	Move Tracking Relative
	PPR	Move Plunger Relative
	PPA	Move Plunger to absolute position
	RDS	Report Dilutor Status
	RDD	Report Dilutor Drive Status
7.5.6	RDE	Report Status Of Lower Diti Eject Option
	RSD	Report Presence Lower Diti Eject Option
	RST	Report Lower Diti Eject Logical Positions
	RDT	Report Diti Discard / Aspirate Parameter
	RXT	Report Discard Offset (only 8+1)
	SDT	Set Diti Discard / Aspirate Parameter
	RTS	Report Tip Status Diti
	SSP	Set Pick Speed For Diti Commands
	SSD	Set Discard Speed For Diti Commands
	SST	Set Lower Diti Eject Logical Positions
	SDE	Switch Lower Diti Eject On Or Off
	SXT	Set Discard Offset (only 8+1)
	AGT	Get A Disposable Tip
	ADT	Discard Disposable Tip
	AST	Discard Disposable Tip with Lower Diti Eject Option
	AXT	Discard Disposable Tip with Lower Diti Eject Option
7.5.7	BMX	Stop X Drive Movement Immediately
	BMY	Stop Y Drive Movement Immediately
	BMZ	Stop Z Drive Movement Immediately
	BMA	Stop All Axis Immediately

7.5.8	RYR	Report Y Auto Range in Increments
	CST	Calibrate Automatically Lower Diti Eject Logical Positions
	ARX	Auto Range X-Axis
	ARY	Auto Range Y-Axis
	ARZ	Auto Range Z-Axis
	NOC	Automatic Reference Pin Coarse Detection
	NOK	Automatic Reference Hole Detection
7.5.9	SPS	Set Pierce Speed For Piercing Commands
	APT	Pierce With Tip
	SFP	Set Force Parameter for all Movements
	RFP	Report Force Parameter for all Movements
7.5.10	PID	Initialize Plunger And Valve Drive (Reverse Polarity)
	PVL	Position Valve Logical
	AHS	Start Hit Pinch Valve Solenoids
	APS	Start Piezo Pump For N Drops
	ADV	Dispense Volume
	Txx	Pipeline to Slave Device
	SEP	Set End Speed for Plungers
	SPE	Set PMP Error Handling
	SPP	Set Stop Speed for Plungers
	STP	Set Start Speed for Plungers
	RPE	Report PPMP Error Handling
	RPP	Report Plunger Drive Parameter
	RYV	Report Syringe Volume
7.5.11	PAA	Position Absolute For All Axis
	MAA	Position Absolute For All Axis with Slow Speed
	PSY	Y-Spacing Of Tips
	SYB	Set/Report Y Backlash and Z Positioning Parameter
	RYB	Report Y Backlash and Z Positioning Parameter
	PAY	Position Absolute Y-Axis
	MAY	Position Absolute with Slow Speed Y-Axis
7.5.12	AAT	Auto Adjustment X and Y-axis direction
	AAZ	Auto Adjustment Z-axis direction
	RAT	Report Adjustment Position of X and Y-axis direction
	RAZ	Report Adjustment Position of Z-axis direction
	ATP	Auto Tip Step Positioning
9.1	RTS	Report Tip Status Diti
9.2	SOF	Firmware Download Watchdog solved in electronics HW
9.3	SBC	Send Broadcast Message to specific Slave Device
	SCC	Send Broadcast Message to all Slave Devices
9.5	RSU	Report Stack Usage
9.6	BMX	Stop X Drive Movement Immediately
	BMY	Stop Y Drive Movement Immediately
	BMZ	Stop Z Drive Movement Immediately
	SBC	Send Broadcast Message to specific Slave Device
	SCC	Send Broadcast Message to all Slave Devices

6.2 Requirement Upwards Traceability

FCS (3letter Cmd)	FRS	Description (FRS)
RFV	7.2	Configuration
RDF	7.3	Calibration and Diagnose
RGD	7.3	Calibration and Diagnose
RED	7.3	Calibration and Diagnose
RDA	7.3	Calibration and Diagnose
RKA	7.1	Communication
RSU	7.3 9.5	Calibration and Diagnose Program Code Integrity
RBT	7.3	Calibration and Diagnose
RSL	7.2.1	Detection of two LIHA Configuration
RNT	7.2	Configuration
RSD	7.5.6	Diti Fetch/Discard
RDE	7.5.6	Diti Fetch/Discard
RST	7.5.6	Diti Fetch/Discard
RDT	7.5.6	Diti Fetch/Discard
RXT	7.5.6	Diti Fetch/Discard
RYS	7.5.2	Axis Movement&Parameter
RYB	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
RPX	7.5.2	Axis Movement&Parameter
RPY	7.5.2	Axis Movement&Parameter
RPZ	7.5.2	Axis Movement&Parameter
RTG	7.5.2	Axis Movement&Parameter
RVZ	7.5.2	Axis Movement&Parameter
RGZ	7.5.2	Axis Movement&Parameter
RFP	7.5.9	Adjust force of Z-axes
RTL	7.5.3	Liquid Detection
RML	7.5.3	Liquid Detection
RBL	7.5.3	Liquid Detection
RDL	7.5.3	Liquid Detection
RDR	7.5.4	Clot Detection
RSR	7.5.4	Clot Detection
RLR	7.5.4	Clot Detection
RDM	7.5.3	Liquid Detection
RLA	7.5.3	Liquid Detection
RTZ	7.5.5	Aspirate and Dispense
RTS	7.5.6 9.1	Diti Fetch/Discard Diti security
RSM	7.5.2	Axis Movement&Parameter
REE	7.5.2	Axis Movement&Parameter
RDX	7.3	Calibration and Diagnose
RDY	7.3	Calibration and Diagnose
RDZ	7.3	Calibration and Diagnose
RYR	7.5.8	Setup

© Copyright by Tecan Schweiz AG

RPP	7.5.10	Subdevice Communication
RDS	7.5.5	Aspirate and Dispense
RDD	7.5.5	Aspirate and Dispense
RYV	7.5.10	Subdevice Communication
RAT	7.5.12	Readjustment Absolute Positioning
RAZ	7.5.12	Readjustment Absolute Positioning
RAP	7.5.3	Liquid Detection
RDP	7.5.3	Liquid Detection
RVP	7.5.3	Liquid Detection
RPE	7.5.10	Subdevice Communication
RHS	7.5.2	Axis Movement&Parameter
RBK	7.5.2	Axis Movement&Parameter
SFV	7.3	Calibration and Diagnose
SGD	7.3	Calibration and Diagnose
SED	7.3	Calibration and Diagnose
SRS	7.1	Communication
SBC	7.1 9.3 9.6	Communication Security commands Emergency Stop
SCC	7.1 9.3 9.6	Communication Security commands Emergency Stop
SKA	7.1	Communication
SOF	7.4 9.2	Firmware Download AC power failure
SRX	7.5.2	Axis Movement&Parameter
SRY	7.5.2	Axis Movement&Parameter
SRZ	7.5.2	Axis Movement&Parameter
SYS	7.5.2	Axis Movement&Parameter
SYB	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
SHZ	7.5.2	Axis Movement&Parameter
SSL	7.5.3	Liquid Detection
SSX	7.5.2	Axis Movement&Parameter
SSY	7.5.2	Axis Movement&Parameter
SSZ	7.5.2	Axis Movement&Parameter
SPS	7.5.9	Adjust force of Z-axes
SFP	7.5.9	Adjust force of Z-axes
SSP	7.5.6	Diti Fetch/Discard
SSD	7.5.6	Diti Fetch/Discard
SST	7.5.6	Diti Fetch/Discard
SDE	7.5.6	Diti Fetch/Discard
SDT	7.5.6	Diti Fetch/Discard
SXT	7.5.6	Diti Fetch/Discard
STL	7.5.3	Liquid Detection
SML	7.5.3	Liquid Detection
SBL	7.5.3	Liquid Detection
SDL	7.5.3	Liquid Detection
SDR	7.5.4	Clot Detection
SSR	7.5.4	Clot Detection

© Copyright by Tecan Schweiz AG

SLR	7.5.4	Clot Detection
SDM	7.5.3	Liquid Detection
SFX	7.5.2	Axis Movement&Parameter
SFY	7.5.2	Axis Movement&Parameter
SFZ	7.5.2	Axis Movement&Parameter
SLA	7.5.3	Liquid Detection
SOX	7.5.2	Axis Movement&Parameter
SOY	7.5.2	Axis Movement&Parameter
SOZ	7.5.2	Axis Movement&Parameter
SAX	7.5.2	Axis Movement&Parameter
SAY	7.5.2	Axis Movement&Parameter
SAS	7.5.2	Axis Movement&Parameter
SSM	7.5.2	Axis Movement&Parameter
SLX	7.5.2	Axis Movement&Parameter
SLY	7.5.2	Axis Movement&Parameter
SLZ	7.5.2	Axis Movement&Parameter
SMC	7.3	Calibration and Diagnose
STZ	7.5.5	Aspirate and Dispense
SEP	7.5.10	Subdevice Communication
SPP	7.5.10	Subdevice Communication
STP	7.5.10	Subdevice Communication
SAP	7.5.3	Liquid Detection
SDP	7.5.3	Liquid Detection
SVP	7.5.3	Liquid Detection
SPE	7.5.10	Subdevice Communication
SHS	7.5.2	Axis Movement&Parameter
SBK	7.5.2	Axis Movement&Parameter
ACW	7.3	Calibration and Diagnose
AWE	7.3	Calibration and Diagnose
ARE	7.3	Calibration and Diagnose
Txx	7.5.10	Subdevice Communication
PIA	7.5.1	Initialization
PIB	7.5.1	Initialization
PIF	7.5.1	Initialization
PIX	7.5.1	Initialization
PIY	7.5.1	Initialization
PIZ	7.5.1	Initialization
PAA	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
PXZ	7.5.2	Axis Movement&Parameter
PAX	7.5.2	Axis Movement&Parameter
PAY	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
PSY	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
PAZ	7.5.2	Axis Movement&Parameter
PRX	7.5.2	Axis Movement&Parameter
PRY	7.5.2	Axis Movement&Parameter
PRZ	7.5.2	Axis Movement&Parameter
PCX	7.5.2	Axis Movement&Parameter

© Copyright by Tecan Schweiz AG

PCY	7.5.2	Axis Movement&Parameter
PTG	7.5.2	Axis Movement&Parameter
MAX	7.5.2	Axis Movement&Parameter
MAY	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
MAZ	7.5.2	Axis Movement&Parameter
MAA	7.5.2 7.5.11	Axis Movement&Parameter Position 1536 Plates
MSD	7.5.2 7.5.5	Axis Movement&Parameter Aspirate and Dispense
MRX	7.5.2	Axis Movement&Parameter
MRY	7.5.2	Axis Movement&Parameter
MRZ	7.5.2	Axis Movement&Parameter
MDT	7.5.3	Liquid Detection
MET	7.5.3	Liquid Detection
MCT	7.5.4	Clot Detection
APT	7.5.9	Adjust force of Z-axes
AGT	7.5.6	Diti Fetch/Discard
ADT	7.5.6	Diti Fetch/Discard
AST	7.5.6	Diti Fetch/Discard
AXT	7.5.6	Diti Fetch/Discard
BMX	7.5.7 9.6	Break Movement Emergency Stop
BMY	7.5.7 9.6	Break Movement Emergency Stop
BMZ	7.5.7 9.6	Break Movement Emergency Stop
BMA	7.5.7	Break Movement
CST	7.5.8	Setup
ARX	7.5.8	Setup
ARY	7.5.8	Setup
ARZ	7.5.8	Setup
NOC	7.5.8	Setup
NOK	7.5.8	Setup
PPR	7.5.5	Aspirate and Dispense
PPA	7.5.5	Aspirate and Dispense
MTR	7.5.5	Aspirate and Dispense
PID	7.5.10	Subdevice Communication
PVL	7.5.10	Subdevice Communication
AHS	7.5.10	Subdevice Communication
APS	7.5.10	Subdevice Communication
ADV	7.5.10	Subdevice Communication
ATP	7.5.12	Readjustment Absolute Positioning
AAT	7.5.12	Readjustment Absolute Positioning
AAZ	7.5.12	Readjustment Absolute Positioning

7 Index of Commands

AAT Auto Adjustment X- and Y-axis direction: 76
AAZ Auto Adjustment Z-axis direction: 75
ACW Erase all Setup Data in the Flash: ACW Key 55
ADT Discard Disposable Tip: 65
ADV Dispense Volume: 74
AGT Get A Disposable Tip: 64
AHS Start Hit Pinch Valve Solenoids: 74
APS Start Piezo Pump For N Drops: 74
APT Pierce With Tip: 64
ARE Read System Parameters to FLASH-EPROM: 54
ARX Auto Range X-Axis: 68
ARY Auto Range Y-Axis: 68
ARZ Auto Range Z-Axis: 68
AST Discard Disposable Tip with Lower Diti Eject Option: 65
ATP Auto Tip Step Positioning: 75
AWE Write System Parameters to FLASH-EPROM: 54
AXT Discard Disposable Tip with Lower Diti Eject Option (only 8 + 1 Configuration): 66
BMA Stop All Axis Immediately: 67
BMX Stop X Drive Movement Immediately: 66
BMY Stop Y Drive Movement Immediately: 67
BMZ Stop Z Drive Movement Immediately: 67
CST Calibrate Automatically Lower Diti Eject Logical Positions: 67
MAA Position Absolute For All Axis with Slow Speed: 61
MAX Position Absolute with Slow Speed X-Axis: .60
MAY Position Absolute with Slow Speed Y-Axis: .61
MAZ Position Absolute with Slow Speed Z-Axis: ..61
MCT Check For Clot On Selected Tips: 64
MDT Move Tip, Detect Liquid, Submerge: 63
MET Move Tip, Detect Liquid, Submerge: 63
MRX Position Relative with Slow Speed X-Axis: ..62
MRY Position Relative with Slow Speed Y-Axis: ..62
MRZ Position Relative with Slow Speed Z-Axis: ...62
MSD X/Y/Z-Spiral Move with Dilutor Tracking: 70
MTR Move Tracking Relative: 73
NOC Automatic Reference Pin Coarse Detection: 69
NOK Automatic Reference Hole Detection: 69
PAA Position Absolute For All Axis: 57
PAX Position Absolute X-Axis: 58
PAY Position Absolute Y-Axis: 58
PAZ Position Absolute Z-Axis: 59
PCX Position Relative In Increment Resolution For X-Axis: 60
PCY Position Relative In Increment Resolution For Y-Axis: 60
PIA Position Initialization X/Y/Z – Axis: 55
PIB Position Pre Initialization: 55
PID Initialize Plunger And Valve Drive (Reverse Polarity): 73
PIF Fake Initialization X/Y/Z – Axis: 56
PIX Position Initialization X-Axis: 56
PIY Position Initialization Y-Axis: 56
PIZ Position Initialization Z-Axis: 56
PPA Move Plunger to Absolute Position; 72
PPR Move Plunger Relative: 72
PRX Position Relative For X-Axis: 59
PRY Position Relative Y-Axis: 59
PRZ Position Relative Z-Axis: 59
PSY Y-Spacing Of Tips: 58
PTG Position Logic for Optional Tip Guard Drive: 60
PVL Position Valve Logical: 73
PXZ Fast Positioning Absolute for X and Z Axis: . 57
RAP Report Pressure LLD Parameter (Aspirate Part): 36
RAT Report Adjustment Position of X and Y-axis direction: 35
RAZ Report Adjustment Position of Z-axis direction: 36
RBK Report Z Drive Brake Status (only 8 + 1 Configuration): 34
RBL Report Individual Submerge For Liquid Search Commands: 30
RBT Report Board Temperature: 24
RDA Report Device Allocation Array of Subdevices: 23
RDD Report Dilutor Drive Status: 35
RDE Report Status Of Lower Diti Eject Option: 25
RDF Report Diagnostic Functions: 22
RDL Report Individual Safe Detection Retract Distance For Liquid Search: 30
RDM Report Liquid Detection Mode: 31
RDP Report Pressure LLD Parameter (Dispense Part): 36
RDR Report Individual Retract Distance For Clot Detection: 30
RDS Report Dilutor Status: 34
RDT Report Diti Discard / Aspirate Parameter: 26
RDX Report Diagnostic Functions for the X-Axis: 32
RDY Report Diagnostic Functions for the Y-Axis: 33
RDZ Report Diagnostic Functions for the Z-Axis: . 33
RED Read FLASH EPROM Data: 23
REE Report Extended Error Code or Axis Configuration String: 32
RFP Report Force Parameter for all Movements: 29
RFV Report Firmware Version: 22
RGD Report Global Data: 23
RGZ Report Global Z-Axis Values And Parameters: 29
RHS Report Enhanced Speed Setting for EVO75: 33
RKA Report Keep Alive Function: 24

RLA Report Liquid Detection Acceleration: 31
RLR Report Individual Retract Limit For Clot Detection:.....31
RML Report Individual Z-Max For Liquid Search Commands: 29
RNT Report Number Of Tips On Arm: 25
RPE Report PMP Error Handling:.....37
RPP Report Plunger Drive Parameter: 34
RPX Report Current Parameter For X-Axis: 27
RPY Report Current Parameter For Y-Axis: 27
RPZ Report Current Parameter For Z-Axis:.....28
RSD Report Presence Lower Diti Eject Option:....25
RSL Report Second LIHA: 25
RSM Report X-Axis Smooth Move Mode:.....32
RSR Report Individual Retract Speed For Clot Detection:.....30
RST Report Lower Diti Eject Logical Positions: 26
RSU Report Stack Usage: 24
RTG Report Optional Tip Guard Status: 28
RTL Report Individual Z-Start For Liquid Search Commands: 29
RTS Report Tip Status Diti:.....32
RTZ Report Z-Axis relative tracking Values:.....31
RVP Report PMP Pressure Value Before and After Detection:.....37
RVZ Report Z-Axis Values And Parameters:.....28
RXT Report Discard Offset (8+1):.....34
RYB Report Y Backlash and Z Positioning Parameter:.....26
RYR Report Y Auto Range in Increments:.....33
RYS Report Minimum Y Space Distance:.....26
RYV Report Syringe Volume:.....35
SAP Set Pressure LLD Parameter (Aspirate Part): 52
SAS Set Scale Adjust Factor For Y- Space Axis Only: 49
SAX Set Scale Adjust Factor For X-Axis: 49
SAY Set Scale Adjust Factor For Y-Axis: 49
SBC Send Broadcast to all Subdevices:.....38
SBK Set Z Drive Brake On or Off (only 8 + 1 Configuration): 51
SBL Set Individual Submerge For Liquid Search Commands: 44
SCC Send Broadcast to Device: 39
SDE Switch Lower Diti Eject On Or Off:.....43
SDL Set Individual Safe Detection Retract Distance For Liquid Search Cmd:.....45
SDM Set Liquid Detection Mode: 46
SDP Set Pressure LLD Parameter (Dispense Part): 53
SDR Set Individual Retract Distance For Clot Detection Commands: 45
SDT Set Diti Discard / Aspirate Parameter: 44
SED Set FLASH-EPROM Data:.....38
SEP Set End Speed for Plungers: 51
SFP Set Force Parameter for all Movements:.....42
SFV Set Serial Number:.....37
SFX Set X-Move Parameters: 47
SFY Set Y-Move Parameters: 47
SFZ Set ZMove Parameters: 48
SGD Set Global Data:.....38
SHS Set Enhanced Speed Setting for EVO75: 51
SHZ Set Individual Z-Travel Height: 41
SKA Set Keep Alive Function:.....39
SLA Set Liquid Detection Acceleration:.....47
SLR Set Individual Limit For Clot Detection Commands: 45
SLX Set New X-Axis Scaling Factor And Motion Direction: 50
SLY Set New Y-Axis Scaling Factor And Motion Direction: 50
SLZ Set New Z-Axis Scaling Factor And Motion Direction: 50
SMC Set All LIHA Axis Move Counter To Zero: ...50
SML Set Individual Z-Max For Liquid Search Commands: 44
SOF Firmware Download: 39
SOX Set Initialization Offset For X-Axis:.....48
SOY Set Initialization Offset For Y-Axis:.....48
SOZ Set Initialization Offset For Z-Axis: 48
SPE Set PMP Error Handling: 53
SPP Set Stop Speed for Plungers: 52
SPS Set Pierce Parameter For Piercing Commands: 42
SRS Reset System (Whole System inclusive this DCU):.....38
SRX Set X-Axis Range: 40
SRY Set Y-Axis Range: 40
SRZ Set All Z-Axis Range: 40
SSD Set Discard Parameter For Diti Commands: 43
SSL Set Search Speed For Liquid Search Commands: 41
SSM Set X-Axis Smooth Move Mode: 49
SSP Set Pick Parameter For Diti Commands: 43
SSR Set Individual Retract Speed For Clot Detection Commands:.....45
SST Set Lower Diti Eject Logical Positions: 43
SSX Set Slow Speed for X-Axis: 41
SSY Set Slow Speed for Y-Axis: 42
SSZ Set Individual Slow Speed For Z1..Z8: 42
STL Set Individual Z-Start For Liquid Search Commands: 44
STP Set Start Speed for Plungers: 52
STZ Set Z-Axis Relative Tracking Distance:.....41
SVP Set Delta Pressure Overrun Limit:.....53
SXT Set Discard Offset (8+1): 51
SYB Set Y Backlash and Z Positioning Parameter: 40
SYS Set Minimum Y-Space Distance:.....39
Txx Pipeline to Slave Device:.....55