MOTOR CONTROL UNIT - NEEDLE AND METERING VALVE DRIVES

MCU-VA VERSION GAL 1.3

USER MANUAL

DCA Instruments Oy
Vajossuonkatu 8
20360 Turku
Finland
+358 2 2382500
www.dca.fi

Version

1.0	original version
1.1	update: analogue control; status indication prior initialization
1.2	update: mechanical torque limiter, revised display contents and status information
1.3	update: emergency jog implemented; minor changes

Table of Contents

1. Safety Information

This system should only be operated by qualified personnel.

When working on the system, electrical safety is a primary concern.

All electrical connections must be checked before switching-on any power supplies.

Power supplies must be turned off before any maintenance.

Description of safety icons:

CAUTION: Users should use caution when performing these actions, incorrect usage may cause damage to the system.

WARNING: High-risk of user injury and system damage if these instructions are not adhered to.

2. General Description

The DCA motorized valve driver for needle and metering valves consists of:

- Stepper motor with differential position encoder
- MCU-VA with HMI, communication interface, digital interface, analog control interface
- Motor cable, sensor cable
- Mains cable
- Handheld control (possibly shared with other MCUs)
- Mounting hardware for the motor
- Optional for metering valves: Torque limiter

The DCA motorized valve drive is specially made for needle and metering valves used on DCA valved sources. It comprises a stepper motor with an integrated differential position encoder for precise and reliable positioning and stall detection. A mechanical torque limiter (TL) is available for metering valve drives. The TL detects the valve's closed position based on a preset closing torque threshold and protects the valve mechanism from over-torquing. The motor control unit (MCU) allows the operation of the valve in either of the following ways:

1. Using the Human Machine Interface (HMI)
   The valve can be virtually continuously adjusted by jogging the motor using the jog-toggle at the controller or handheld control. The MCU features two push buttons for fast positioning to two independently and freely define-able position set-points.

2. Using the Computer Interface (Ethernet), applicable equally with 1)
   The valve can be adjusted to any position set-point given via a simple communication protocol.

3. Using the analog control interface, applicable alternatively to 1) and 2)
   The valve can be adjusted according to an analog control signal ranging 0…+5 VDC.

3. Installation and Drive Maintenance

Never plug/unplug the motor cable with the MCU powered up. Failing to follow this advice may lead to permanent damage of the MCU.

3.1 Mounting the motor

To mount the motor, perform the following steps:

1. Assemble motor / motor with TL, clutch, motor mounting adapter. Watch the bevel at the motor.
2. Tighten the screws securely.
3. When mounting the assembly onto the drive, watch the bevel at the valve-drive shaft to be access-able. Tighten the screws at the clutch securely.
4. Attach the reference switch if applicable.

Do not modify the position of the actuator – it is pre-adjusted. If, for some reason, the actuator or its position has been altered, consult the factory prior to take the drive into operation.

5. Make sure MCU is off. Connect the motor cables.
6. Power up the MCU.
7. Run self-test and initialization procedure (see section 4.3.2).

3.2 Dismounting the motor

The motor with encoder and the reference switch are not bake-able and must be dismounted from the drive prior to baking the system (if applicable).

NOTE

Dismounting the motor with encoder is not required for the Hg source as they are positioned outside of the bake-out area.

1. Switch off the MCU.
2. Disconnect the cables from motor and encoder.

3. Remove the reference switch assembly but re-install the protective cover (if applicable).
4. Remove the motor mounting screws and pull off the motor / motor-and-TL assembly. Ensure the plastic part of the clutch (if applicable) comes off along with the motor as it is not bake-able.

3.3 DRIVE MAINTENANCE

Following the bake-out procedure, it is important to maintain sufficient lubrication of the bearings. DCA recommends MoS_2 containing high temperature lubricants (like C100 by FEL-PRO) for the worm gear and Fomblin® oil or similar for ball screw and bearings.

NOTE

Refer to the Appendices for drive maintenance instructions for the specific sources.

4. Motor Control Unit (MCU) for metering and valve drives

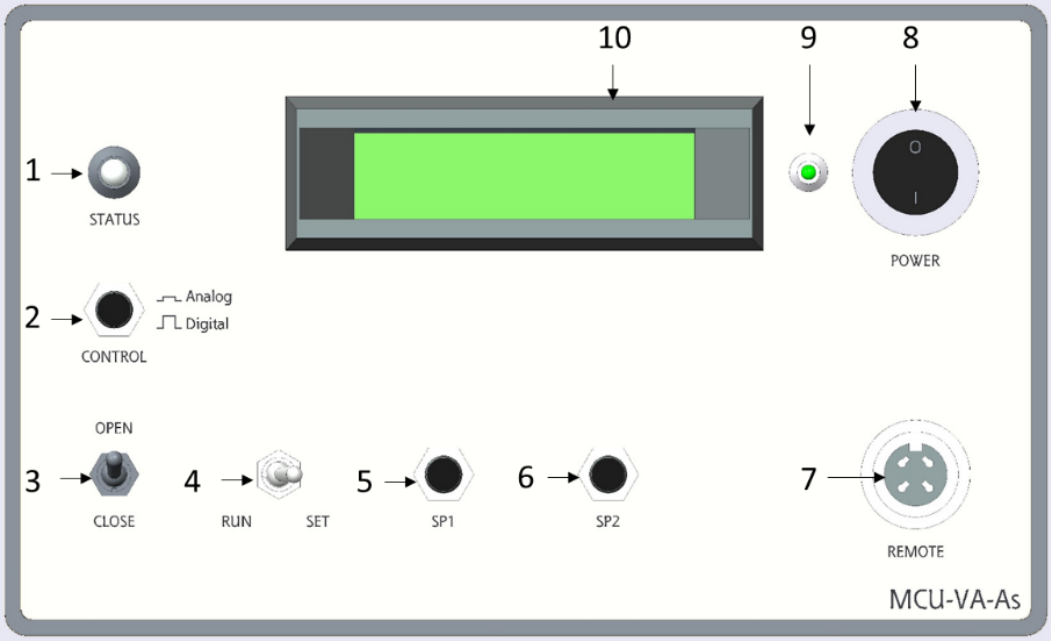


Figure 1: MCU-VA (e.g. As): 1. Status LED, 2. Control mode selector Analog/Digital, 3. Jog toggle Open/Close, 4. Mode toggle Run/Set, 5. Set-point 1 push button, 6. Set-point 2 push button, 7. Socket for handheld control with jog toggle, 8. Main power switch, 9. Power LED, 10. Display.

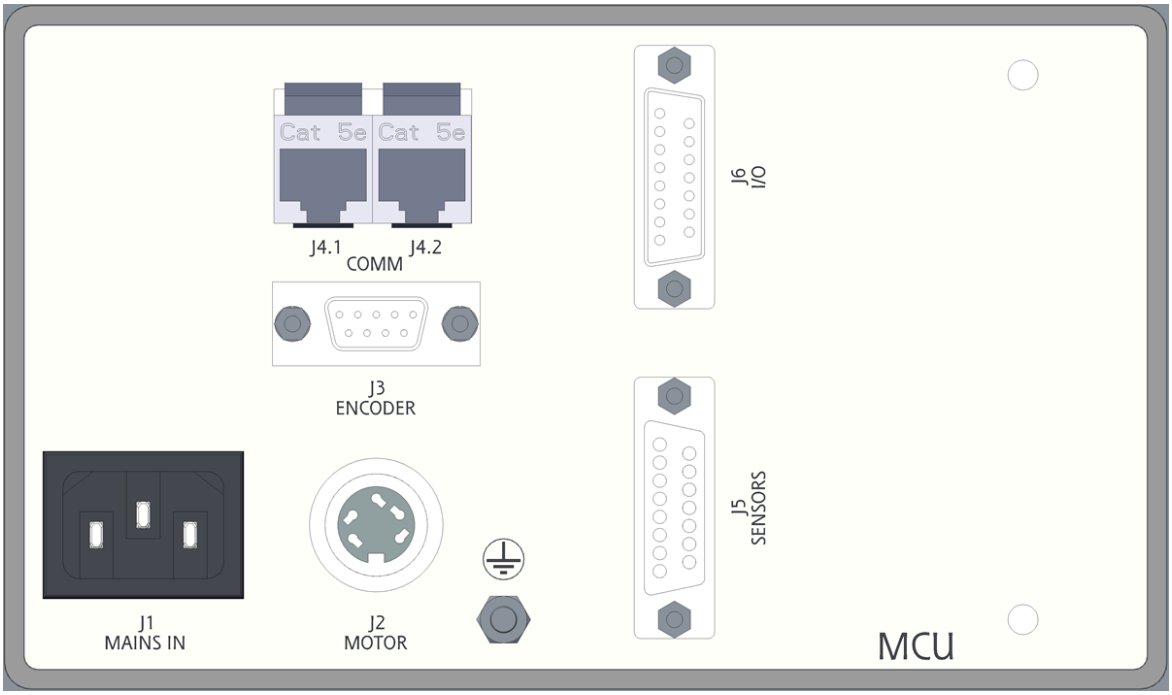


Figure 2: MCU-VA rear panel: J1: Mains (110…240) VAC, J2: Motor Output, J3: Encoder, J4.1/J4.2: Ethernet, J5: Sensors (n/a), J6: I/O.

4.1 FEATURES

The MCU-VA has the following features:

- Supports valve drives of DCA valved sources with stepper motors and differential encoders
- User interface (HMI) for position based valve control
    - Jog toggle for position adjustment
    - Two programmable position set-points
    - Status indication, position read-out
    - Optional handheld remote control
- Digital interlock input
- Configurable: speed, backlash compensation, interlock response
- Input (0…5V) for analog position programming
- Ethernet interface for remote control

4.2 SET-UP

Install stepper motor with differential encoder, valve actuator, and home switch assembly.

With the power switch set OFF, connect motor cable (J2), encoder/sensor cable (J3), I/O cable (J6), mains cable (J1), communication cable (J4) for PC control.

NOTE

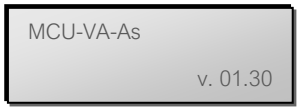
The internal Galil motion controller powers up when main and control voltages (via J6) are applied. The stepper motor output and sensor supply voltage remain off as those are controlled by the POWER switch of the MCU.

Do not open the MCU with the mains cable connected – hazardous voltages are present inside even with the POWER switch being off.

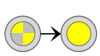
Never plug/unplug the motor cable with the MCU powered up (POWER switch ON). Failing to follow this advice may lead to permanent damage of the MCU.

4.3 LOCAL OPERATION

4.3.1 START-UP

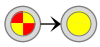
Action	Status indicator	Description	Display
Switch on 'Power'		MCU starts up and runs self-test.	 MCU displays device name and software version during startup. Device name includes specifier according to valve type: here As for needle valve (As cracker cell)
		MCU waits for initialization. Operating any control other than that to start initialization causes the Status LED to flicker red.	

4.3.2 INITIALIZATION

Action	Status indicator	Description	Display
MCU in Digital control mode (RUN).		MCU needs initialization.	 Position reading is invalid.
Operate and hold JOG (CLOSE), release when LED STAT is steady on.		MCU performs Homing sequence. Valve is closed until home switch is triggered and then opened as much as needed to reset the state of the switch (creep off the switch).	

		Then, drive adjusts to preset offset at valve's fully closed position.	R indicates the position read out from the encoder is relative to starting position
		Position reading is reset to 0 and switches from relative (R) to absolute display	Pos_As 0.000 000.0% Valve fully closed. Position reading is referenced to this position.

4.3.3 OFFSET ADJUSTMENT (ADVANCED INITIALIZATION)

Action	Status indicator	Description	Display
MCU in Digital control mode (RUN).		MCU needs initialization.	Pos_As ******* Position reading is invalid.
Press/operate and hold SP1 AND SP2 AND JOG (CLOSE) until the LED STAT is lid steady yellow.	 	The MCU performs the homing sequence. However, at the end, it displays the preset offset (current distance from home switch trip point). *See note below.*	OFFS(e) -0.025* SET
Use JOG to adjust the offset.		Stall detection is disabled during this procedure.	OFFS(e) -0.030* SET Valve without TL: offset is ≤ 0 ('closed' is beyond home switch trip point) Valve with TL: offset is ≥ 0 ('closed' is reached after reversing from home switch trip point).

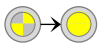
Press SP2 to apply and save the changes		Offset is saved to non-volatile memory. The LED STAT is blinking red/yellow while MCU is busy with that. Position reading is reset to 0.	Pos_As 0.000 000.0% Valve fully closed.

NOTE

For a valve without torque limiter, the offset corresponds to the travel by which the motor shall 'overturn' the home switch trip point in order to reach the valve's 'closed' position (with ref. to a BFM signal for example). Care must be taken not to overtorque the valve mechanism.

For a valve with a torque limiter, the offset corresponds to the travel that is needed to reverse the motor from the home switch trip point in order to release the lever, so that it rests on the base. The 'closing' position is determined by the torque applied when running into the home switch – this depends on the spring load setting. The spring load must be carefully adjusted not to overtorque the valve mechanism.

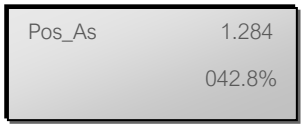
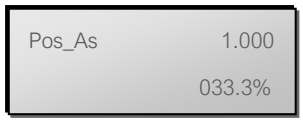
4.3.4 OPERATION WITHOUT INITIALIZATION (EMERGENCY JOG)

Action	Status indicator	Description	Display
MCU in Digital control mode (RUN).		MCU needs initialization.	Pos_As ******* Position reading is invalid.
Press and hold SP1 AND SP2 until the LED STAT is lid steady yellow.		The MCU switches to Emergency Jog Mode.	
Use JOG to move the drive.  CAUTION:		Stall detection and position feedback are disabled in this mode of operation.	Pos_As 0.000R R in position read-out indicates relative measure.

Driving against mechanical limits may cause severe damage to the valve!			
Power down to exit Emergency Jog Mode.			

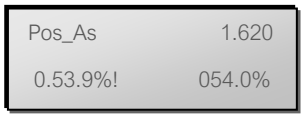
4.3.5 POSITIONING

I. Digital Control Mode

Action	Status indicator	Description	Display
Operate JOG to adjust the valve position.		LED STAT lights up: Yellow - driver is in motion, Red - valve in fully closed position (0) Green - valve in fully open position (according to its set allowed travel). The applied speed is adjustable: see Configuration >jgspd	 Position reading (valve stem displacement): upper line in mm, second line is the percentage of allowed travel.
Press SP1 (SP2) to position the valve at position set-point #1 (#2). Move can be aborted by operating JOG, SP1, or SP2.		LED STAT lights up yellow while the drive is moving. The applied speed is adjustable: see Configuration >mvspd For how to change the position set-point setting: see Configuration >SP1 / SP2	
Operate and hold JOG (CLOSE) AND press SP1 to fully close the valve fast (mvspd applied). Move can be aborted by operating JOG, SP1, or SP2		LED STAT lights up red when Close Position is reached.	

Operate and hold JOG (OPEN) AND press SP2 to fully open the valve fast (mvspd applied). Move can be aborted by operating JOG, SP1, or SP2		LED STAT lights up green when Open Position (according to allowed travel) is reached. The allowed travel is adjustable: see Configuration >Trvl.	

II. Analogue Control Mode

Action	Status indicator	Description	Display
With the Control Mode Selector set to Analog (depressed) all other controls at the HMI are disabled. The Control Mode Selector lights up when Analog position programming is activated.		LED STAT lights up: Yellow - drive is moving, Red - valve in fully closed position (0), Green - valve in fully open position (according to its allowed travel).	 Lower left reading is the spanned relative control signal (ACS). Refer to the Appendices for variables. ACS = (AISc*AIN+AISh)/5V. (AIN being the control voltage between 0 and +5V.) For how to adjust AISc and AISh, see Configuration >AISc/AISh.

See Appendix A Pinout J6 for wiring information for the analog input (J6).

NOTE

The MCU must have been initialized before Analog Control Mode can be applied. If the Control Mode Selector is set to Analog, before initialization, the Status LED flickers red while the control mode indicator flashes.

4.3.6 CONFIGURATION

Action	Status indicator	Description	Display
MCU in Digital control mode, mode toggle in SET. Operate JOG to scroll through configuration menus. Use SP1/SP2 to select the variable to be changed.		In case of an interlock getting active, the MCU will leave the configuration mode.	- - Conf_As - - <jgspd> <mvspd> See appendix for the list of variables
Variable selected. Use JOG to increase/decrease parameter. Press SP1 to discard changes, SP2 to apply and save changes.	 	Hint: By holding SP1 or SP2 for 3 seconds when selecting SP1, SP2 or Trvl for change, the current position reading is copied into the configuration screen. Parameters can be changed within predefined limits. Changes will be internally evaluated before saving. Parameters are saved to non-volatile memory. The LED STAT is blinking red/yellow while MCU is busy with that.	SP1: 0.501* BCK SET * indicates the parameter has been modified.

4.3.7 REMOTE CONTROL

A handshake protocol is implemented in order to allow remote control of the MCU. DCA Instruments provides a software driver to operate the MCU via its Ethernet interface. Refer to the separate DCA Software manual for detailed instructions.

4.3.8 INTERLOCK

Action	Status indicator	Description	Display
When the interlock is activated, the drive is locked at its current position or forced close,		LED STAT flashes: Red/Yellow - while drive is moving.	Pos_As 1.284 (Intl)

depending on the interlock response setting (see configuration >AMvE) but independently from which control mode is selected or from whether or not the MCU is set for configuration.	  	Off/Red - valve is locked at its closed position (0). Red/Off - drive is locked at arbitrary position, Red/Green – drive locked fully open. If in analog control mode, the analog mode indicator is also flashing while the interlock is active.	Interlock active.

See Appendix A for wiring information for the digital interlock input (MCU-enable) at J6.

4.3.9 ERROR

Action	Status indicator	Description	Display
In case an internal error occurs, the MCU stops and displays an error code.		The LED STAT blinks in sequences corresponding to the error code. A homing is required to reset the MCU.	MCU-VA-As Error: 8 See Appendix F for list of error codes.

5. WARRANTY

1. DCA warrants that the MCU-VA will be free from defects in material and workmanship for a period of 12 months from date of shipment.

2. DCA instruments shall incur no liability under this warranty if
    a. The allegedly defective goods are not returned prepaid to DCA instruments within thirty (30) days of the discovery of the alleged defect and in accordance with DCA Instruments' repair procedures; or
    b. DCA instruments' tests disclose that the alleged defect is not due to defects in material or workmanship.

3. DCA Instruments' liability shall be limited to repair or replacements of the defective goods at DCA Instruments' option.

4. DCA Instruments makes no express or implied warranties regarding the quality, merchantability, or fitness for a particular purpose beyond those that appear in the applicable DCA instruments' user's documentation. DCA instruments shall not be responsible for consequential, incidental or punitive damage, including, but not limited to, loss of profits or damages to business or business relations. This warranty is lieu of all other warrantees.

6. CONTACT

DCA Instruments Oy

Head Office and Factory

Vajossuonkatu 8

20360 Turku

Finland

Email: info@dca.fi

Tel: +358 2 2382 500

Appendix A. PINOUT J6

Pinout J6 (Mating connector: Sub-D 15 Female)

Pin	Signal	Remark
1	MCU Power On	IN: Powers MCU's control circuit. 24 VDC, >100 mA must be supplied to power up the MCU.
2	Motor Enable	IN: Enables motor output. To be used for external EMO circuit. 24 VDC must be applied to enable the motor output.
3	n/c	
4	n/c	
5	n/c	
6	n/c	
7	Analog In	Analog input (12-bit resolution) Range: 0…5 V Impedance: 100 KOHM
8	Analog Return (AGND)	Connect 7 and 8 to an external voltage source for analog programming. 7 and 8 bridged by factory default.
9	Reserved	Do not connect
10	MCU Enable	IN: To be used for external interlock circuit. 24 VDC must be applied to enable the MCU.
11	Jog+ (RC)	IN: copy of the remote-control inputs at the front. (24VDC, Active high)
12	Jog- (RC)	
13	Analog Ready	OUT: sourcing 24VDC, 20 mA if analog control mode is active.
14	Reserved	Do not connect
15	DGND	Reference for digital inputs / outputs.

Appendix B. ARSENIC (AS) CRACKER

MCU-VA-AS VARIABLES

Variable	Meaning	Min	Max	Default
JgSpd	Speed applied for jog move (mm/s)	0.005	0.7	0.01
MvSpd	Speed applied for positioning move (mm/s)	0.01	0.7	0.25
SP1	Position setpoint #1 (mm)	0	3.5	0.5
SP2	Position setpoint #2 (mm)	0	3.5	2
Trvl	Allowed travel (mm) Distance between fully closed position (as defined by the offset from home sensor trip point) and open position.	0.35	3.5	3.5
Bklsh	Overshoot for backlash compensation (mm) If greater zero, the drive will overshoot a closing move by this distance before it returns to the target position. Doing so, gear backlash is compensated as any (final) position is always approached from the same side. No Backlash compensation for target position < Bklsh.	0	0.5	0.001
AMvE	Interlock response (auto move enable). If auto move is enabled (AMvE=1), the valve will be closed in case the interlock gets activated. Otherwise the driver will stay at current position. In either case, the MCU is locked until the interlock is reset, all motion commands are refused.	0	1	0
Reset	Reset to factory defaults. If set 1, the MCU will reset all parameters to their factory defaults.	0	1	0
AISc	Factor to span the analog input AIN (0…5V) In analog control mode, the target for positioning is calculated according to: Trvl * (AISc* AIN + AISh) / 5V	0.5	2	1
AISh	Constant to shift the analog input AIN.	-2	2	0
Offs	Offset: To be adjusted during advanced initialization.	0.025	0.3	0.025

DRIVE MAINTENANCE (AS)

Areas that require lubrication after bake-out are highlighted red in Figure 3.

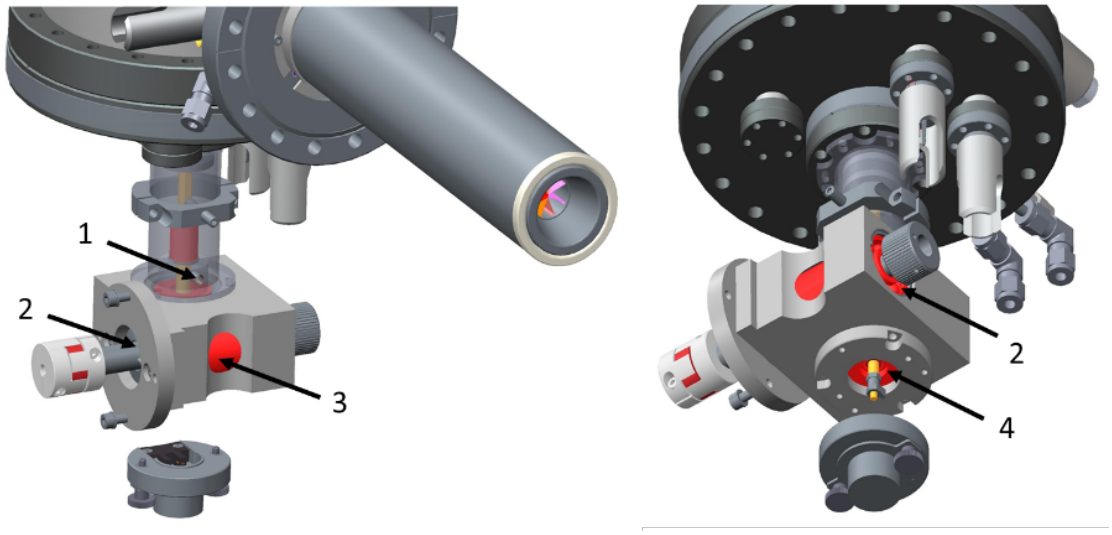


Figure 3: Schematic of the arsenic cracker driving valve. The following parts (highlighted red) require lubrication after bake-out: 1. Linear bearings (accessed via the hole), 2. Radial bearings (x2), 3. Worm gear, 4. Radial bearing.

The linear bearings (part 1, Figure 3) are lubricated through the hole indicated. To access the radial bearing (part 4, Figure 3) the sensor cap must first be removed.

Appendix C. PHOSPHORUS (P) CRACKER

MCU-VA-P VARIABLES

Variable	Meaning	Min	Max	Default
JgSpd	Speed applied for jog move (mm/s)	0.1	3	0.1
MvSpd	Speed applied for positioning move (mm/s)	0.1	3	3
SP1	Position setpoint #1 (mm)	0	3.8	1
SP2	Position setpoint #2 (mm)	0	3.8	2
Trvl	Allowed travel (mm) Distance between fully closed position (as defined by the offset from home sensor trip point) and open position.	0.38	3.8	3.8
Bklsh	Overshoot for backlash compensation (mm) If greater zero, the drive will overshoot a closing move by this distance before it returns to the target position. Doing so, gear backlash is compensated as any (final) position is always approached from the same side. No Backlash compensation for target position < Bklsh.	0	0.5	0.01
AMvE	Interlock response (auto move enable). If auto move is enabled (AMvE=1), the valve will be closed in case the interlock gets activated. Otherwise the driver will stay at current position. In either case, the MCU is locked until the interlock is reset, all motion commands are refused.	0	1	1
Reset	Reset to factory defaults. If set 1, the MCU will reset all parameters to their factory defaults.	0	1	0
AISc	Factor to span the analog input AIN (0…5V) In analog control mode, the target for positioning is calculated according to: Trvl * (AISc* AIN + AISh) / 5V	0.5	2	1
AISh	Constant to shift the analog input AIN.	-2	2	0
Offs	Offset: To be adjusted during advanced initialization.	0.05	0.5	0.05

DRIVE MAINTENANCE (P)

Areas that require lubrication after bake-out are highlighted red in Figure 4.

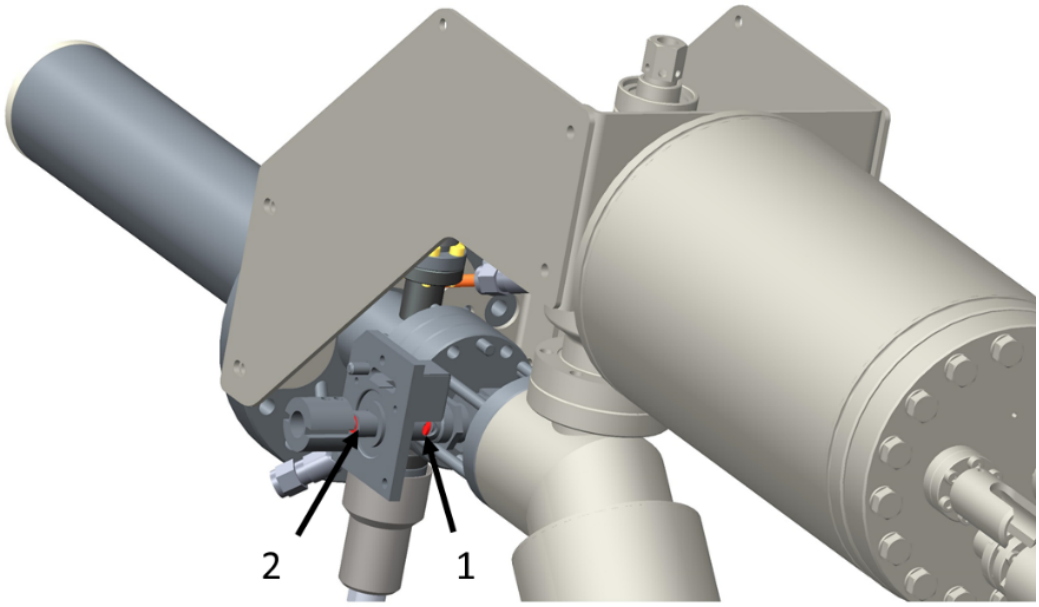
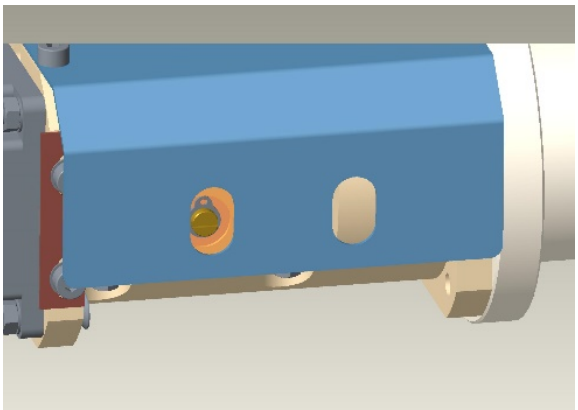


Figure 4: Schematic of the phosphorus cracker driving valve. The following parts (highlighted red) require lubrication after bake-out: 1. Actuator thread and 2. 'Slider' gear.

The actuator thread (position 1, Figure 4), is located beneath the backing jacket, therefore it will need to be removed to provide access.

TORQUE LIMITER

Removing the cover (depicted blue in the figure below) allows access to components of the mechanical torque limiter.



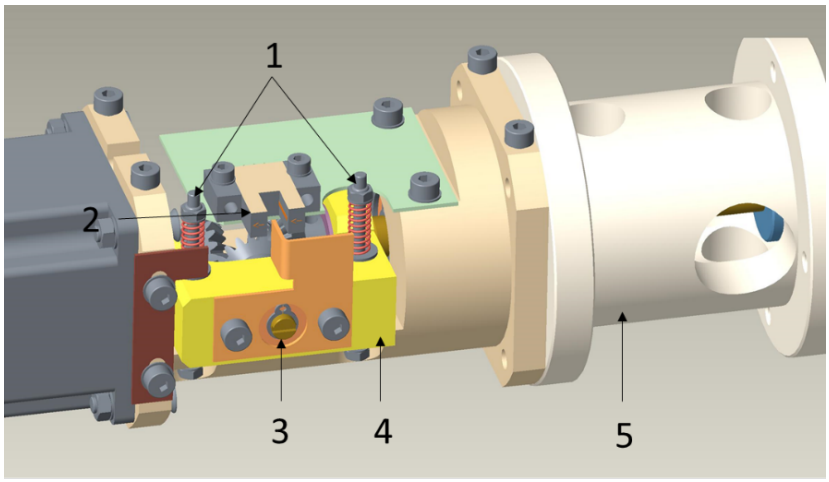


Figure 5: Torque Limiter for metering valves with cover removed, parts labeled: 1. Adjustment springs for torque limiter (1 or 2), 2. Optical switch, 3. Manual valve screw (rotate C/W to close the valve) 4. Lever, 5. Mounting adapter for valve drive.

Areas that require lubrication are highlighted red in Figure 6.

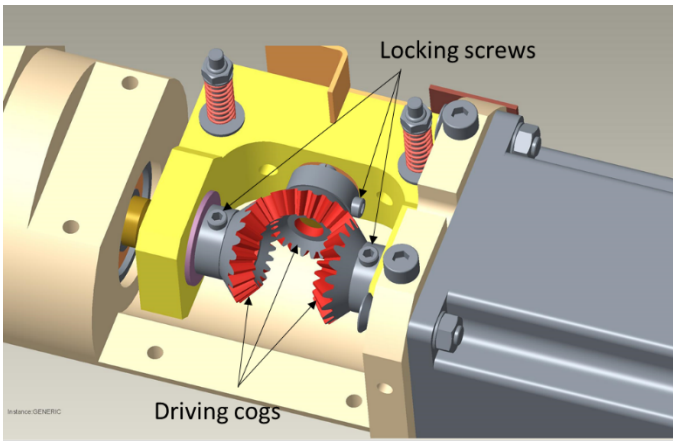


Figure 6: Schematic of the torque limiter with optical sensor removed.

For increasing the closing torque, increase the pre-load of the spring(s) by turning the adjustment nut(s) clockwise. The MCU must be off for this. Note that driving the valve with increased closing torque will reduce the life-time of the valve seat. Per factory default setting, the pre-load can be increased by up to 7 full nut revolutions with the available motor torque.

Appendix D. ANTIMONY (SB) CRACKER

MCU-VA-SB VARIABLES

Variable	Meaning	Min	Max	Default
JgSpd	Speed applied for jog move (mm/s)	0.1	6	0.1
MvSpd	Speed applied for positioning move (mm/s)	0.1	6	1
SP1	Position setpoint #1 (mm)	0	17	1.5
SP2	Position setpoint #2 (mm)	0	17	3.5
Trvl	Allowed travel (mm) Distance between fully closed position (as defined by the offset from home sensor trip point) and open position.	1.7	17	17
Bklsh	Overshoot for backlash compensation (mm) If greater zero, the drive will overshoot a closing move by this distance before it returns to the target position. Doing so, gear backlash is compensated as any (final) position is always approached from the same side. No Backlash compensation for target position < Bklsh.	0	0.5	0.01
AMvE	Interlock response (auto move enable). If auto move is enabled (AMvE=1), the valve will be closed in case the interlock gets activated. Otherwise the driver will stay at current position. In either case, the MCU is locked until the interlock is reset, all motion commands are refused.	0	1	0
Reset	Reset to factory defaults. If set 1, the MCU will reset all parameters to their factory defaults.	0	1	0
AISc	Factor to span the analog input AIN (0…5V) In analog control mode, the target for positioning is calculated according to: Trvl * (AISc* AIN + AISh) / 5V	0.5	2	1
AISh	Constant to shift the analog input AIN.	-2	2	0
Offs	Offset: To be adjusted during advanced initialization.	0.1	1.2	0.1

DRIVE MAINTENANCE (SB)

Areas that require lubrication after bake-out are highlighted red in Figure 5.

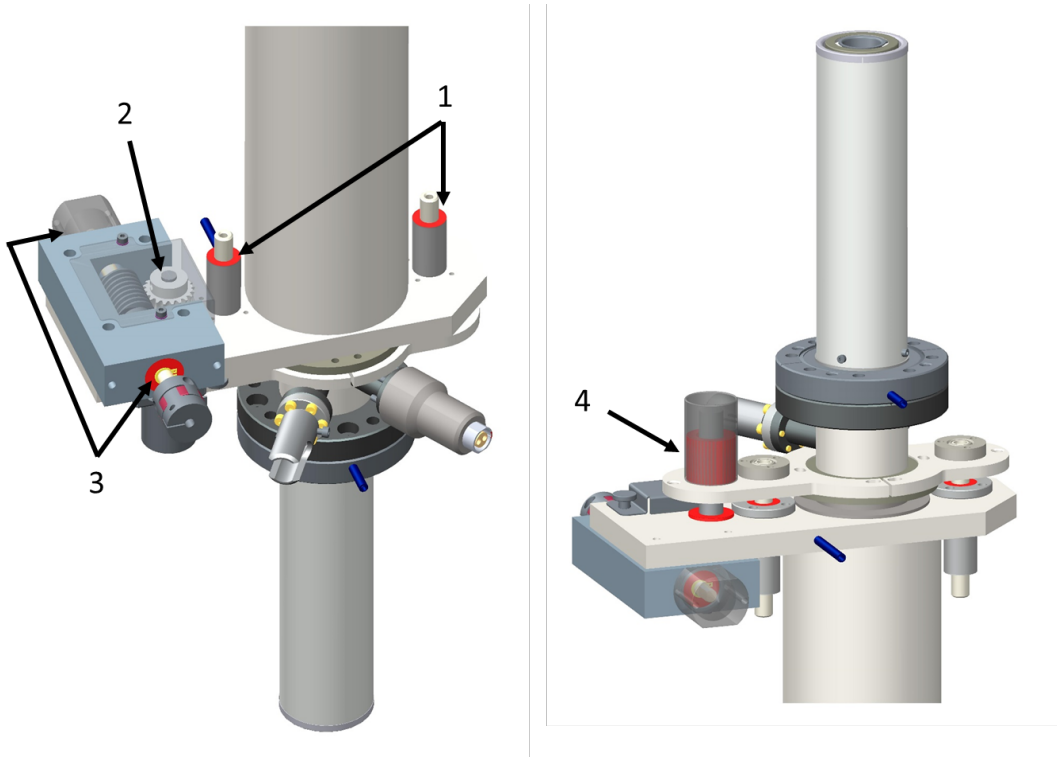


Figure 5: Schematic of the antimony cracker driving valve. The following parts (highlighted red) require lubrication after bake-out: 1. Linear bearings (x2), 2. Worm gear, 3. Radial bearings (x2), 4. Ball screw.

To access the second radial bearing (part. 3, Figure 5), the cover must first be removed.

Appendix E. MERCURY (HG) SOURCE

MCU-VA-HG VARIABLES

Variable	Meaning	Min	Max	Default
JgSpd	Speed applied for jog move (mm/s)	0.005	1.5	0.01
MvSpd	Speed applied for positioning move (mm/s)	0.01	1.5	0.25
SP1	Position setpoint #1 (mm)	0	Trvl	0.5
SP2	Position setpoint #2 (mm)	0	Trvl	2.0
Trvl	Allowed travel (mm) Distance between fully closed position (as defined by the offset from home sensor trip point) and open position.	0.38	3.8	3.8
Bklsh	Overshoot for backlash compensation (mm) If non-zero, the drive will overshoot a closing move by this distance before it returns to the target position. Doing so, gear backlash is compensated as any (final) position is always approached from the same side. No Backlash compensation for target position < Bklsh (this applies to drives w/o TL only). The Bklsh is entered as negative value, backlash compensation is enabled in analog mode too (may improve regulation performance)	-0.5	0.5	0.025
AMvE	Interlock response (auto move enable). If auto move is enabled (AMvE=1), the valve will be closed in case the interlock gets activated. Otherwise the driver will stay at current position. In either case, the MCU is locked until the interlock is reset, all motion commands are refused.	0	1	1
Reset	Reset to factory defaults. If set 1, the MCU will reset all parameters to their factory defaults.	0	1	0
AISc	Factor to span the analog input AIN (0…5V) In analog control mode, the target for positioning is calculated according to: Trvl * (AISc* AIN + AISh) / 5V	0.5	2	1
AISh	Constant to shift the analog input AIN.	-2	2	0
Offs	Offset: To be adjusted during advanced initialization.	0	0.125	0.025

SCHEMATICS OF DRIVE

Figure below show the schematics of the mercury source valve drive,

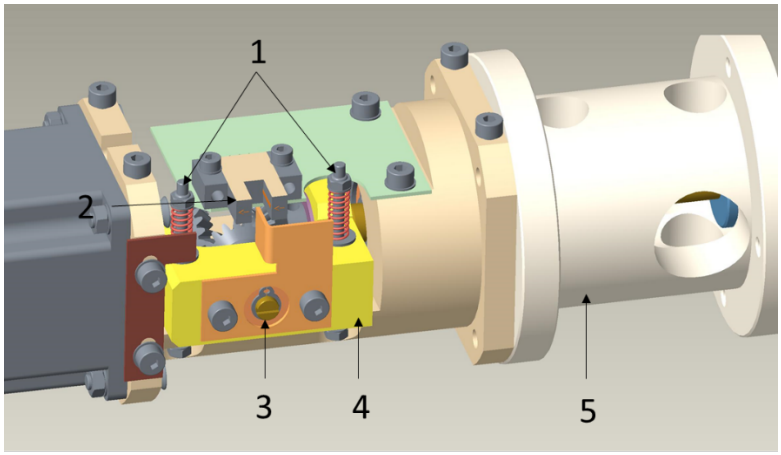


Figure 6: Valve drive for Hg Source with outer cover removed, parts labeled: 1. Adjustment springs for torque limiter, 2. Optical switch, 3. Manual valve screw (C/W close) 4. Torque limiter swing ,6. Thermal insulator connection to Hg source.

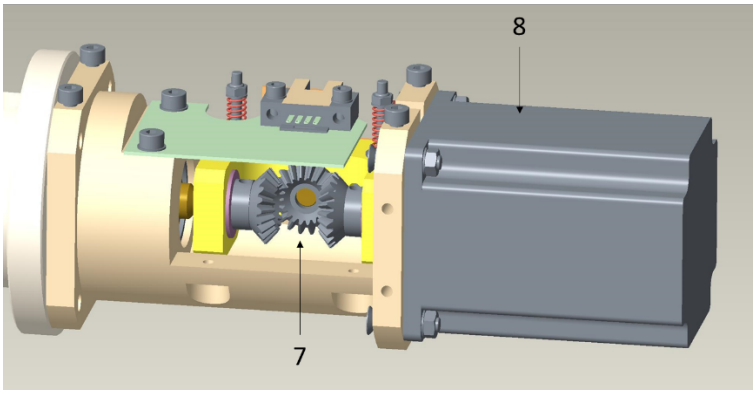


Figure 7: Valve drive for Hg Source with outer cover removed, parts labeled: 7. Driving cog wheels, 8. Stepper motor.

Figure 8: A spare spring (with greater stiffness) and spring constants are provided. These allow the user to increase the tightness of the valve seal.

DRIVE MAINTENANCE (HG)

The mercury source is treated with light lubrication (Rocol grease) at the DCA factory.

Areas that require lubrication after bake-out are highlighted red in Figure 9Figure 5.

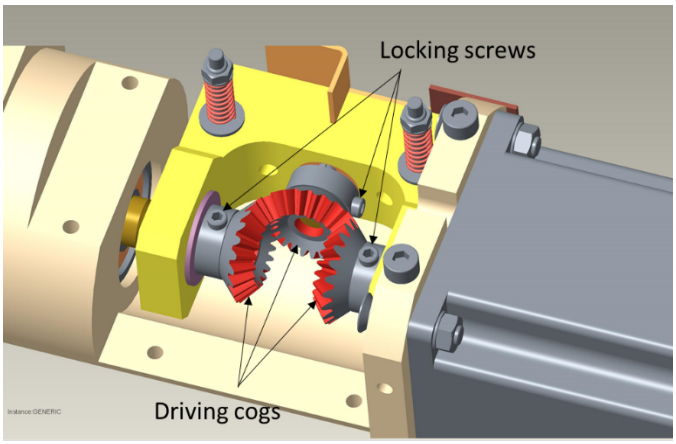


Figure 9: Schematic of the mercury source driving valve. Cogs (highlighted red) indicate region that requires light lubrication. The three locking screws for the cogs are also shown.

To ensure the cog wheels do not become loose, it is advisable to check and tighten if necessary, the three locking screws shown in Figure 9.

Appendix F. LIST OF ERROR CODES (MOST RELEVANT)

Code	Meaning	Remarks
5	Home sensor not found	The home sensor is found staying inactive while the driver tries to change its state during the initial closing move. Check the sensor and its wiring. The indicator at the optical through-beam switch should change its state when blocking/unblocking the beam.
6	Can't creep off from Home sensor	The home sensor is found staying active while the driver tries to free the switch during the creep-off step of the homing sequence. See above.
8	Stall detected	Internal motor step clock and encoder counter mismatch. While this could be due to an encoder wiring problem or encoder failure, it may indicate a mechanical problem of the valve or the drive. Check the wiring of the encoder. Check the valve and the drive for mechanical issues. Drive with TL: error is triggered by the home switch being activated unexpectedly while closing the valve (Torque limit exceeded) Consult DCA if the error persists.
10	Positioning error	May be triggered because of a hardware failure of the indexer. Consult the factory.
26	Hardware failure	Consult DCA factory
27	Stop code generator not started	Internal logic error. This error can be triggered in case of an interlock being active while AMvE=1 and the MCU having not finished the homing sequence - to be ignored in this case.

NOTES: