General

The RMS gap controller is designed to regulate the plate gap so it corresponds to the set point value. The regulation is proportional so an error will be corrected in one regulation. Several other functions to increase plate protection is included making it a dedicated controller for a pulp refiner.
This manual covers both the DCU-RM1 (RMS-SD) and the DCU-RM2 (RMS-CD).

There is a single controller for the RMS-SD system (DCU-RM1) and the rotor position is controlled through a electrical stepping motor.

The RMS-CD system (DCU-RM2) includes two controllers, one for the CD zone (moves the rotor position) and one for the flat zone (moves the stator). The controllers are integrated in the way that when the rotor is moved to correct the CD zone gap, the stator is also moved to maintain a constant flat zone gap. The speed of the movement of the rotor can be adjusted so it corresponds to the moving speed of the stator. At a 1.00 mm movement of the rotor, the CD-zone will change 0.25 mm while the flat zone will change 1.00 mm. A 1.0 mm change of the stator will change the flat zone gap 1.00 mm while the CD cone gap is unaffected.

GapGuard. ”Faster than the gap controller but much less dramatic than a FeedGuard”.
The GapGuard is an additional function to speed up the controller and thereby avoid the production disturbances that will follow when the TDC value reaches the “min-min-limit” and causing a FeedGuard. The GapGuard is integrated in the controller but have its own menu for the parameter settings. The GapGuard is described in the end of this manual.

Following gap controller parameters is set from the DCU unit.

Parameter	*Abb.*	*Min*	*Default*	*Max*	*Step*	*Sort*	*Comment*
DEADBAND	DB	0.01	0.05	0.25	0.01	mm	
INTERVAL	INT	2	10	20	1	s	
GAIN	GAIN	40	100	120	5	%	
FILTER	FILT	1	5	10	1	s	only DCU-RM2
FF TOGETHER	FFT	10	100	100	10	%	only DCU-RM2
FF APART	FFA	10	100	100	10	%	only DCU-RM2
GEAR PLAY	GRP	0.00	0.00	0.30	0.01	mm	
OVER ALARM	OA	5/0.00	50	95/1.00	5/0.05	%/mm	
SPEED LIM.	SP	0.02	0.10	1.00	0.02	mm/min	
UNDER ALARM	UA	5	10	20	1	step	

Dametric AB
Box 120
SE-127 23 SKÄRHOLMEN
SWEDEN

Delivery address
Jägerhorns väg 19
SE-141 75 KUNGENS KURVA
SWEDEN

Phone
+46-8 556 477 00
E-mail: info@dametric.se

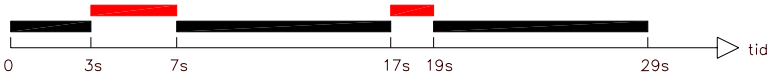
Telefax
+46-8 556 477 29

DEADBAND

A "band" below and above the SPV and there will no regulation if the error is within this band.
If (SPV - DB) <= TDC <= (SPV + DB) there will be no regulation.
Ex. SPV = 1.00, DB = ± 0.03 ⇒ ” the band” = 0.97 - 1.03 mm.
The parameter should be adjusted depending of the stability in the process and prevent that the stepping motor is working constantly.

INTERVAL

The time between each gap to setpoint evaluation. The first regulation starts 3 sec after the controller is activated and the following intervals starts after the previous action is completed.



0s = the controller is started, 3s = regulation for 4s, 7s = interval 10s,
17s = regulation for 2s, 19s = interval 10s, 29s = interval 10s (no regulation)
If a regulation activity is due, the correction signal is calculated:
CORR = SPV - TDC.
If SPV > TDC ⇒ run the discs apart, if SPV < TDC ⇒ run them together.

GAIN

The gain factor. The correction value (the regulating distance) is the TDC value minus the set point value. The correction value is multiplied with the GAIN factor to be able to compensate (over or under) the actual regulating distance. At a GAIN factor of 100% there is no compensation.
Ex. GAIN = 50%, SPV = 1.00, TDC = 1.50 ⇒ ERR = 0.50,
regulating distance = ERR * GAIN = 0.25, the TDC value after a regulation is then 1.25 mm.

FILTER

The FILTER parameter sets the number of TDC-values that is used for the mean value. If FILTER = 4, the mean value is the four last measured TDC-values before a regulation evaluation is calculated.
To eliminate the risk of self-oscillation, the FILER setting is limited to half of the INTERVAL.

FF TOGETHER

The FEED FORWARD TOGETHER parameter is only used in the flat zone controller in the DCU-RM2 (RMS-CD) system.
When the CD-zone controller is moving the CD discs together by moving the rotor, the flat-zone controller must move apart the stator to compensate for the rotor movement. The compensation distance can be modified by the FEED FORWARD TOGETHER factor. A setting of 100 % means full compensation while lower settings will give less compensation and thereby a lower flat zone gap.
This error in the flat zone gap will however be corrected at the next regulation activity.

FF APART

The FEED FORWARD APART parameter is only used in the flat zone controller in the DCU-RM2 (RMS-CD) system.
When the CD-zone controller is moving the CD discs apart by moving the rotor, the flat-zone controller must move the stator together to compensate for the rotor movement. The compensation distance can be modified by the FEED FORWARD APART factor. A setting of 100 % means full

compensation while lower settings will give less compensation and thereby a higher flat zone gap. This error in the flat zone gap will however be corrected at the next regulation activity.

GEAR PLAY

The GEAR PLAY parameter is only used in the flat zone controller in the DCU-RM2 (RMS-CD) and in the DCU-RM3 unit for RMS-SD2 system.
The parameter is used to compensate for the gear box play for the flat zone movement when the direction is changed.
If the GRP is set to 0.02, the flat zone controller will add 0.02 to the regulating distance when the direction is changed relative the previous movement.
The play must be measured when the refiner is loaded which should give a lower play as to when the refiner is idling.

OVER ALARM

This is a safety function and is designed to prevent the plates from clashing if the TDC-sensor is indicating a faulty high value. (a faulty TDC-sensor or loss of some segment bars). OA is the maximum allowed distance of regulations of the disc together. The distance parameter can be set as a percent of the set point or as an absolute value in mm (0.00 means that the function is disconnected).
A counter is reset when the controller is activated (or the set point value is changed more than 0.03mm without an over alarm) and will then monitor the regulation activities together (increases the counter) and apart (decreases the counter).
When the counter adds up (more together than apart actions) and passes the set OA distance an over alarm is generated. From this point the controller is prevented from bringing the plates together but can still bring them apart. See more details under ALARM below.
The alarm must be reset on the DCU-unit.

SPEED LIMIT

The over alarm counter is decreased with a low frequency clock signal (SPEED LIM.) to enable changes due to the heat expansion of the refiner or plate wear during production without generating an over alarm.

UNDER ALARM

This is a safety function and is designed to track if the controller is not working properly. The UNDER ALARM function will detect if the TDC value does not reach the set point value after a set number of consecutive regulation actions. This will happen if the control equipment for the rotor or stator movement fails. A counter is incremented at each interval and is reset if the TDC-value is within or passes the deadband. If the counter passes the set value, the controller is stopped and an alarm is generated. The alarm must be reset on the DCU-unit.

SET POINT ALARM

The Set point alarm is activated if the set point value is at or below 0.00 mm or higher than the range of the DCA (2.00 or 3.00 mm). An alarm will force the gap controller to the off state, the alarm must be acknowledged on the DCU-unit and thereafter the controller can be started again.

CONTROLLER ALARMS

There are three types of gap controller alarm, OVER ALARM, UNDER ALARM and SET POINT ALARM. They all has to be acknowledged by pushing in the ENTER button on the DCU-unit. This will happen after an alarm:
OVER ALARM. The gap controller is still active but can not bring the plates further together. It is however possible to bring the plates apart if the set point value is higher than the actual DCA value. The GapGuard is also working to bring the plates apart. The suggested action is of course to read the alarm type and then reset the alarm as soon as possible to minimize process variations.
UNDER ALARM. The gap controller is shut off.
SET POINT ALARM. The gap controller is shut off.
DO+DCRAL is the digital output for the gap controller. It is normally high and will drop low at a gap controller alarm. The output remains low until the alarm is acknowledged by pressing the ENTER button on the DCU unit.
DI+DCRON is the digital input which will enable the controller (high level). It is triggered by the positive edge of the input when switching from low to high level. For the CD system there are two inputs, DI+DCROc for CD-zone and DI+DCROf for flat zone.

GapGuard

The GapGuard is an additional function to speed up the controller and thereby avoid the production disturbances that will follow when the TDC value reaches the “min-min-limit” and causing a FeedGuard. The GapGuard function continuously measure the flat-zone and cd-zone gap and compares it with respective set point. If the difference is larger than a set parameter, the DCU will start the GapGuard retraction. That means that the stepping motor, which controls the rotor position, will go apart at high speed. The distance it will run is proportional to the actual difference between the gap and the set point for the zone that triggered the GapGuard.

After a GapGuard is fired the DCU will continue regulate as usual with the first regulation a full regulation interval after the GapGuard has finished. A GapGuard also resets the over alarm and under alarm counters for both cd- and flat zone. The first regulation after a GapGuard doesn’t affect the overalarm counter.

The GapGuard is active while the gap controller is active. It means that is active even when an over alarm has occurred.

This is the principal differences between the GapGuard and the controller:

- The GapGuard will work continuously (not controlled by the interval setting) and is therefore much faster than the controller
- The GapGuard is crossed, which means that a change in the flat zone gap will affect the rotor instead of the stator (only applies on CD refiners). A change in the cd-zone gap will also affect the rotor.
- The GapGuard works single-sided in the way that it and can only work to increase the TDC-gap.
- The GapGuard will move the rotor at high speed (0.25 mm/s) instead of at low speed (0.05 mm/s).

GapGuard parameters

TIME This setting determines the minimum time between two consecutive GapGuards in seconds. It is needed because of the filter time at the TDC-readings. Time is adjustable to less than half of the interval time (1-4 s when the controller interval is 10s). The default setting is 2s

DEVIATE FL GapGuard is constantly checking the difference between the actual reading and the set point. This difference is then compared to the DEVIATE FL setting. GapGuard triggers if the difference is larger than the DEVIATE FL setting and the stepping motor starts going apart at high speed.
E.g. if the set point is 0.8 mm and DEVIATE FL is set to 0.20 mm, gap guard will be fired if the flat-zone gap falls under 0.60 mm. You can also chose DEVIATE FL to be a percentage of the set point. In the example above, with set point set to 0.8 mm and DEVIATE FL equals to 0.20 mm, a setting of 25% will do the same job. The range of the DEVIATE FL setting is from 1% to 99%. If you exceed 99% the setting will show in mm and is adjustable between 0.00 mm and 1.00 mm. Default is 25%. The GapGuard is not used if set to 0.00 mm.

DEVIATE CD DEVIATE CD works in the same way as DEVIATE FL but uses the cd-zone set point and cd-zone gap.

GAIN FLAT If GapGuard is triggered because a to small flat zone gap, the distance that the stepping motor runs is proportional to the difference between the actual flat zone reading and the flat zone set point. The difference is then multiplied with the GAIN FLAT setting. If you see that GapGuard always compensates too much, you can lower the gain and minimize the recovery time after a GapGuard. In the same way if the first flat zone regulation after a GapGuard always is apart, you could rise GAIN FLAT a bit. GAIN FLAT could be changed in the interval of 25% and 250% with the default setting of 100%.

GAIN CD GAIN CD works in the same way as GAIN FLAT but uses the cd-zone set point and cd-zone gap and therefore is multiplied to the difference between cd-zone gap and cd-zone set point.

The following Gap Guard -parameters is set from the DCU-RM2 unit.

Parameter	*Abb.*	*Min*	*Default*	*Max*	*Step*	*Sort*	*Comment*
TIME	TIME	1	2	4	1	s	
DEVIATE CD	DEV.CD	0.00	25 %	1.00	0.01	mm (or in % of SPV)	
DEVIATE FLAT	DEV.FL	0.00	25 %	1.00	0.01	mm (or in % of SPV)	
GAIN CD	GAIN CD	25	100	250	5	%	
GAIN FLAT	GAIN FLAT	25	100	250	5	%	

Revision

Oct. 10, 2005/BL: Uppdated the events after the gap controller alarms.