EVAC

Knorr – Bremse India

EVAC- Vacuum Toilet System for Vande-Metro Train.

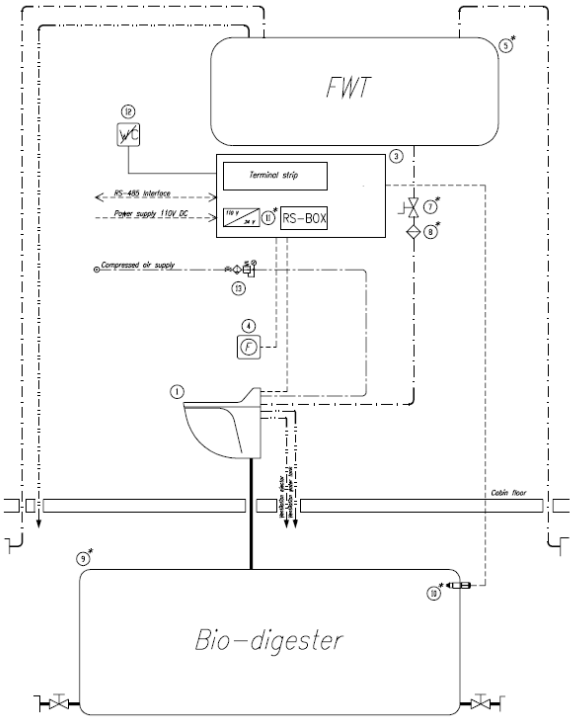
System Engineering
Friday, 07th March 2025

Agenda

Section 1	■ System Overview
Section 2	■ Main components
Section 3	■ Functional Principle
Section 4	■ Preventive Maintenance
Section 5	■ Troubleshooting
Section 6	■ Service Tool

Section 1: System Overview

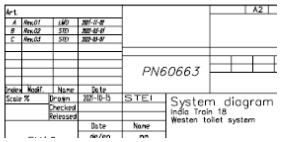
System Configuration western toilet (for reference only)



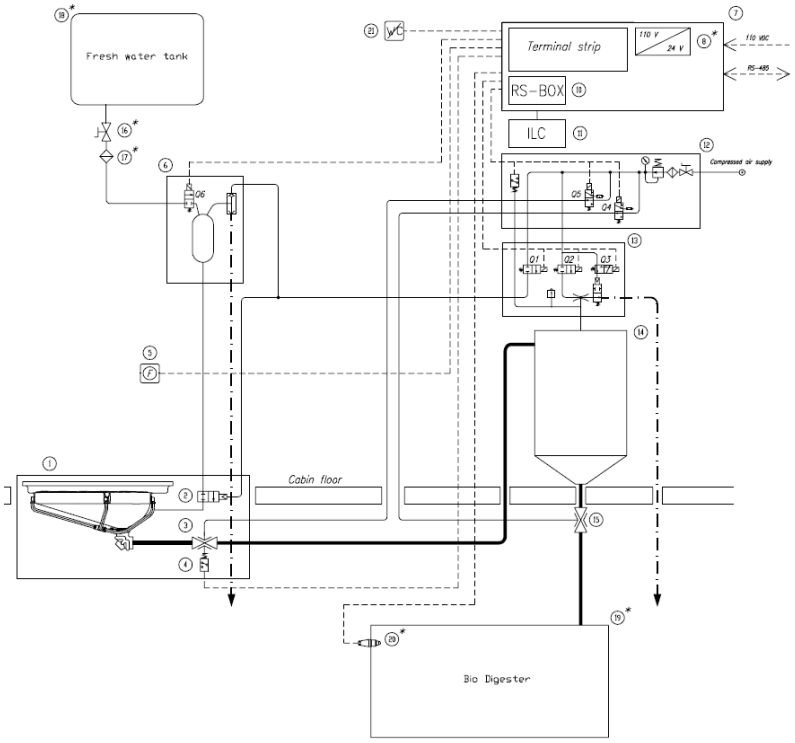
No	Denotation
1	Vacuum toilet western type
3	Control panel with display
4	Push button for toilet flush
5	Fresh water tank *
7	Maintenance ball valve *
8	Water filter 200µm *
9	Bio-digester tank *
10	Liquid level guard WWT * (highly recommended)
11	DC/DC converter *
12	Out of order indicator
13	Filter pressure regulator

* not EVAC scope of supply

Caption:
- Electrical line
- Compressed air pipe
- Fresh water pipe
- Ventilation pipe
- Waste water pipe



System Configuration squatting toilet (for reference only)



No	Denotation
1	Toilet bowl squatting type
2	Rinsing valve
3	Inlet pinch valve
4	Pressure switch inlet pinch valve
5	Flush button
6	Water pressurizer panel
7	Control panel
8	DC/DC converter *
.	.
10	RS-Box
11	ILC microcontroller
12	Pneumatic control panel
13	Vacuum pump unit
14	Transfer tank
15	Outlet pinch valve
16	Maintenance ball valve *
17	Water strainer 200µm *
18	Fresh water tank *
19	Bio-digester tank *
20	Liquid level guard WWT *
21	Out of order indicator

* not EVAC scope of supply

Caption:
- Electrical line
- Compressed air pipe
- Fresh water pipe
- Ventilation pipe
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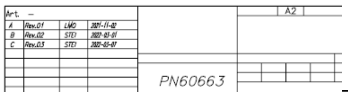


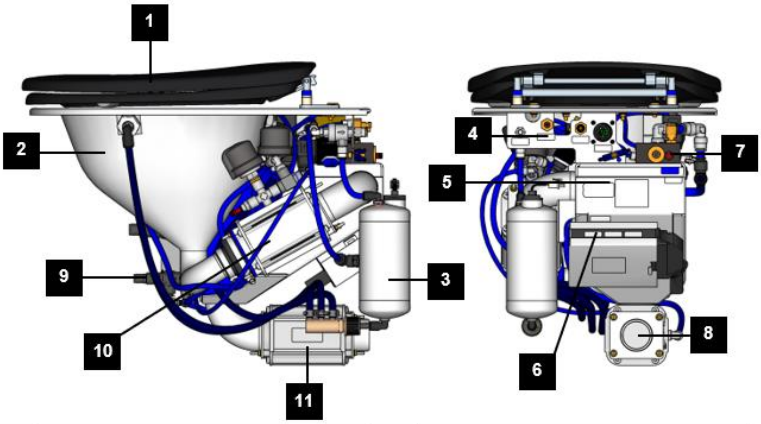
Water is supplied to the vacuum toilet from the coach fresh water tank through a water filter in the flush water tank.
The water is stored in the flush water tank until a flush sequence is started.

Compressed air supplied from the train via a filter/pressure regulator to the vacuum toilet.

Waste water is transported to the waste water (bio-digester) tank. The ejector exhaust from the vacuum toilet is connected to the outside of the coach, as well as the flush water tank venting.

Section 2: Main Components

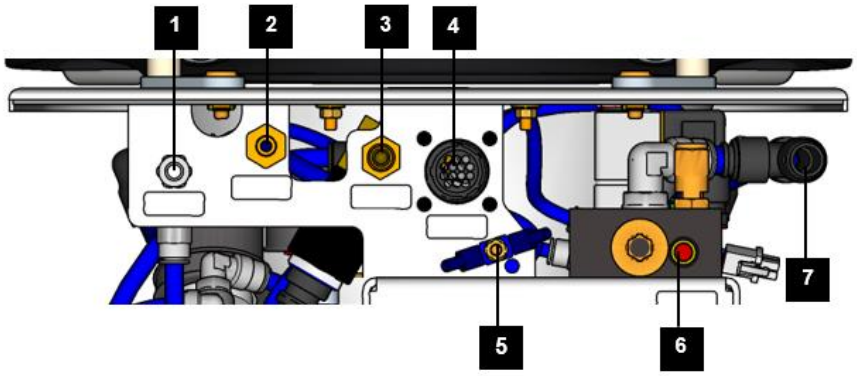
Western type toilet



1	WC seat and cover	2	Toilet bowl
3	Flush water tank	4	Connection panel
5	Intermediate tank	6	Control unit
7	Vacuum pump	8	Outlet
9	Ejector	10	Inlet pinch valve
11	Outlet pinch valve		

Figure 1: Vacuum toilet – QVT-H-C-W0-ICF

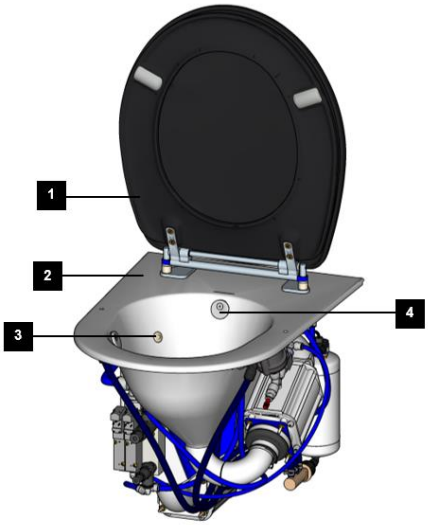
Western Toilet - Interface



1	Compressed air output Ø 8 mm	2	Compressed air input DN5
3	Water input DN7.2	4	Electrical connection
5	Grounding	6	Test connection Ø 6 mm
7	Compressed air Ø 12 mm		

Figure 2: Interfaces – QVT-H-C-W0-ICF

Toilet Bowl



1	Toilet seat with hinge	2	Toilet Bowl
3	Liquid level guard	4	Flush nozzles (3x)

Figure 3: Toilet bowl

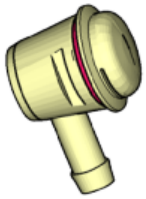


Figure 5: Flush Nozzle (for reference only)

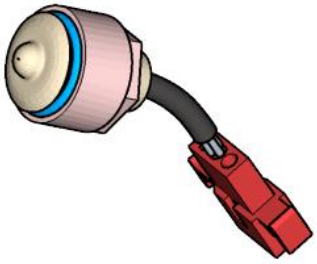
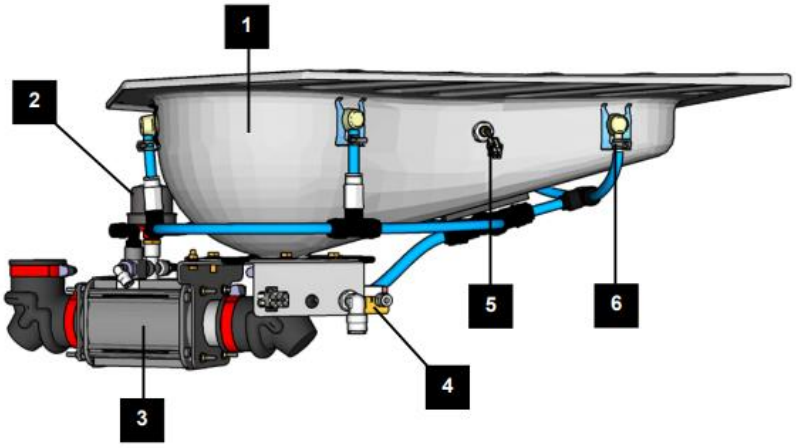


Figure 6: Liquid Level Guard (for reference only)

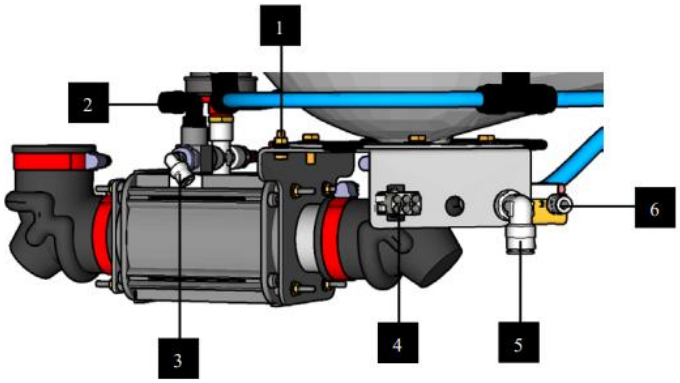
Squatting/ Indian type toilet



1	Bowl Unit	2	Pressure Guard
3	Pinch Valve	4	Water Inlet Valve
5	Liquid Level Guard	6	Flush Nozzle (5x)

Figure 2: Squatting Toilet (for reference only)

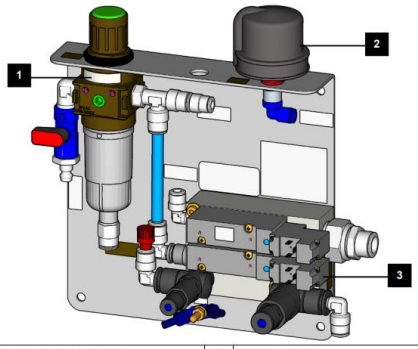
Squatting Toilet - Interfaces



1	Grounding Connection M5	2	Pinch Valve to Ejector Ø 8 mm
3	Pressure Switch to Ejector Ø 6 mm	4	Mini Mate-N-Lok, 4 pol
5	Water Inlet Ø 12 mm	6	Compressed Air Inlet Ø 6 mm

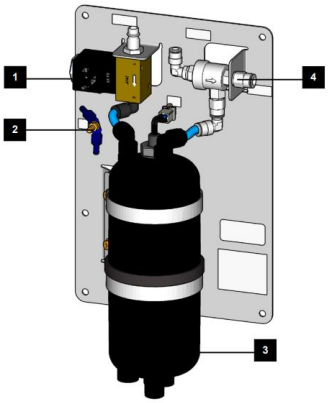
Figure 3: Interfaces – Squatting Toilet (for reference only)

Squatting Toilet – System units



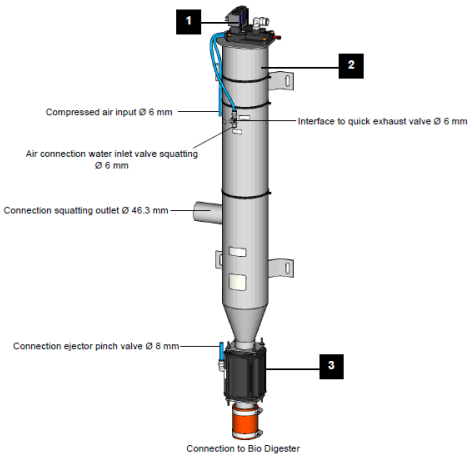
1	Filter Pressure Regulator	2	Pressure Guard
3	Ejector		

Figure 14: Pneumatic Panel (for reference only)



1	Water Inlet Valve	2	Grounding M5
3	Flush Water Tank	4	Quick Exhaust Valve

Figure 12: Water System Panel (for reference only)



1	Vacuum pump	2	Base unit
3	Pinch valve DN40		

Figure 8: Base unit (for reference only)

Toilet sub components

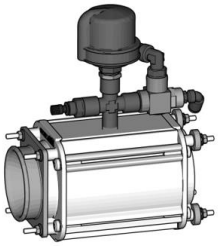


Figure 5: Inlet pinch valve with pressure guard (for reference only)

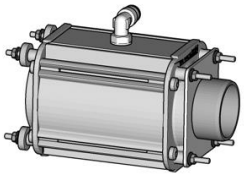
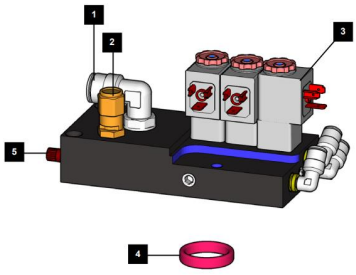
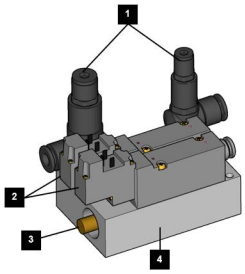


Figure 6: Outlet pinch valve (for reference only)



1	Compressed Air Output Ø 12 mm	2	Safety Valve
3	Solenoid Valves (3x)	4	Gasket
5	Test Connection Ø 6 mm		

Figure 10: Vacuum Pump (for reference only)



1	Solenoid valve (2x)	2	Pressure regulator valve (2x)
3	Silencer	4	Ejector housing

Figure 9: Ejector (for reference only)

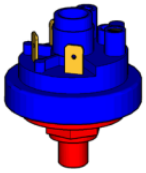


Figure 8: Pressure Guard (for reference only)

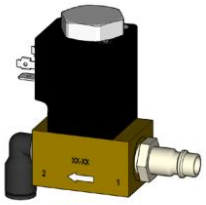
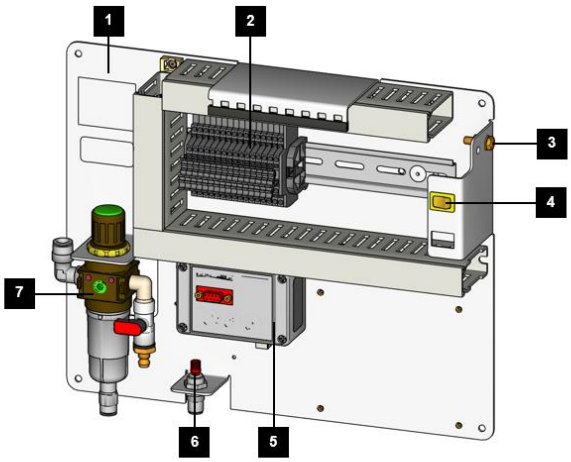


Figure 13: Water Inlet Valve (for reference only)

Control panels

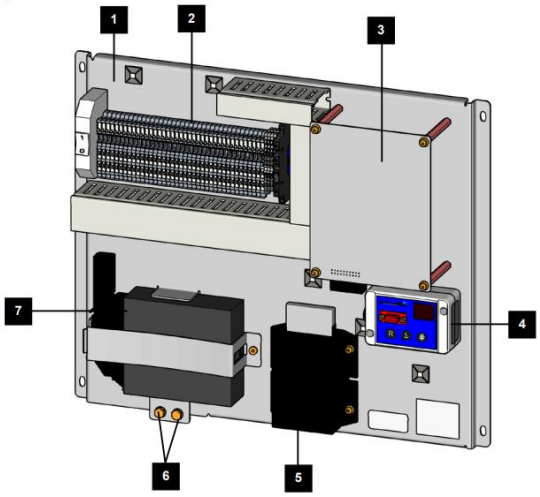
- Western toilet system



1	Base plate	2	Terminal strip
3	Earth connection	4	Freeze drain switch
5	RS-box	6	Test conduit
7	Filter pressure regulator		

Figure 10: Control board

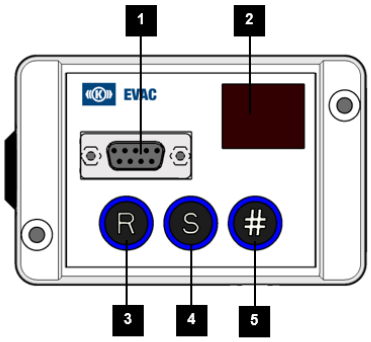
- Squatting/ Indian toilet system



1	Terminal strip	2	Terminal Strip
3	LED Board	4	RS-Box
5	DC/DC Converter	6	Grounding (2x)
7	Standard Toilet Controller		

Figure 17: Control Board (for reference only)

RS box



1	Sub-D interface (9-pol)	2	System status indication
3	Button «R»	4	Button «S»
5	Button «#»		

Figure 11: RS-Box

System status report

-Reverse flush button «R»

-Service flush button «S» (Flush without water)

-Button «#» (reserved)

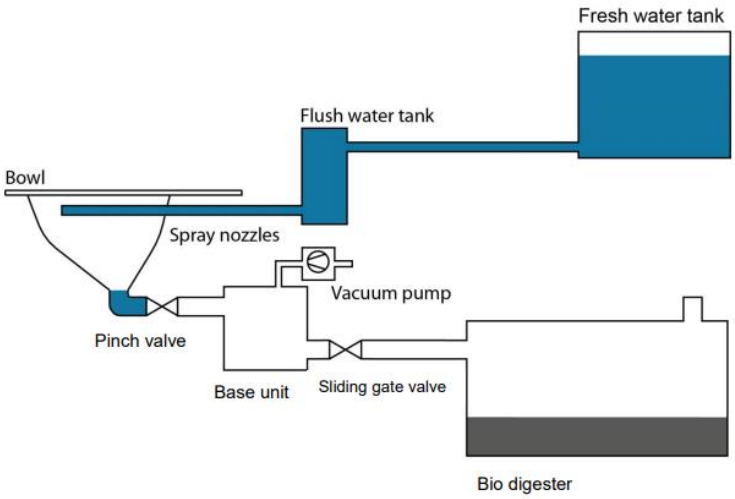
-Sub-D connector (9-pole) for MT service terminal or RS232 Interface for PC

Section 3: Functional Principle

System Stand-By

In stand-by the toilet bowl is filled with an initial water supply, the flush water tank on the water system panel is filled up and the base unit is empty.

Inlet Pinch valve and outlet Pinch valve/ sliding gate valve are closed and the LED on the flush button illuminates permanently.



1. Flushing the bowl and evacuating the intermediate tank (base unit)

The flush button is pressed, the LED on the flush button begins to flash and the toilet starts the flush cycle. The complete cycle takes approx. 25 seconds.

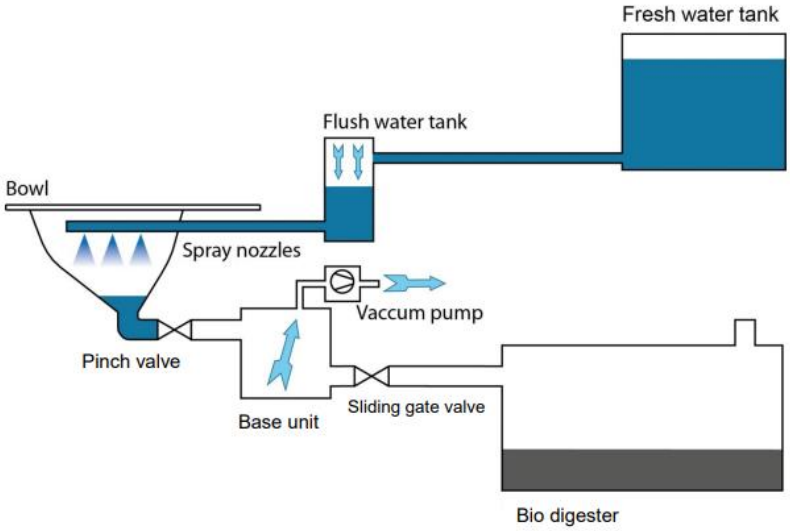
Compressed air is pressed into the flush water tank.

Flush water is pressed through the spray nozzles by the pressurized flush water tank.

The toilet bowl is flushed with high efficiency.

At the same time the vacuum pump evacuates the intermediate tank until the necessary vacuum level

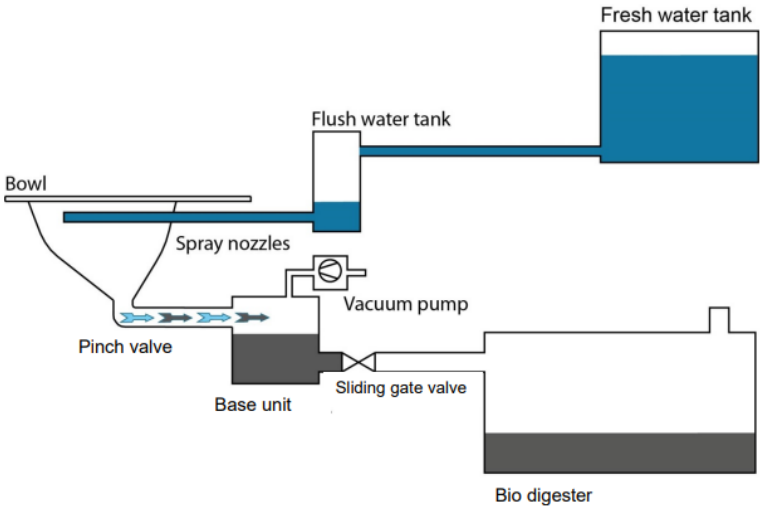
-0.5 bar in squatting & western type is reached.



2. Emptying the bowl

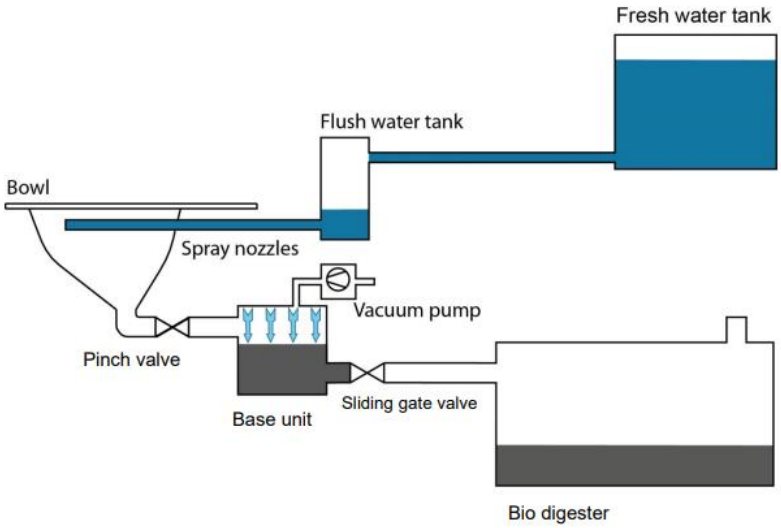
As soon as the required vacuum level is reached the pinch valve between squatting bowl and base unit (intermediate tank) is opened for a short time.

The vacuum inside the base unit sucks the contents of the bowl into the base unit.



3. Pressure built up

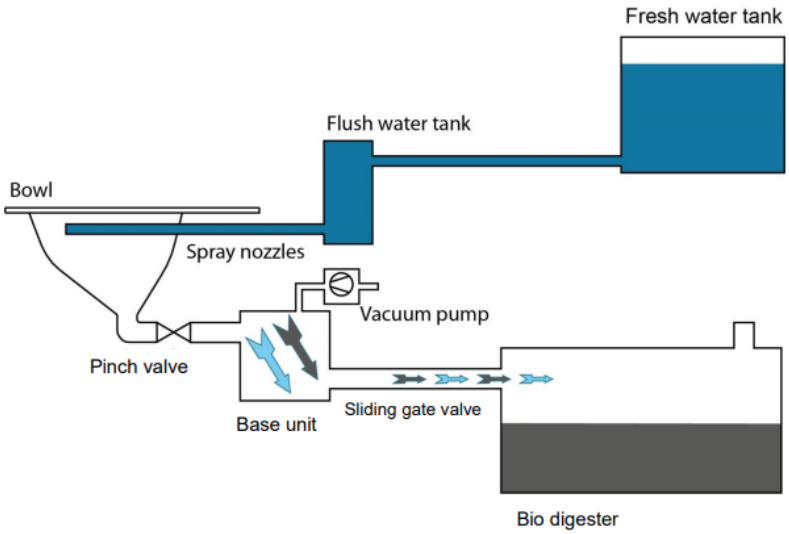
The pinch valve is closed and now compressed air is blown into the base unit/ intermediate tank until a pressure of approx. +0.6 bar is reached.



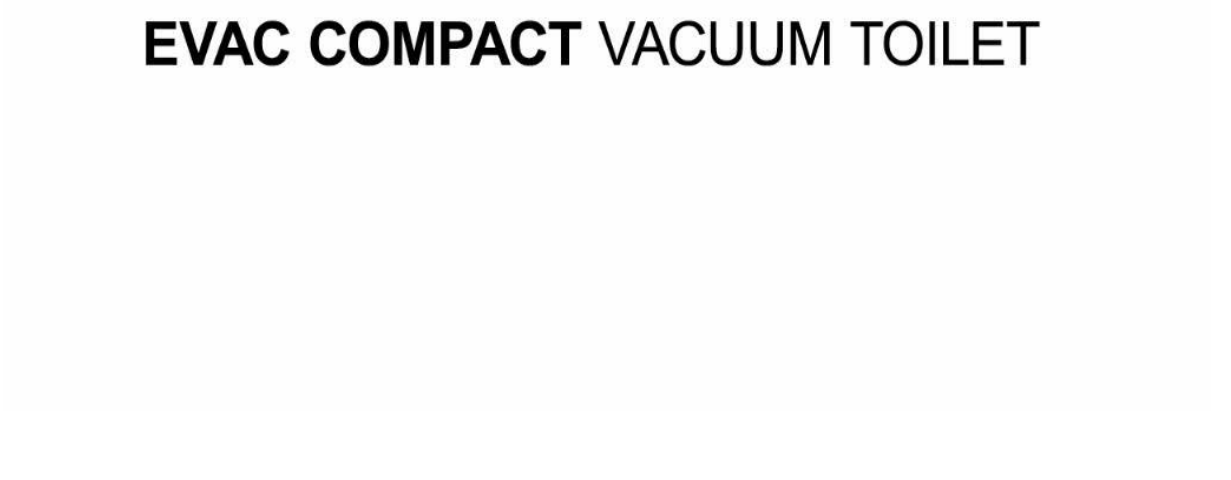
4. Emptying the intermediate tank

The outlet pinch/ sliding gate valve shortly opens the piping to the Bio digester. Two pressure surges emptied the contents of the base unit into the Bio digester.

At the same time the water inlet valve positioned on the water system panel opens and the flush water tank is refilled.



Evac Compact PV – YouTube
https://www.youtube.com/watch?v=xAMjk8n2OTA



Section 4: Preventive Maintenance

Preventive Maintenance

Only qualified personnel is permitted to carry out the installation!

⚠ WARNING ***Risk of infection!***

Refer to safety at work

- **Use personal protective equipment**
- **Do not eat, drink or smoke**

1. The recommended preventive maintenance and overhaul intervals presume medial working conditions. Due to dissenting Conditions (water hardness, amount of using, cleansers etc.) an adjustment of the intervals is necessary.

2. A deflection of the recommended maintenance intervals is possible. But be aware that will occur other efforts and costs.

3. The necessary interval for the decalcification procedure is depending on the working conditions. If the first signs of lime scale will be recognized the appropriate procedure is necessary. The definition of this interval is not possible in advance.

Preventive Maintenance ON TRAIN

Maintenance work	1M	1Y	3Y	6Y	9Y	15Y
Clean/decalcify vacuum toilet	X					
Clean/decalcify flush nozzles	X					
Clean/decalcify liquid level guard	X					
Visual check		X				
Clean filter/pressure regulator		X				

Cleaning Toilet: Neutral cleaning agent and warm water
Cleaner approved for rolling stocks with following composition:

Citric acid	<15% weight/volume
Amidosulfuric acid	<15% weight/volume
Phosphoric acid	< 5% weight/volume

!!! Do not use cleaner which contains chlorine, particles or other abrasives !!!

Preventive Maintenance ON TRAIN

Cleaning – Flush Nozzles

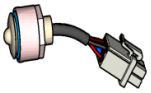
- Clean the spray nozzles opening carefully with a small metal sheet (thickness < 0.65 mm)

Or

- Cleaning tool for flush nozzles (p/n: 79017)

Cleaning – Liquid Level Guard Bowl

- Clean optical liquid level guard carefully with water and a soft cloth

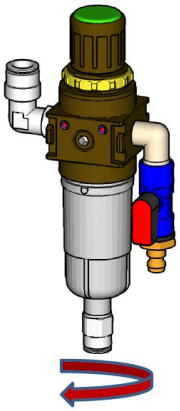


Preventive Maintenance ON TRAIN

Cleaning – Filter Pressure Regulator

Switch off power, water and air supply.
Use warm water!

- Disconnect condensate pipe.
- Turn container and remove from filter pressure regulator.
- Clean container.
- Remove filter element.
- Blow out with compressed air (max. 6 bar).
- Install filter element.
- Install container.
- Reconnect condensate pipe.
- Switch ***ON*** all supplies.



Preventive Maintenance ON TRAIN

Cleaning/Decalcification – Western/Squatting Toilet bowl

Do not rub hard or scratch to clean!
Never clean spray nozzles with aggressive acids or cleaning agent which contains chlorine.

Clean and decalcify the western toilet with the following cleaning agents:

- Neutral cleaner and warm water.
- 4% citric acid.

Cleaning instructions:

- Fill bowl with 4% citric acid (max residence time: 0.5 hour).
- Clean with toilet brush if necessary.
- Flush toilet once.

Preventive Maintenance ON TRAIN

Approved Cleaner

Do not use cleaner which contains chlorine, particles or other abrasives! Follow the instructions of the manufacturer data sheet!

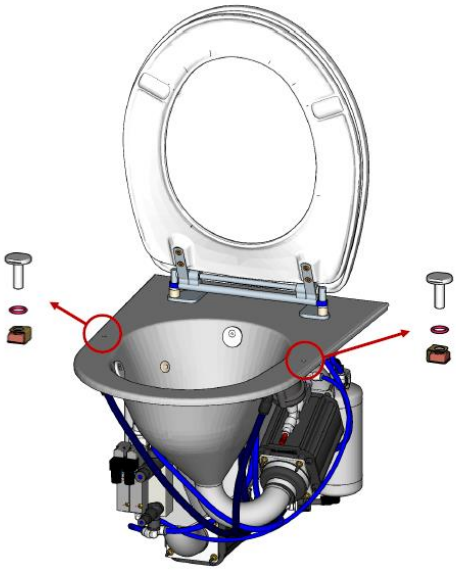
- Neutral cleaning agent and warm water
- Cleaner approved for rolling stock with following composition:
  - Citric acid <15% weight/volume
  - Amidosulfuric acid <15% weight/volume
  - Phosphoric acid < 5% weight/volume

Example:

- Into-Top from Ecolab
- Nepurin from Saniclean
- Retirol from Deutsche Hahnerol

Preventive Maintenance

Visual Check – Western Toilet



Check and record the following:

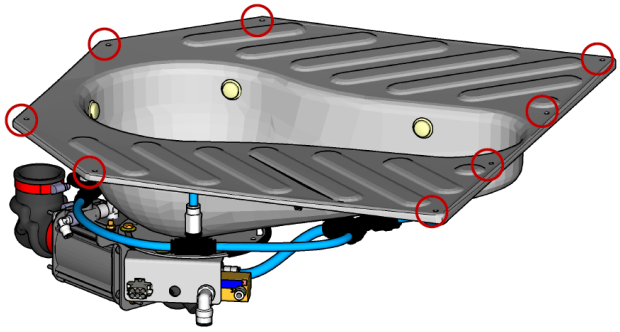
- Are the hoses undamaged and not bent?
- Are all electrical connections firmly mounted?
- Is the cable harness undamaged?
- Are all components firmly mounted and undamaged?
- Are all water connections firmly connected?
- Are all compressed air connections firmly connected?
- Are any gaskets (e.g bowl connection) porous, damaged or untight?
- Is the outlet pinch valve dirty (defects or leakages waste pipe to waste water tank)?
- Is the exhaust air piping of the vacuum pump clean?

- Shut off power supply to the vacuum toilet
- Shut off fresh water and compressed air supply
- Disconnect supply connections
- Disconnect mechanical connections
- Remove vacuum toilet from shroud

- Reconnect supply connections
- Turn on fresh water and compressed air supply
- Turn on the power supply of the western toilet, the toilet will perform an initial flush cycle.
- If everything is ok install shroud.

Preventive Maintenance

Visual Check – Squatting Toilet



Check and record the following:

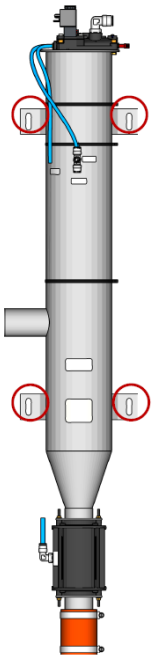
- Are the hoses undamaged and not bent?
- Are all electrical connections firmly mounted?
- Is the cable harness undamaged?
- Are all components firmly mounted and undamaged?
- Are all water connections firmly connected?
- Are all compressed air connections firmly connected?
- Are any gaskets (e.g bowl connection) porous, damaged or untight?
- Pinch valve not contaminated on the outside (if yes, might indicate leakages)?

- Shut off power supply to the squatting toilet (miniature circuit breaker control board).
- Shut off fresh water and compressed air supply.
- Disconnect supply connections.
- Disconnect mechanical connections.
- Open revision hatch to get access to the squatting toilet.

- Reconnect supply connections.
- Turn on fresh water and compressed air supply.
- Turn on the power supply of the squatting toilet, the toilet will perform an initial flush cycle.
- If everything is ok close revision hatch.

Preventive Maintenance

Visual Check – Base Unit / Intermediate tank



Check and record the following:

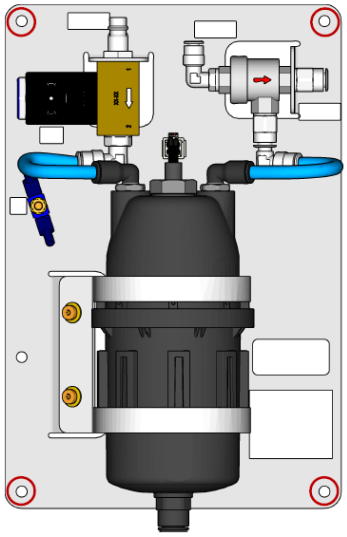
- Are the hoses undamaged and not bent?
- Are all electrical connections firmly mounted?
- Is the cable harness undamaged?
- Are all components firmly mounted and undamaged?
- Are all water connections firmly connected?
- Are all compressed air connections firmly connected?
- Are any gaskets (e.g bowl connection) porous, damaged or untight?
- Gaskets, sealing muffs or rubber elbows (e.g. at the bowl connection) not porous, damaged or leaky?
- Pinch valve not contaminated on the outside (if yes, might indicate leakages)?
- Exhaust pipe of the vacuum pump clean?

- Shut off power supply of base unit.
- Shut off fresh water and compressed air supply.
- Open revision hatch to get access to the base unit.

- Reconnect supply connections.
- Turn on fresh water and compressed air supply.
- Turn on the power supply of the squatting toilet, the toilet will perform an initial flush cycle.
- If everything is ok close revision hatch.

Preventive Maintenance

Visual Check – Water Panel



Check and record the following:

- Piping not damaged or bent?
- Electrical connections tightly mounted?
- Cable harness undamaged?
- All components tightly mounted and undamaged?
- Compressed air hoses mounted correctly?

- Shut off power supply of water panel.
- Shut off fresh water and compressed air supply.
- Open revision hatch to get access to the water panel.

- Reconnect supply connections.
- Turn on fresh water and compressed air supply.
- Turn on the power supply of the squatting toilet, the toilet will perform an initial flush cycle.
- If everything is ok close revision hatch.

Preventive Maintenance

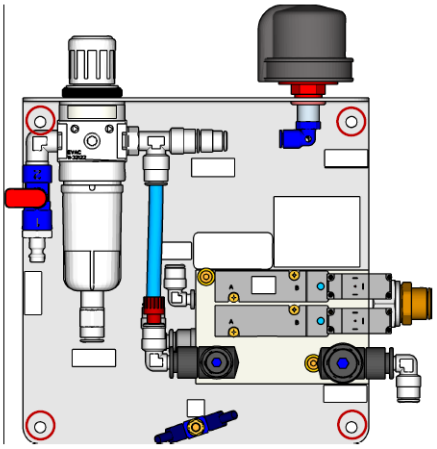
Visual Check – Pneumatic Panel

Check and record the following:

- Piping not damaged or bent?
- Electrical connections tightly mounted?
- Cable harness undamaged?
- All components tightly mounted and undamaged?
- Compressed air hoses mounted correctly?

- Shut off power supply of pneumatic panel.
- Shut off compressed air supply.
- Open revision hatch to get access to the pneumatic panel.

- Reconnect supply connections.
- Turn on fresh water and compressed air supply.
- Turn on the power supply of the squatting toilet, the toilet will perform an initial flush cycle.
- If everything is ok close revision hatch.

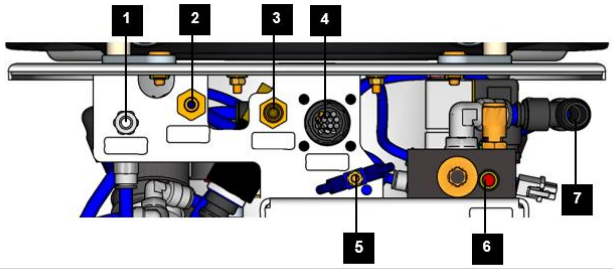


Preventive Maintenance OFF TRAIN

For maintenance tasks it is necessary to separate the vacuum toilet from the fresh water tank and to empty it completely.

Activate a flush cycle afterwards.

Disconnect all supplies and remove the toilet module



1	Compressed air output Ø 8 mm	2	Compressed air input DN5
3	Water input DN7.2	4	Electrical connection
5	Grounding	6	Test connection Ø 6 mm
7	Compressed air Ø 12 mm		

Figure 2: Interfaces – QVT-H-C-W0-ICF

Section 5: Troubleshooting

Errors and Errors routine

After detecting error conditions (except: waste tank full) the control unit initiates an error correction routine.

Should the error correction routine be unsuccessful, the control unit will switch off the vacuum toilet.

The error detection of the vacuum toilet will be carried out by the following sensors:

- Pressure guard sensor intermediate tank.
- Bowl sensor- liquid level guard
- Level sensor- flush water tank.

Failure codes on the RS box

Display	Description	Indication mode
00	System healthy	Constant
01	Waste tank full	Blinking
02	Pressure rise	Constant → Blinking
03	Pressure@Vacuum	Constant → Blinking
04	Pressure detected	Constant → Blinking
05	Bowl full	Constant → Blinking
06	No water	Constant → Blinking
09	Inlet valve can't open	Constant → Blinking
10	Inlet valve can't close	Constant → Blinking
87	Freeze drain active	Constant → Blinking
88	Initial startup/reset	All LED segments active for 5 s
90	Terminal (PC) connected	constant
92	Service terminal HT793 connection	constant

After system conditions are detected (exception: 01 Waste water tank full) the control unit will perform automatic error correction routines. During the routines the code will be displayed constantly. If the error cannot be corrected the toilet will switch to out of order and the code display will start blinking.

Code 01: WWT full	
Possible cause	**Action**
WWT full	Empty WWT
Float switch clogged	Clean component
Float switch defect	Replace component

Code 02: Pressure rise	
Possible cause	**Action**
No compressed air available	Check compressed air supply
Test conduit untight	Check test conduit, must be closed with a blind plug.
Inlet or outlet gate valve leaky	Replace component
Pressure switch defect	Replace component
Wrong supply connections	Check compressed air connection

Code 03: Pressure Vacuum	
Possible cause	**Action**
Overpressure instead of vacuum; waste water piping clogged	Remove clogging in the waste water piping
WWT full	Empty WWT
Vacuum pump defect	Replace component

The vacuum toilet could not generate pressure inside the intermediate tank after bowl emptying and starts the failure correction routine

The vacuum toilet measures pressure instead of vacuum inside the intermediate tank and starts the failure correction routine

Code 04: F: Pressure detected	
Possible cause	**Action**
Blockage in the waste pipe or tank. Pressure cannot be reduced, waste water tank is full, frozen or cannot be vented.	Remove clogging in the waste water piping
Pressure switch defect	Replace component
Outlet gate valve does not open	Connect service terminal and activate maintenance mode: manually control outlet gate valves **⚠ WARNING** ***Do not open the inlet gate valve!***

The pressure guard of the intermediate tank measures overpressure after the first emptying pressure shock or after the start of a new flush cycle and the vacuum toilet starts the failure correction routine

Code 05: Bowl full	
Possible cause	**Action**
Bowl level to high	Activate service flush or reverse flush (low pressure) or reverse flush (hard) on the RS-Box
Bowl sensor defect	Replace component
Exhaust piping clogged	Clean the exhaust piping

The optical bowl liquid level guard is active and the vacuum toilet starts the failure correction routine. The vacuum toilet starts some flush cycles without adding water to empty the bowl

Code 06: no water	
Possible cause	**Action**
FWT empty	Fill FWT
Water filter clogged	Clean component
Water inlet valve defect	Replace component

the liquid level guard inside the flush water tank measures no water and the vacuum toilet starts the failure correction routine

Code 09: Inlet can`t open	
Possible cause	**Action**
Interrupted air supply to valve	Check pipe for blockages Check if pipe is connected right

The pressure switch at the inlet pinch valve measures still air at the inlet pinch valve when expected no air.

Code 10: Inlet can`t close	
Possible cause	**Action**
Inlet valve clogged/defect	Check/Clean valve; replace if necessary.

The pressure switch at the inlet pinch valve measures no air at the inlet pinch valve when expected no air.

If the bowl is clogged:

1. Service Flush

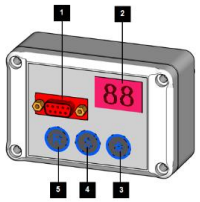
Press the Service-flush button <<S>> for at least 1 seconds. The toilet system proceeds a flush cycle without adding fresh water.

2. Flush

Empty the bowl as far as possible.

Close toilet lid and weight it with something down. Blockages are pushed out of bowl by compressed air !!!

Press the Reverse-flush button <<R>> for at least 0.7 seconds. The system performs an automatic valve actuation. The pressure in the intermediate tank is scanned. If excess pressure is detected, the sequence will be interrupted. Otherwise the intermediate tank is pressurized for a certain time period.



4 Pressure levels:

pressure VERY WEAK

pressure WEAK

pressure MODERATE

pressure HIGH

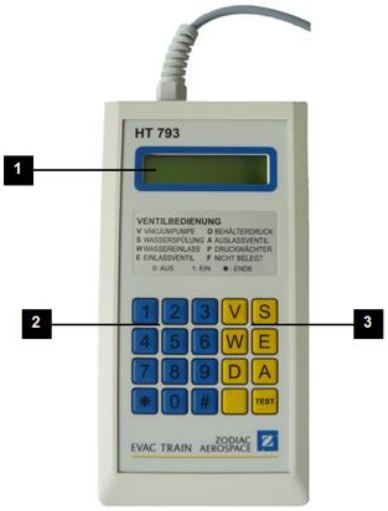
press the «R» button within 2 minutes an additional time to get the next pressure value

When the blockage is loosened it should be removed. The toilet is now operational, and the flush button could be pressed.

An intense reverse flush may be activated by pressing both «R» and «S» simultaneously.

Section 6: Service Tool

General Information

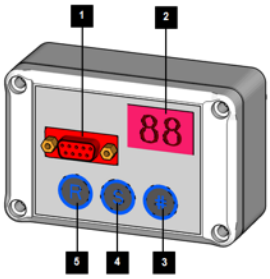


1	LCD-Display	2	Numeric pad
3	Alpha pad		

Figure 1: Serviceterminal

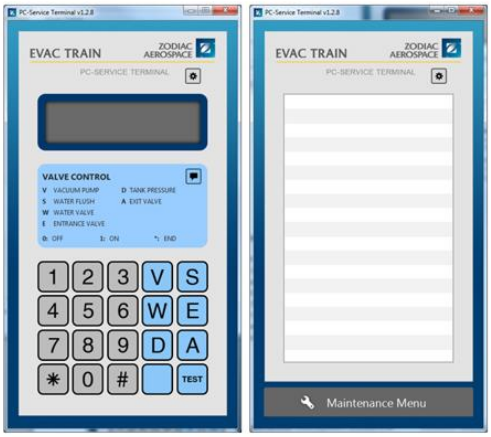
Figure 1: Serviceterminal - PC Version – Classic View – Modern View

Push «S» (service flush) for 10 seconds ➔ 92 continuous-light and the service terminal will be active

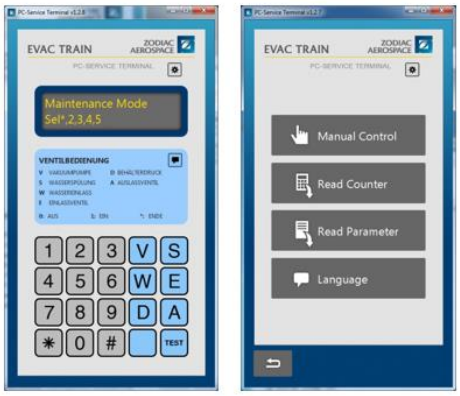


Connect to the RS232 interface at the RS box (1)

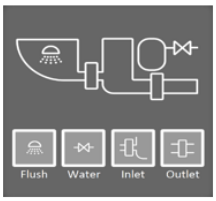
Push «#» until the display is blinking ➔ push # to change from modus 00 to 90

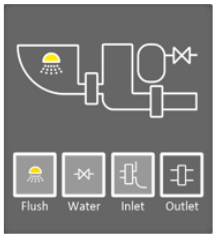


Action	Classic View	Modern View
General Settings		
Language Settings- Valve Control		not available
Activation Maintenance Mode	1 2 3	Maintenance Menu



Action	Classic View	Modern View
Manual Control	2	Manual Control
Read Error Counter	3	Read Counter
Read Parameter	4	Read Parameter
Select Language	5	Language
Back (exit Menu)	*	⮌
Next	#	not available





Action	Classic View	Modern View
Flush	S	
Water Inlet	W	
Inlet Valve	E	
Outlet Valve	A	

Initialisations
Flush button
Flush cycle
Press dedect
Compressed Air
Press Vacuum
Bowl Full
Flush water
Interruption FLBU
Can‘t open
Can‘t close

Action	Classic View	Modern View
Start	1	not available
Back (exit Menu)	*	⮌
Next	#	not available
Change error counter		not available
Save as CSV	not available	Save as CSV

Thank you very much for your attention!

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