AVS Electronic Circulating Valve

Technical Summary

Intelligent Drilling Tools introduce the Annular Velocity Splitflow or AVS electronic circulating valve with split flow and full bypass positions. AVS is an electronic multi-position circulating valve.

The AVS tools are not activated by drop balls or darts or any other type of mechanism delivered from surface through the drill pipe. The tools are electronic and intelligent, meaning they have onboard sensors with logic and can respond to surface commands sent by "Downlinking" a coded signal to the tool via a pattern of pumps on/off and specific RPMs according to a function map. The AVS tools read the signals and shift to the particular position requested

The AVS has 3 positions:

1. **Through Bore** – all the drilling fluid flow goes directly through the tool, BHA and Bit.
2. **Split Flow** – This is an open position that can be nozzled to allow a certain amount of the flow to be diverted into the Annulus, bypassing the BHA. This can be engineered using IDT's SplitFlow software to allow the minimum flow requirement to power MWD / RSS / Motor / Bit hydraulics etc., and the remainder out to the annulus. This maximises Annular Velocity for a given surface pressure increasing Hole Cleaning ability.
3. **Full Bypass** – This position opens up the Total Flow Area (TFA) further thus allowing maximum flow rate to the annulus for the highest Annular Velocity at the lowest surface pressure. Additionally if Lost Circulation Material (LCM) is pumped, the tool can pass 150ppb coarse LCM. A ball valve closes off the bore to ensure that the Drilling tools and Bit do not become blocked by the LCM material.

Features

- No drop balls, Darts or RFID tags
- Command via surface Downlink
- Simple and Rapid commands
- Throughbore at all times
- Battery powered. Low power draw
- In excess of 200 cycles
- Splitflow position with Variable Nozzles
- Bypass position with BHA shutoff
- 4in^2 TFA in full Bypass position

Benefits

- Can be run in any inclination well
- Can be activated in Horizontal wells
- Can be run anywhere in the BHA
- Can be run below an MWD
- Splitflow maximises Annular Velocity
- > 500kg/M3 LCM through Bypass Position
- LCM will not enter BHA in Bypass position
- Cleans hole while drilling in Splitflow
- No waiting for Balls and Darts to drop

AVS Applications

The AVS has multiple applications including:

- Maximise hole cleaning while drilling
- Pumping LCM
- Jetting stabilisers preventing pack offs
- Run behind Reamer
- Subsea Riser / BOP Jetting
- Hole cleaning with Tapered String

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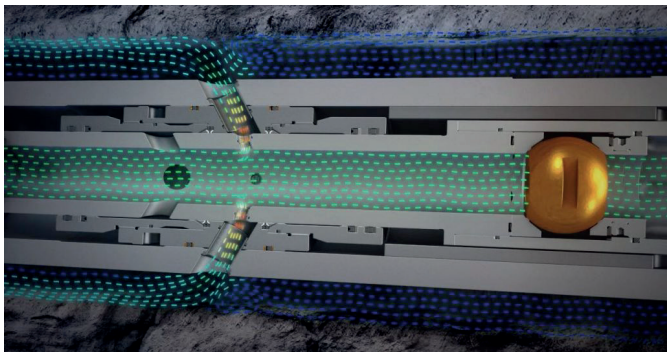
AVS SPLITFLOW +BYPASS

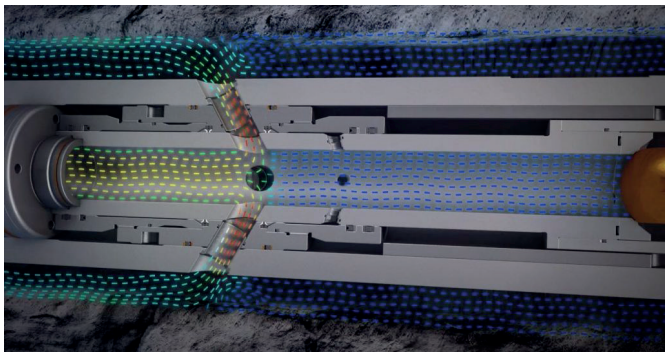
Technical Specification

AVS Tool OD (in)	7	8.25
Hole Size (in)	8.5	12.25
Tool ID, min (in)	2	2.36
Tool Length m (ft)	4.42 (14.5)	5.18 (17)
Tool Weight Kg	637	1015
Total Flow Area (in2):		
Pre-Activation TFA (Through Bore)	3.14	4.37
Split Flow TFA (To Annulus), min - max*	0.11 - 0.60	0.11 - 0.60
Full Bypass TFA (To Annulus)	4.00	4.00
Number of Ports	4	4
Number of Cycles	> 200	> 200
Maximum Flow Rate lpm (gpm)	3400 (900)	5300 (1400)
Maximum Differential Pressure (psi)	5000	5000
Pre-Activation Pressure Drop Across Tool (water) (psi) **	34@500gpm	45@1000gpm
Maximum Tensile Load (lbf)	690000	800000
Maximum Torsional Load (ft-lbf)	61000	87000
Tool Joint End Connections (Box x Pin) ***	NC50 / DPM-DS50	6 5/8 API REG
Temperature Rating (°C) max.	150	150

* Nozzle TFA can be selected to fit required Splitflow / Bit flow ratio
** Depends on Bit TFA/hydraulics
*** Alternative End Connections available on Request



Splitflow Position



Bypass Position

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Data Sheets

7" AVS Performance Data Sheet (Metric)

Material: **AISI 4330V** Yield Strength: **1034 Mpa**

TOOL BODY	Nominal 100% RBW	96% RBW
OD (mm)	**179.32**	**177.80**
Wall Thickness (mm)	**22.35**	**21.59**
ID (mm)	**134.62**	**134.62**
Critical Buckling Force (kN)	**1048.6**	**1001.8**
Tensile Strength (kN)	**4549.6**	**4309.5**
Torsional Strength (N-m)	**222591**	**209760**

Note: Buckling Force Calculated based on uniform OD and wall thickness.

UPPER EXTERNAL CONNECTION: DS50	
Tool Connection OD (mm)	**177.80**
Example Mating Component Connection ID (mm)	**71.44**
Example Mating Component Material Yield (MPa)	**758**
Maximum MUT (N-m)	**42734**
Tension at Connection Yield (Max MUT) (kN)	**4373.1**
Minimum MUT (N-m)	**39198**
Tension at Connection Yield (Min MUT) (kN)	**5074.9**
Connection Torsional Strength (N-m)	**71222**
Connection Tensile Strength (kN)	**5074.9**

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable MUT values are based on a dope friction factor of 1.0

AVS ASSEMBLY	
Weight (kg)	**637**
Length (m)	**4.42**
Drift Size (mm)	**49.22**
Fluid Displacement (L)	**89.68**
Fluid Capacity (L)	**21.92**
Differential Pressure Capacity (MPa)	**34.47**
Hydrostatic Pressure Capacity (MPa)	**103.42**

INSPECTION INTERVALS	
Standard Operating Conditions	**2200 krev**
Severe Operating Conditions	**1350 krev**

Notes: Standard operating conditions assume maximum 3 deg/30.5m DLS and no significant impact or shock loading. Severe conditions upto a maximum 10 deg/30.5m DLS or if jarring / high vibration events occur.

LOWER EXTERNAL CONNECTION: DS50	
Example Mating Component Connection OD (mm):	**171.45**
Tool Connection ID (mm):	**71.44**
Example Mating Component Material Yield (MPa):	**758**
Maximum MUT (N-m)	**42206**
Tension at Connection Yield (Max MUT) (kN)	**3864.9**
Minimum MUT (N-m)	**35395**
Tension at Connection Yield (Min MUT) (kN)	**5074.9**
Connection Torsional Strength (N-m)	**70344**
Connection Tensile Strength (kN)	**5074.9**

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable. MUT values are based on a dope friction factor of 1.0.

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AVS Electronic Circulating Valve

Data Sheets

8.25" AVS Performance Data Sheet (Metric)

Material: **AISI 4330V** Yield Strength: **689 Mpa**

TOOL BODY	Nominal 100% RBW	96% RBW
OD (mm)	**209.55**	**207.26**
Wall Thickness (mm)	**28.58**	**27.43**
ID (mm)	**152.40**	**152.40**
Critical Buckling Force (kN)	**1063.7**	**1017.2**
Tensile Strength (kN)	**3699.9**	**3579.8**
Torsional Strength (N-m)	**241758**	**233990**

Note: Buckling Force Calculated based on uniform OD and wall thickness.

UPPER EXTERNAL CONNECTION: 6 5/8 REG	
Tool Connection OD (mm)	**209.55**
Example Mating Component Connection ID (mm)	**71.44**
Example Mating Component Material Yield (MPa)	**689**
Maximum MUT (N-m)	**70808**
Tension at Connection Yield (Max MUT) (kN)	**6225.9**
Minimum MUT (N-m)	**48057**
Tension at Connection Yield (Min MUT) (kN)	**7343.8**
Connection Torsional Strength (N-m)	**118012**
Connection Tensile Strength (kN)	**7343.8**

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable MUT values are based on a dope friction factor of 1.0.

AVS ASSEMBLY	
Weight (kg)	**1015**
Length (m)	**5.18**
Drift Size (mm)	**57.00**
Fluid Displacement (L)	**153.54**
Fluid Capacity (L)	**25.14**
Differential Pressure Capacity (MPa)	**34.47**
Hydrostatic Pressure Capacity (MPa)	**103.42**

INSPECTION INTERVALS	
Standard Operating Conditions	**2200 krev**
Severe Operating Conditions	**1350 krev**

Notes: Standard operating conditions assume maximum 3 deg/30.5m DLS and no significant impact or shock loading. Severe conditions upto a maximum 10 deg/30.5m DLS or if jarring / high vibration events occur.

LOWER EXTERNAL CONNECTION: 6 5/8 REG	
Example Mating Component Connection OD (mm):	**193.68**
Tool Connection ID (mm):	**71.44**
Example Mating Component Material Yield (MPa):	**689**
Maximum MUT (N-m)	**69269**
Tension at Connection Yield (Max MUT) (kN)	**5289.8**
Minimum MUT (N-m)	**41202**
Tension at Connection Yield (Min MUT) (kN)	**7343.8**
Connection Torsional Strength (N-m)	**115448**
Connection Tensile Strength (kN)	**7343.8**

Notes: Mating connection information provided is intended as a guide, user must ensure adjoining components are suitable. MUT values are based on a dope friction factor of 1.0.

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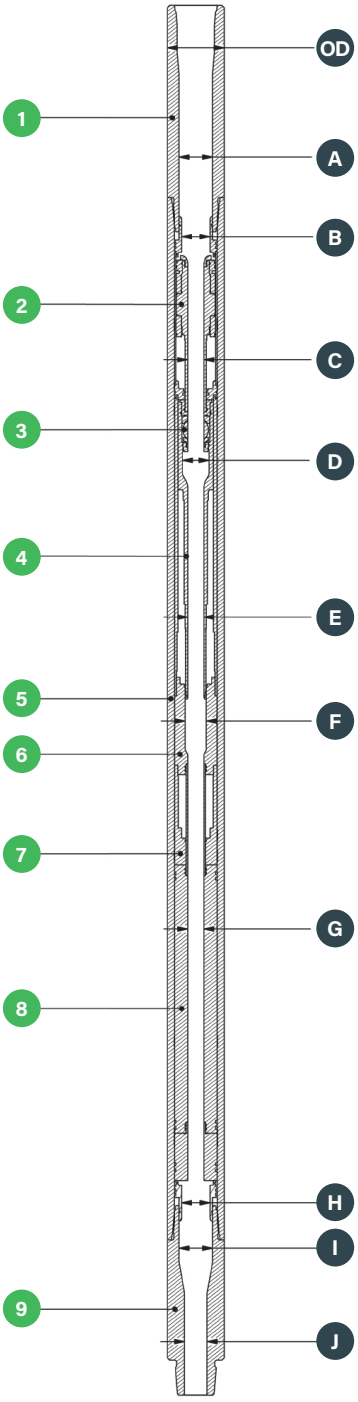
Fishing Diagram (7in)



COMPONENT	DESCRIPTION
1	Upper Connector
2	Upper Piston
3	Ball Valve
4	Lower Piston
5	Tool Body
6	Motor Housing
7	Compensator Housing
8	Electronics Housing
9	Lower Connector

LOCATION	DIAMETER (in)	LENGTH OF SECTION (in)
OD	7.0	173
A	4.2	19
B	3.54	5
C	2.0	24
D	3.32	4
E	2.0	27
F	2.67	7
G	2.0	53
H	3.54	5
I	4.2	6
J	2.81	13

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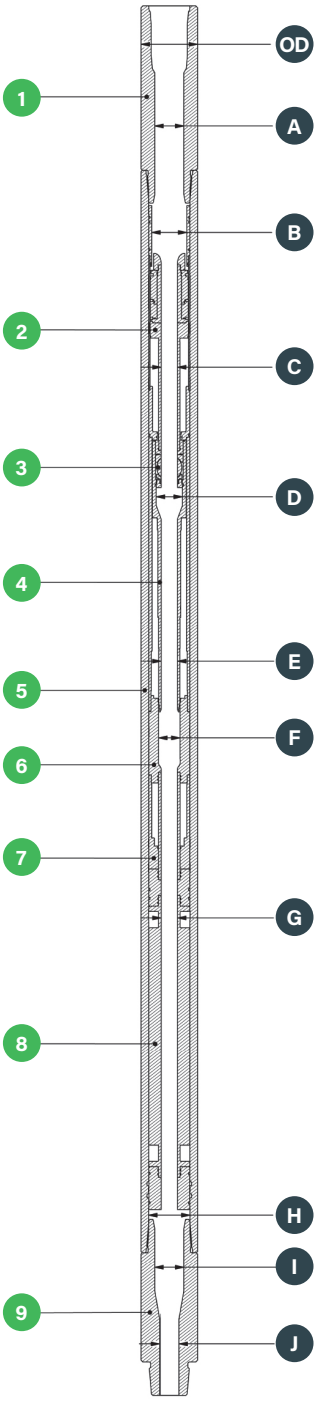
Fishing Diagram (8.25in)



COMPONENT	DESCRIPTION
1	Upper Connector
2	Upper Piston
3	Ball Valve
4	Lower Piston
5	Tool Body
6	Motor Housing
7	Compensator Housing
8	Electronics Housing
9	Lower Connector

LOCATION	DIAMETER (in)	LENGTH OF SECTION (in)
OD	8.25	198
A	4.25	19
B	5.12	7
C	2.36	34
D	3.82	4
E	2.36	28
F	3.12	8
G	2.36	65
H	6.05	2
I	4.25	11
J	2.81	12

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