

Deskription of the control systems

1.1 Rudder control system.

Rudder control system is created of two couple steel welded pedals, on each of the couple has welded lewer, which transfers the pilot forces to the the cable in central tunnel to the lever on the lower part of rudder. All the cable circuit is closed through conection with nose landing gear. The stops are situated on the lower suspension of the rudder.

Rudder control system is idential for the UFM-13 and UFM-11 too.

Design see in the drawing.

1.2 Elevator control system.

Elevator control system is created of two control sticks, which are conected with welded tube, which has welded lever. From this lever continues the control system with two control rods to the two-arm angular lever, situated in the lower part the vertikal stabilizer. The rods are connected with the screw and go through two guides, which distribute their in the four section. With two-armed angular lever the line changes the direction and with next rod is the system connected with the lever of elevator. The stops are situated on the welded tube, which connected the control sticks under seats.

Elevator control system is idential for UFM-13 and UFM-11 too.

Design see in the drawing.

1.3 Aileron control system UFM-11.

From each of both control sticks the aileron control system steers the rods to the two armed angular levers sideward in fuselage. The lever wheels the way of ailerons control systém sideward to the interconnection with the wing per angular lever, engages to the welded component in the wing. This part of control line is created with two rods, which are in the conection place supported with a rocking member on the countershaft of flaps control. This member holds up the rods and thereby alloweds transfer of the axis force and in dependence on the position of the flaps lever cageworks the line and this way changes zero position ailerons, which so in part acts as flaps. In the wing continues the aileron control with laminated rod to the angular lever, which wheels the way and per short tow bar is controled the aileron. Both control sticks are connected with tow an rod. The stops are situated in bottom part of control sticks.

Design see in the drawing.

1.4 Flaps control system UFM-11.

Control lever of flaps is situated on the countershaft between pilot seats. The countershaft has welded levers sideward in fuselage. The control way continues wheel above sideward with one rod to connected the line with wing per the same system as ailerons. In the wing continues the flaps control with the rodto the angular lever and per the short rod is controled the flap. The stops are situated on flaps lever.

Design see in the drawing.

1.5 Flapperon control system UFM-13.

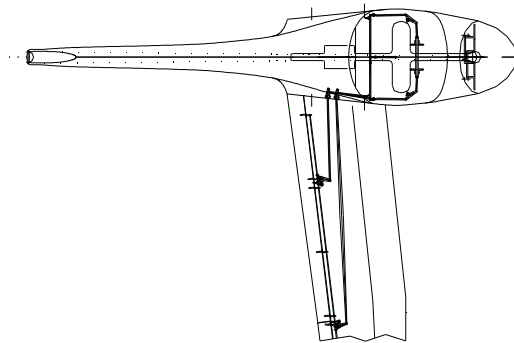
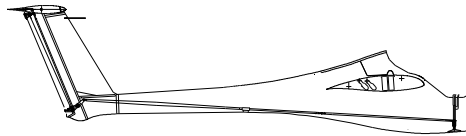
Flaperon control system is combination of function of ailerons and flaps. Flapperon control system is actuanged exact idential as the ailerons control systém by UFM-11, different is the length of tow rod in the wing for this reason: the angular lever, which controls the flapperon has another position along the span. The funktion of flaps is controled with the same flaps lever as the flaps by UFM-11, its up-and-down motion brings through the angular levers sidewords in fuselage cagework line of rods of flapperon and this is why also the flapperon moves as flaps. The stops are identical with UFM-11.

Design see in the drawing.

1.6 Air brake control system UFM-13.

Air brake control system is created as by UFM-11 – flap control system . This system has another tow rod, which steers to the lever thrown up the air brake.

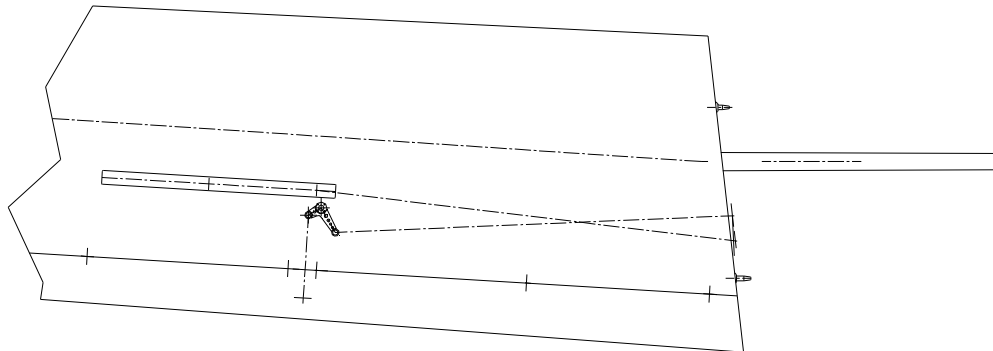
1.7 Drawings of control systems



On the upper drawing is the elevator control system. From the control sticks to the elevator wheel two rods 1 and 2.

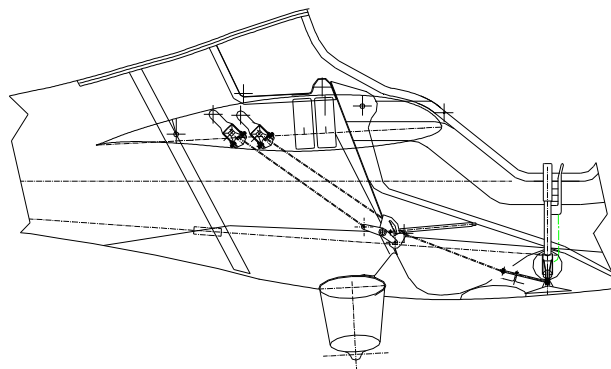
The bottom drawing shows the cable circuit of rudder control system. Further is on the drawing scheme of the rods in wing by UFM-11, which control the flap and aileron.

Next drawing shows the scheme of the rods of flaperon control system and air brake control system in the wing UFM-13



On the next side-view is scheme of the position of control sticks and flaps lever and guidance to the wing.

According the version the flap lever controls air brakes and flapperon (UFM-13) or flaps (UFM-11)



2. Load of the single elements of control systems.

In this report was set out the demands of regulations on the load the hinge moments and pilot forces. From this demands is necessary to fix the loads single elements of control system and so to win the basis for stability calculation.

It was drawn the kinematic of motions all of control systems and discovered gear ratios on the single elements of control systems. From this gear ratios was calculated forces in the single elements. This forces are in following tab. Set out are forces for different regulations and recently is performed reverse calculation the systems from hinge moment, to be possible to select critical load.

2.1 Elevator control system.

Pilot forces	Rod 1	Rod 2	Hinge moment	Remark
[N]	[N]	[N]	[Nmm]	
450.00	1285.65	-1087.86	-96819.33	P-Ull1
-450.00	-1423.80	2808.59	174132.45	P-Ull1
270.00	771.39	-652.71	-58091.60	UL-2 60%
-270.00	-854.28	1685.15	104479.47	UL-2 60%
220.77	630.75	-533.71	-38000.00	Calc. from hinge moment
-220.77	-630.75	533.71	38000.00	Calc. from hinge moment

push		pull	
k1=	2.857	k1=	3.164
k2=	-0.84615	k2=	-1.9726
k3=	89	k3=	62

Rod 1 is created from two rods, screw together

For calculation is taken the load of control system according Slovak regulations, which is decisive

2.2 Ailerons control system UFM-11.

Pilot forces	Rod 1	Rod 2	Rod 3	Rod 4	Hinge moment	Remark
[N]	[N]	[N]	[N]	[N]	[Nmm]	
200.00	400.00	496.55	231.72	-321.42	13821.20	JAR-VLA
200.00	-400.00	-943.40	-523.58	1115.24	55761.78	JAR-VLA
90.00	180.00	223.45	104.28	-144.64	6219.54	UL-2 60%
90.00	-180.00	-424.53	-235.61	501.86	25092.80	UL-2 60%
182.11	364.22	452.14	211.00	-292.67	10068.00	Calc. from hinge moment
45.14	-90.28	-212.92	-118.17	251.70	10068.00	Calc. from hinge moment

up		down	
k1=	2	k1=	-2
k2=	1.2413793	k2=	-2.35849
k3=	0.466666	k3=	-0.555
k4=	-1.387096	k4=	2.13
k5=	-43	k5=	50

Rod 2 is created with twin of rods sideward in fuselage, connected through an lever, which don't change the gear ratio.

For the calculation is taken the load of control system according Slovak regulations, which is decisive.

2.3 Flapperon control system UFM-13.

Flapperon control system till the critical buckling place in the wing is the same and we use identical values according the aileron systems.

2.4 Flap control system UFM-11.

Pilot forces	Rod 1	Rod 2	Rod 3	Hinge moment	Remark
[N]	[N]	[N]	[N]	[Nmm]	
-350.00	-2625.00	-1456.88	-1802.88	-99158.55	JAR-VLA
350.00	749.88	415.59	787.44	37797.12	JAR-VLA
-67.50	-506.25	-280.97	-347.70	-19123.44	UL-2 45%
67.50	144.62	80.15	151.86	7289.44	UL-2 45%
-35.19	-263.90	-146.46	-181.25	-7975.00	Calc. from hinge moment
369.24	791.10	438.44	830.73	31900.00	Calc. From hinge moment

push		pull	
k1=	15	k1=	4.285
k2=	0.555	k2=	0.5542168
k3=	1.2375	k3=	1.894736842
k4=	55	k4=	48

For calculation of the system (except direct control elements in cockpit) we will use the values from hinge moments for this reason: by negative position of flaps it gos to the lock up of control system over deadlock and the pressure in the tow bars aren't realistic by the application the manipulation loads on handle control lever.

2.5 Air brakes control system UFM-13.

Air brakes control system is identical in fuselage as flap control system UFM-11 with pull strein, that is why we use values from tab. regulations JAR-VLA

2.6 Rudder control system.

Pilot forces	Cable	Hinge moment	Remark
[N]	[N]	[Nmm]	
600.00	1074.00	61218.00	P-Ull1
-600.00	-1380.00	-78660.00	P-Ull1
360.00	644.40	36730.80	UL-2 60%
-360.00	-828.00	-47196.00	UL-2 60%
600x2x0.75	2070.00	117990.00	UL-2 75% two pilots
1000.00	1790.00	0.00	Lean at pedalls
292.39	523.38	23866.00	Calc. from hinge moment
292.39	523.38	23866.00	Calc. From hinge moment

push		pull	
k1=	1.79	k1=	2.3
k2=	57	k2=	57

For the calculation is decisive simultaneous act two pilots according UL-2 and the lean of pilots according JAR-VLA 1000 N