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A = Added, R = Revised, D = Deleted, O = Overflow, C = Customer Originated Change

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O	32	Jun 15/2009		O	55	Jun 15/2009	
O	33	Jun 15/2009		O	56	Jun 15/2009	
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O	35	Jun 15/2009		O	58	Jun 15/2009	
O	36	Jun 15/2009		O	59	Jun 15/2009	
O	37	Jun 15/2009		O	60	Jun 15/2009	
O	38	Jun 15/2009		O	61	Jun 15/2009	
O	39	Jun 15/2009		O	62	Jun 15/2009	
O	40	Jun 15/2009		O	63	Jun 15/2009	
O	41	Jun 15/2009		O	64	Jun 15/2009	
O	42	Jun 15/2009		O	65	Jun 15/2009	
O	43	Jun 15/2009		O	66	Jun 15/2009	
O	44	Jun 15/2009		O	67	Jun 15/2009	
O	45	Jun 15/2009		O	68	Jun 15/2009	
O	46	Jun 15/2009		O	69	Jun 15/2009	
O	47	Jun 15/2009		O	70	Jun 15/2009	
O	48	Jun 15/2009		O	71	Jun 15/2009	
O	49	Jun 15/2009		O	72	Jun 15/2009	
O	50	Jun 15/2009		O	73	Jun 15/2009	
O	51	Jun 15/2009		O	74	Jun 15/2009	

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O	77	Jun 15/2009		O	98.2	Jun 15/2009	
O	78	Jun 15/2009		O	98.3	Jun 15/2009	
O	79	Jun 15/2009		O	98.4	Jun 15/2009	
O	80	Jun 15/2009		O	98.5	Jun 15/2009	
O	81	Jun 15/2009		O	98.6	Jun 15/2009	
O	82	Jun 15/2009		O	98.7	Jun 15/2009	
O	83	Jun 15/2009		O	98.8	Jun 15/2009	
O	84	Jun 15/2009		O	98.9	Jun 15/2009	
O	85	Jun 15/2009		O	98.10	Jun 15/2009	
O	86	Jun 15/2009		O	98.11	Jun 15/2009	
O	87	Jun 15/2009		O	98.12	Jun 15/2009	
O	88	Jun 15/2009		O	98.13	Jun 15/2009	
O	89	Jun 15/2009		O	98.14	Jun 15/2009	
O	90	Jun 15/2009		O	98.15	Jun 15/2009	
O	91	Jun 15/2009		O	98.16	Jun 15/2009	
O	92	Jun 15/2009		O	98.17	Jun 15/2009	
O	93	Jun 15/2009		O	98.18	Jun 15/2009	
O	94	Jun 15/2009		O	98.19	Jun 15/2009	
O	95	Jun 15/2009		O	98.20	Jun 15/2009	
O	96	Jun 15/2009		O	98.21	Jun 15/2009	
O	97	Jun 15/2009		O	98.22	Jun 15/2009	

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O	98.24	Jun 15/2009		O	98.47	Jun 15/2009	
O	98.25	Jun 15/2009		O	98.48	Jun 15/2009	
O	98.26	Jun 15/2009		O	98.49	Jun 15/2009	
O	98.27	Jun 15/2009		O	98.50	Jun 15/2009	
O	98.28	Jun 15/2009		O	98.51	Jun 15/2009	
O	98.29	Jun 15/2009		O	98.52	Jun 15/2009	
O	98.30	Jun 15/2009		O	98.53	Jun 15/2009	
O	98.31	Jun 15/2009		O	98.54	Jun 15/2009	
O	98.32	Jun 15/2009		O	98.55	Jun 15/2009	
O	98.33	Jun 15/2009		O	98.56	Jun 15/2009	
O	98.34	Jun 15/2009		O	98.57	Jun 15/2009	
O	98.35	Jun 15/2009		O	98.58	Jun 15/2009	
O	98.36	Jun 15/2009		O	98.59	Jun 15/2009	
O	98.37	Jun 15/2009		O	98.60	Jun 15/2009	
O	98.38	Jun 15/2009		O	98.61	Jun 15/2009	
O	98.39	Jun 15/2009		O	98.62	Jun 15/2009	
O	98.40	Jun 15/2009		O	98.63	Jun 15/2009	
O	98.41	Jun 15/2009		O	98.64	Jun 15/2009	
O	98.42	Jun 15/2009		O	98.65	Jun 15/2009	
O	98.43	Jun 15/2009		O	98.66	Jun 15/2009	
O	98.44	Jun 15/2009		O	98.67	Jun 15/2009	
O	98.45	Jun 15/2009		O	98.68	Jun 15/2009	

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O	98.70	Jun 15/2009		O	98.93	Jun 15/2009	
O	98.71	Jun 15/2009		O	98.94	Jun 15/2009	
O	98.72	Jun 15/2009		O	98.95	Jun 15/2009	
O	98.73	Jun 15/2009		O	98.96	Jun 15/2009	
O	98.74	Jun 15/2009		O	98.97	Jun 15/2009	
O	98.75	Jun 15/2009		O	98.98	Jun 15/2009	
O	98.76	Jun 15/2009		O	98.99	Jun 15/2009	
O	98.77	Jun 15/2009		O	98.100	Jun 15/2009	
O	98.78	Jun 15/2009		O	98.101	Jun 15/2009	
O	98.79	Jun 15/2009		O	98.102	Jun 15/2009	
O	98.80	Jun 15/2009		O	98.103	Jun 15/2009	
O	98.81	Jun 15/2009		O	98.104	Jun 15/2009	
O	98.82	Jun 15/2009		O	98.105	Jun 15/2009	
O	98.83	Jun 15/2009		O	98.106	Jun 15/2009	
O	98.84	Jun 15/2009		O	98.107	Jun 15/2009	
O	98.85	Jun 15/2009		O	98.108	Jun 15/2009	
O	98.86	Jun 15/2009		O	98.109	Jun 15/2009	
O	98.87	Jun 15/2009		O	98.110	Jun 15/2009	
O	98.88	Jun 15/2009		O	98.111	Jun 15/2009	
O	98.89	Jun 15/2009		O	98.112	Jun 15/2009	
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O	98.116	Jun 15/2009		O	98.139	Jun 15/2009	
O	98.117	Jun 15/2009		O	98.140	Jun 15/2009	
O	98.118	Jun 15/2009		O	98.141	Jun 15/2009	
O	98.119	Jun 15/2009		O	98.142	Jun 15/2009	
O	98.120	Jun 15/2009		O	98.143	Jun 15/2009	
O	98.121	Jun 15/2009		O	98.144	Jun 15/2009	
O	98.122	Jun 15/2009		O	98.145	Jun 15/2009	
O	98.123	Jun 15/2009		O	98.146	Jun 15/2009	
O	98.124	Jun 15/2009		O	98.147	Jun 15/2009	
O	98.125	Jun 15/2009		O	98.148	Jun 15/2009	
O	98.126	Jun 15/2009		O	98.149	Jun 15/2009	
O	98.127	Jun 15/2009		O	98.150	Jun 15/2009	
O	98.128	Jun 15/2009		O	98.151	Jun 15/2009	
O	98.129	Jun 15/2009		O	98.152	Jun 15/2009	
O	98.130	Jun 15/2009		O	98.153	Jun 15/2009	
O	98.131	Jun 15/2009		O	98.154	Jun 15/2009	
O	98.132	Jun 15/2009		O	98.155	Jun 15/2009	
O	98.133	Jun 15/2009		O	98.156	Jun 15/2009	
O	98.134	Jun 15/2009		O	98.157	Jun 15/2009	
O	98.135	Jun 15/2009		O	98.158	Jun 15/2009	
O	98.136	Jun 15/2009		O	98.159	Jun 15/2009	
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O	98.162	Jun 15/2009		O	98.185	Jun 15/2009	
O	98.163	Jun 15/2009		O	98.186	Jun 15/2009	
O	98.164	Jun 15/2009		O	98.187	Jun 15/2009	
O	98.165	Jun 15/2009		O	98.188	Jun 15/2009	
O	98.166	Jun 15/2009		O	98.189	Jun 15/2009	
O	98.167	Jun 15/2009		O	98.190	Jun 15/2009	
O	98.168	Jun 15/2009		O	98.191	Jun 15/2009	
O	98.169	Jun 15/2009		O	98.192	Jun 15/2009	
O	98.170	Jun 15/2009		O	98.193	Jun 15/2009	
O	98.171	Jun 15/2009		O	98.194	Jun 15/2009	
O	98.172	Jun 15/2009		O	98.195	Jun 15/2009	
O	98.173	Jun 15/2009		O	98.196	Jun 15/2009	
O	98.174	Jun 15/2009		O	98.197	Jun 15/2009	
O	98.175	Jun 15/2009		O	98.198	Jun 15/2009	
O	98.176	Jun 15/2009		O	98.199	Jun 15/2009	
O	98.177	Jun 15/2009		O	98.200	Jun 15/2009	
O	98.178	Jun 15/2009		O	98.201	Jun 15/2009	
O	98.179	Jun 15/2009		O	98.202	Jun 15/2009	
O	98.180	Jun 15/2009		O	98.203	Jun 15/2009	
O	98.181	Jun 15/2009		O	98.204	Jun 15/2009	
O	98.182	Jun 15/2009		O	98.205	Jun 15/2009	
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O	98.208	Jun 15/2009		O	98.231	Jun 15/2009	
O	98.209	Jun 15/2009		O	98.232	Jun 15/2009	
O	98.210	Jun 15/2009		O	98.233	Jun 15/2009	
O	98.211	Jun 15/2009		O	98.234	Jun 15/2009	
O	98.212	Jun 15/2009		O	98.235	Jun 15/2009	
O	98.213	Jun 15/2009		O	98.236	Jun 15/2009	
O	98.214	Jun 15/2009		O	98.237	Jun 15/2009	
O	98.215	Jun 15/2009		O	98.238	Jun 15/2009	
O	98.216	Jun 15/2009		O	98.239	Jun 15/2009	
O	98.217	Jun 15/2009		O	98.240	Jun 15/2009	
O	98.218	Jun 15/2009		O	98.241	Jun 15/2009	
O	98.219	Jun 15/2009		O	98.242	Jun 15/2009	
O	98.220	Jun 15/2009		O	98.243	Jun 15/2009	
O	98.221	Jun 15/2009		O	98.244	Jun 15/2009	
O	98.222	Jun 15/2009		O	98.245	Jun 15/2009	
O	98.223	Jun 15/2009		O	98.246	Jun 15/2009	
O	98.224	Jun 15/2009		O	98.247	Jun 15/2009	
O	98.225	Jun 15/2009		O	98.248	Jun 15/2009	
O	98.226	Jun 15/2009		O	98.249	Jun 15/2009	
O	98.227	Jun 15/2009		O	98.250	Jun 15/2009	
O	98.228	Jun 15/2009		O	98.251	Jun 15/2009	
O	98.229	Jun 15/2009		O	98.252	Jun 15/2009	

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O	98.254	Jun 15/2009		O	98.277	Jun 15/2009	
O	98.255	Jun 15/2009		O	98.278	Jun 15/2009	
O	98.256	Jun 15/2009		O	98.279	Jun 15/2009	
O	98.257	Jun 15/2009		O	98.280	Jun 15/2009	
O	98.258	Jun 15/2009		O	98.281	Jun 15/2009	
O	98.259	Jun 15/2009		O	98.282	Jun 15/2009	
O	98.260	Jun 15/2009		O	98.283	Jun 15/2009	
O	98.261	Jun 15/2009		O	98.284	Jun 15/2009	
O	98.262	Jun 15/2009		O	98.285	Jun 15/2009	
O	98.263	Jun 15/2009		O	98.286	Jun 15/2009	
O	98.264	Jun 15/2009		O	98.287	Jun 15/2009	
O	98.265	Jun 15/2009		O	98.288	Jun 15/2009	
O	98.266	Jun 15/2009		O	98.289	Jun 15/2009	
O	98.267	Jun 15/2009		O	98.290	Jun 15/2009	
O	98.268	Jun 15/2009		O	98.291	Jun 15/2009	
O	98.269	Jun 15/2009		O	98.292	Jun 15/2009	
O	98.270	Jun 15/2009		O	98.293	Jun 15/2009	
O	98.271	Jun 15/2009		O	98.294	Jun 15/2009	
O	98.272	Jun 15/2009		O	98.295	Jun 15/2009	
O	98.273	Jun 15/2009		O	98.296	Jun 15/2009	
O	98.274	Jun 15/2009		O	98.297	Jun 15/2009	
O	98.275	Jun 15/2009		O	98.298	Jun 15/2009	

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O	98.300	Jun 15/2009		O	98.323	Jun 15/2009	
O	98.301	Jun 15/2009		O	98.324	Jun 15/2009	
O	98.302	Jun 15/2009		O	98.325	Jun 15/2009	
O	98.303	Jun 15/2009		O	98.326	Jun 15/2009	
O	98.304	Jun 15/2009		O	98.327	Jun 15/2009	
O	98.305	Jun 15/2009		O	98.328	Jun 15/2009	
O	98.306	Jun 15/2009		O	98.329	Jun 15/2009	
O	98.307	Jun 15/2009		O	98.330	Jun 15/2009	
O	98.308	Jun 15/2009		O	98.331	Jun 15/2009	
O	98.309	Jun 15/2009		O	98.332	Jun 15/2009	
O	98.310	Jun 15/2009		D	98.333	Jun 15/2009	
O	98.311	Jun 15/2009		D	98.334	Jun 15/2009	
O	98.312	Jun 15/2009		22-23-00			
O	98.313	Jun 15/2009			1	Oct 10/2002	
O	98.314	Jun 15/2009			2	Oct 10/2006	
O	98.315	Jun 15/2009			3	Oct 10/2004	
O	98.316	Jun 15/2009			4	Oct 10/2004	
O	98.317	Jun 15/2009			5	Oct 10/2003	
O	98.318	Jun 15/2009			6	Oct 10/2003	
O	98.319	Jun 15/2009			7	Oct 10/2003	
O	98.320	Jun 15/2009			8	Oct 10/2003	
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11	Oct 10/2003		34	Oct 10/2003	
12	Oct 10/2003		35	Oct 10/2003	
13	Oct 10/2003		36	Oct 10/2003	
14	Oct 10/2003		37	Oct 10/2003	
15	Oct 10/2003		38	Oct 10/2003	
16	Oct 10/2003		39	Oct 10/2003	
17	Oct 10/2003		40	Oct 10/2003	
18	Oct 10/2003		41	Oct 10/2003	
19	Oct 10/2003		42	Oct 10/2003	
20	Oct 10/2003		43	Oct 10/2003	
21	Oct 10/2003		44	Oct 10/2003	
22	Oct 10/2003		45	Oct 10/2003	
23	Oct 10/2003		46	Oct 10/2003	
24	Oct 10/2003		47	Oct 10/2003	
25	Oct 10/2003		48	BLANK	
26	Oct 10/2003		22-31-00		
27	Oct 10/2003		1	Feb 15/2009	
28	Oct 10/2003		2	Oct 10/2006	
29	Oct 10/2003		3	Jun 10/2007	
30	Oct 10/2003		4	Feb 15/2009	
31	Oct 10/2003		5	Feb 15/2009	
32	Oct 10/2003		6	Oct 10/2005	

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8	Oct 10/2005		31	Jun 10/2007	
9	Jun 10/2007		32	Feb 15/2009	
10	Feb 15/2009		33	Jun 10/2007	
11	Oct 10/2005		34	Jun 10/2007	
12	Feb 15/2009		35	Jun 10/2007	
13	Jun 10/2007		36	Feb 15/2009	
14	Feb 15/2009		37	Feb 15/2009	
15	Oct 10/2005		38	Jun 10/2007	
16	Oct 10/2005		39	Jun 10/2007	
17	Oct 10/2005		40	Jun 10/2007	
18	Oct 10/2005		41	Jun 10/2007	
19	Oct 10/2005		42	Feb 15/2009	
20	Feb 15/2009		43	Feb 15/2009	
21	Jun 10/2007		44	Feb 15/2009	
22	Feb 15/2009		45	Jun 10/2007	
23	Feb 15/2009		46	Jun 10/2007	
24	Feb 15/2009		47	Feb 15/2009	
25	Oct 10/2005		48	Feb 15/2009	
26	Oct 10/2005		49	Jun 10/2007	
27	Jun 10/2007		50	Jun 10/2007	
28	Feb 15/2009		51	Jun 10/2007	
29	Jun 10/2007		52	Jun 10/2007	

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54	Feb 15/2009		77	Jun 10/2007	
55	Jun 10/2007		78	Jun 10/2007	
56	Feb 15/2009		79	Jun 10/2007	
57	Jun 10/2007		80	Oct 10/2005	
58	Feb 15/2009		81	Jun 10/2007	
59	Feb 15/2009		82	Jun 10/2007	
60	Jun 10/2007		83	Jun 10/2007	
61	Jun 10/2007		84	Jun 10/2007	
62	Feb 15/2009		85	Jun 10/2007	
63	Jun 10/2007		86	Jun 10/2007	
64	Jun 10/2007		87	Jun 10/2007	
65	Jun 10/2007		88	Jun 10/2007	
66	Jun 10/2007		89	Jun 10/2007	
67	Jun 10/2007		90	Oct 10/2005	
68	Feb 15/2009		91	Jun 10/2007	
69	Jun 10/2007		92	Jun 10/2007	
70	Jun 10/2007		93	Jun 10/2007	
71	Jun 10/2007		94	Jun 10/2007	
72	Jun 10/2007		95	Jun 10/2007	
73	Jun 10/2007		96	Feb 15/2009	
74	Jun 10/2007		97	Jun 10/2007	
75	Jun 10/2007		98	Feb 15/2009	

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98.2	Feb 15/2009		98.25	Jun 10/2007	
98.3	Jun 10/2007		98.26	Jun 10/2007	
98.4	Feb 15/2009		98.27	Jun 10/2007	
98.5	Oct 10/2005		98.28	Feb 15/2009	
98.6	Feb 15/2009		98.29	Jun 10/2007	
98.7	Jun 10/2007		98.30	BLANK	
98.8	Jun 10/2007				
98.9	Jun 10/2007				
98.10	Jun 10/2007				
98.11	Jun 10/2007				
98.12	Jun 10/2007				
98.13	Jun 10/2007				
98.14	Jun 10/2007				
98.15	Feb 15/2009				
98.16	Jun 10/2007				
98.17	Jun 10/2007				
98.18	Jun 10/2007				
98.19	Jun 10/2007				
98.20	Jun 10/2007				
98.21	Jun 10/2007				
98.22	Feb 15/2009				
98.23	Jun 10/2007				

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DIGITAL FLIGHT CONTROL SYSTEM - INTRODUCTION

General

The digital flight control system (DFCS) does these functions:

- Autopilot
- Flight director
- Altitude alert
- Speed trim
- Mach trim.

HAP 031-054, 101-999

- Autothrottle

HAP 001-013, 015-026, 028-030

The DFCS has a mode control panel (MCP), two flight control computers (FCC), and actuator inputs to the flight control system. Each FCC can do all of the five functions.

HAP 031-054, 101-999

The DFCS has a mode control panel (MCP), two flight control computers (FCC), and actuator inputs to the flight control system. Each FCC can do all of the first five functions, but only FCC A has the autothrottle function.

HAP ALL

Autopilot

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103

The FCCs get inputs from several systems such as the air data inertial reference system (ADIRS) and the flight management computer (FMC) and sends commands to the aileron and elevator actuators. These actuators control the movement of the ailerons and elevators, which control the flight path of the airplane. There are two autopilots, autopilot A from FCC A and autopilot B from FCC B. When you engage an autopilot from the MCP, the autopilot controls the airplane attitude through these phases of flight:

HAP 038, 042-046, 048, 051-053, 104-999

The FCCs get inputs from several systems such as the air data inertial reference system (ADIRS) and the flight management computer (FMC) and sends commands to the aileron, elevator and rudder actuators. These actuators control the movement of the ailerons and elevators, which control the flight path of the airplane. There are two autopilots, autopilot A from FCC A and autopilot B from FCC B. When you engage an autopilot from the MCP, the autopilot controls the airplane attitude through these phases of flight:

HAP ALL

- Climb
- Cruise
- Descent

- Approach
- Go-around
- Flare.

HAP 038, 042-046, 048, 051-053, 104-999

- Rollout

HAP ALL

Flight Director

The FCCs get inputs from several systems and send flight director commands to the common display system (CDS) to provide guidance for the pilots. When the MCP flight director switches are on, the flight director display shows on the common display system (CDS). The flight crew can use the flight director commands to control the attitude of the airplane. The flight director commands do not show at flare.

Altitude Alert

As the airplane gets near or flies away from the MCP selected altitude, an alert occurs. This alert warns the pilots that they are getting near or leaving the MCP selected altitude. This warning occurs with or without the autopilots engaged or the flight directors on.

Speed Trim

When the engine thrust is high and the airspeed is low, the speed trim function keeps the speed set by the pilots with commands to the horizontal stabilizer. This function primarily occurs during takeoff and only operates when the autopilots are not engaged. The flight directors may be on or off.

Mach Trim

As the speed of the airplane increases, the nose starts to drop. This is called mach tuck. When the airplane airspeed is more than mach 0.615, the mach trim function gives an up elevator to keep the nose of the airplane level. This function operates with or without the autopilot engaged or the flight director on.

HAP 031-054, 101-999

Autothrottle

The autothrottle (A/T) function in flight control computer A (FCC A) uses data from airplane sensors to calculate engine thrust. The A/T system controls engine thrust in response to mode requests from the flight crew through the DFCS MCP and flight deck switches, and from the FMC. The A/T system operates from takeoff to touchdown.

HAP ALL

Abbreviations and Acronyms

- AAM - autopilot actuator monitor
- ac - alternating current
- accel - acceleration
- actr - actuator
- ACQ - acquire
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- ADR - air data reference
- AFCS - automatic flight control system

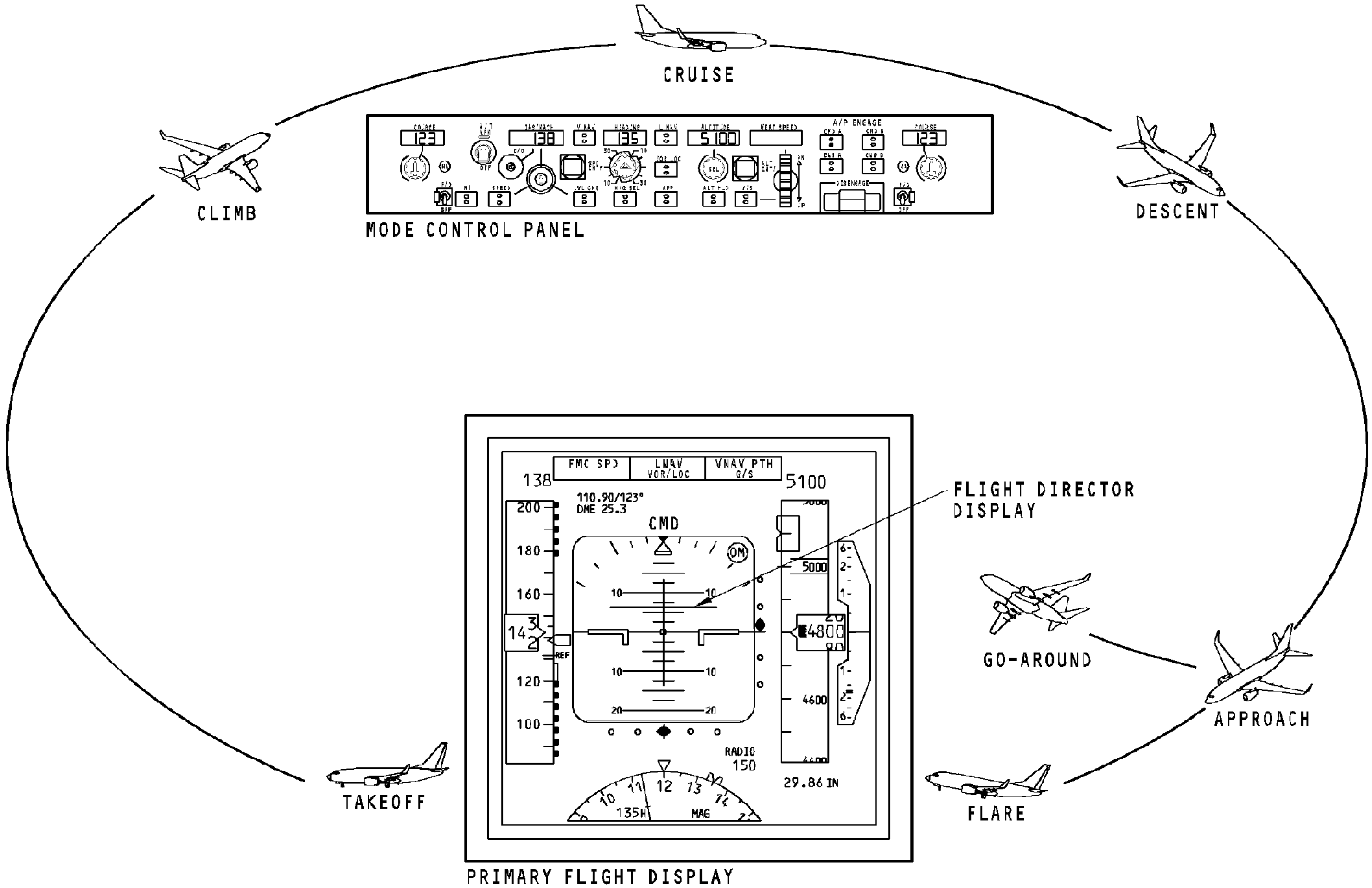
DIGITAL FLIGHT CONTROL SYSTEM - INTRODUCTION

- AFDS - autopilot flight director system
- AGS - air/ground system
- AI - attitude indicator
- ail - aileron
- alt - altitude
- ALT - alternate
- ANN - annunciator
- annun - annunciator
- ANT - antenna
- AOC - approach-on-course
- A/P - autopilot
- APP - approach
- ARINC - Aeronautical Radio Incorporated
- A/S - airspeed
- ASA - autoflight status annunciator
- A/T - autothrottle
- BAT - battery
- BITE - built-in test equipment
- BOV - bias out of view
- CAPT - captain
- CAA - Civil Aviation Authority
- CAS - computed airspeed
- cat - category
- cau - caution
- C/B - circuit breaker
- CDS - common display system
- CDU - control display unit
- CH - channel
- chg - change
- CLB - climb
- CMD - command
- C/O - change over
- cont - control
- CPU - central processing unit
- CRS - course
- CWS - control wheel steering
- dc - direct current
- deg - degree
- DEU - display electronics unit
- DFCS - digital flight control system
- DISC - disconnect
- DMA - direct memory access
- DME - distance measuring equipment
- DN - down
- elec - electric
- elev - elevator
- ELEX - electronic
- eng - engage
- exc - excitation
- FAA - Federal Aviation Administration
- FCC - flight control computer
- F/D - flight director
- FDAU - flight data acquisition unit
- FGN - foreign
- FIM - Fault Isolation Manual
- flt - flight
- FMA - flight mode annunciator
- FMC - flight management computer
- FMCS - flight management computing system
- F/O - first officer
- FPA - flight path angle
- FPM - feet per minute
- FREQ - frequency
- FWD - forward
- G/A - go-around
- gnd - ground

DIGITAL FLIGHT CONTROL SYSTEM - INTRODUCTION

- GPS - global positioning system
- GPWC - ground proximity warning computer
- G/S - glideslope
- hdg - heading
- hld - hold
- hyd - hydraulic
- Hz - hertz
- IAS - indicated airspeed
- IFSAU - integrated flight system accessory unit
- ILS - instrument landing system
- inh - inhibit
- instr - instrument
- intlk - interlock
- I/O - input/output
- IR - inertial reference
- IRS - inertial reference system
- kts - knots
- l - left
- lbs - pounds
- LCD - liquid crystal display
- LCL - local
- LED - light emitting diode
- LNAV - lateral navigation
- LOC - localizer
- LRU - line replaceable unit
- LSK - line select key
- LT - light
- LVDT - linear variable differential transformer
- lvl - level
- MA - master
- MASI - mach airspeed indicator
- MB - marker beacon
- MCP - mode control panel
- MCU - modular concept unit
- MLS - microwave landing system
- Mmo - mach maximum operating
- MMR - multimode receiver
- mst - master
- MSU - mode select unit
- NAV - navigation
- NCD - no computed data
- ND - navigation display
- NSS - neutral shift sensor
- OC - on course
- O/D - out of detent
- OSS - over station sensor
- P - push
- PAM - performance assessment monitor
- PB - push-button
- PCU - power control unit
- PFD - primary flight display
- pnl - panel
- posn - position
- press - pressure
- prev - previous
- prim - primary
- PSEU - proximity switch electronic unit
- PSI - pounds per square inch
- PTH - path
- R - right
- RA - radio altimeter
- RAM - random access memory
- rad - radio
- REF - reference

- REQ - request
- REU - remote electronics unit
- RF - radio frequency
- rly - relay
- RST - reset
- rud - rudder
- sec - second
- sel - select
- sens - sensor
- SMYDC - stall management yaw damper computer
- snsr - sensor
- SPD - speed
- SPM - surface position monitor
- spn - spin
- stab - stabilizer
- surf - surface
- sw - switch
- sync - synchronization
- sys - system
- TAS - true airspeed
- THR - throttle
- T/O - takeoff
- TO/GA - takeoff/go-around
- T/R - thrust reverser
- TR - transformer rectifier
- TRK - track
- typ - typical
- V - volts
- V2 - scheduled target speed
- vert - vertical
- VHF - very high frequency
- Vmo - maximum operating velocity
- V/S - vertical speed
- VNAV - vertical navigation
- VOR - VHF omnidirectional range
- WARN - warning
- WHL - wheel
- X-CH - cross channel
- XCHAN - cross channel
- xmtr - transmitter
- xfer - transfer



DIGITAL FLIGHT CONTROL SYSTEM - INTRODUCTION

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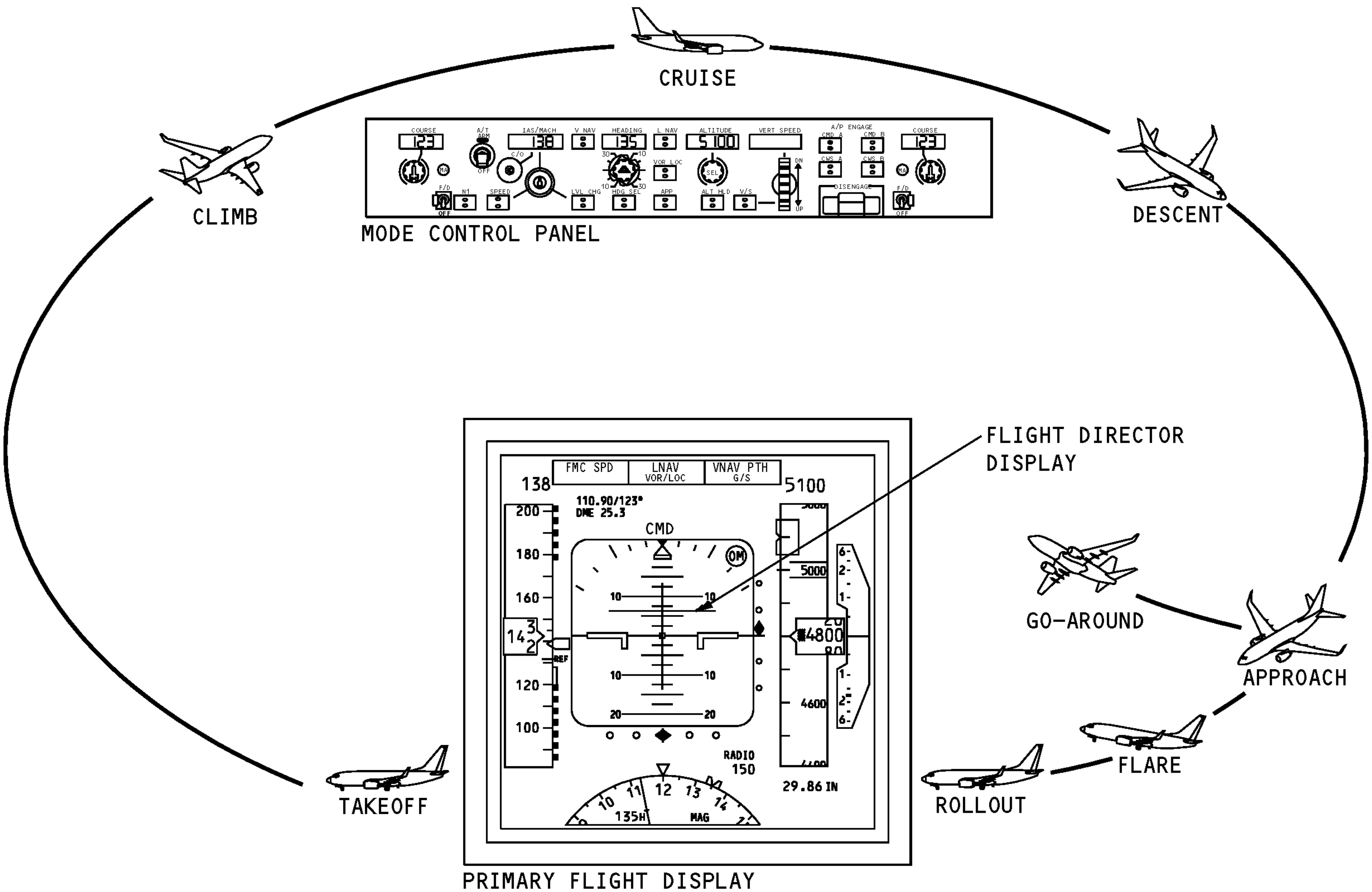

DIGITAL FLIGHT CONTROL SYSTEM - INTRODUCTION

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DFCS - GENERAL DESCRIPTION

Mode Control Panel

The mode control panel (MCP) is the primary interface between the flight crew and the flight control computers (FCCs). The crew uses the MCP to do these functions:

- Engage the autopilots
- Turn on the flight directors
- Select the mode of operation
- Select course and heading
- Select target speeds and altitude.

Other crew inputs to the FCCs are from these components:

- Autopilot (A/P) disengage switches
- Takeoff/Go-around (TO/GA) switches
- Control wheel steering (CWS) force transducers
- Autoflight status annunciators (ASAs).

FCC A and B

The FCCs use data from the MCP, sensors, and these systems to calculate the autopilot and flight director commands:

- Radio navigation systems
- Air data inertial reference system (ADIRS)
- Flight management computer system (FMCS)
- Autothrottle (A/T) system
- Control surface position sensors
- Autopilot actuator position sensors.

The FCCs also use the data to calculate these commands and alerts:

- Speed trim commands
- Mach trim commands
- Altitude alerts
- Autopilot disengage warnings.

Autopilot Commands

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103

The autopilot can be in the command (CMD) or the control wheel steering (CWS) mode. In the CMD mode, the FCC calculates the commands which go to the autopilot actuators. The actuators cause the inputs to the power control units (PCU) to move which control the ailerons and elevator. In the CWS mode, force transducers under the control columns sense control wheel and control column forces from the pilots and send these signals to the FCC. The FCC sends the commands to the autopilot actuators to control the ailerons and elevator. The FCC also sends commands to the stabilizer trim electric actuator to trim the stabilizer.

DFCS - GENERAL DESCRIPTION

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103 (Continued)

HAP 038, 042-046, 048, 051-053, 104-999

The autopilot can be in the command (CMD) or the control wheel steering (CWS) mode. In the CMD mode, the FCC calculates the commands which go to the autopilot actuators. The actuators cause the inputs to the power control units (PCU) to move which control the ailerons, elevator and rudder. In the CWS mode, force transducers under the control columns sense control wheel and control column forces from the pilots and send these signals to the FCC. The FCC sends the commands to the autopilot actuators to control the ailerons and elevator. The FCC also sends commands to the stabilizer trim electric actuator to trim the stabilizer.

HAP ALL

The autopilot mode shows on the common display system (CDS) above the attitude indicator. To disengage the autopilot, the pilot pushes the disengage switches on the control wheel. When the autopilot disengages, an aural warning is heard from the aural warning module and the red A/P light on the autoflight status annunciator (ASA) flashes. The ASA warning and aural alert can be reset if the pilot pushes the red A/P annunciator on the ASA or pushes the A/P disconnect switch.

Flight Director Commands

When the flight directors are on, the FCC calculates the guidance commands that show on the CDS. There is no movement of the control surfaces and no alert if the flight directors are turned off. When you set the flight director mode on the MCP, the mode and its status also show on the CDS display.

Altitude Alert

The altitude alert function uses the altitude that is set on the MCP. The FCCs tells the flight crew when the airplane approaches or departs the set altitude. The autopilot or flight directors do not have to be on for this alert to operate. There is an aural indication from the remote electronic unit (REU) and a visual indication on the CDS displays.

Speed Trim

The FCCs send speed trim signals to the stabilizer trim primary electric actuator to control the horizontal stabilizer movements. This control increases the airplane stability at low air speeds. As the airplane speed slows, the stabilizer is moved to a more nose down position to increase the speed. As the speed increases, the stabilizer is moved to a more nose up position to decrease the speed. This function only operates if the autopilot is not engaged.

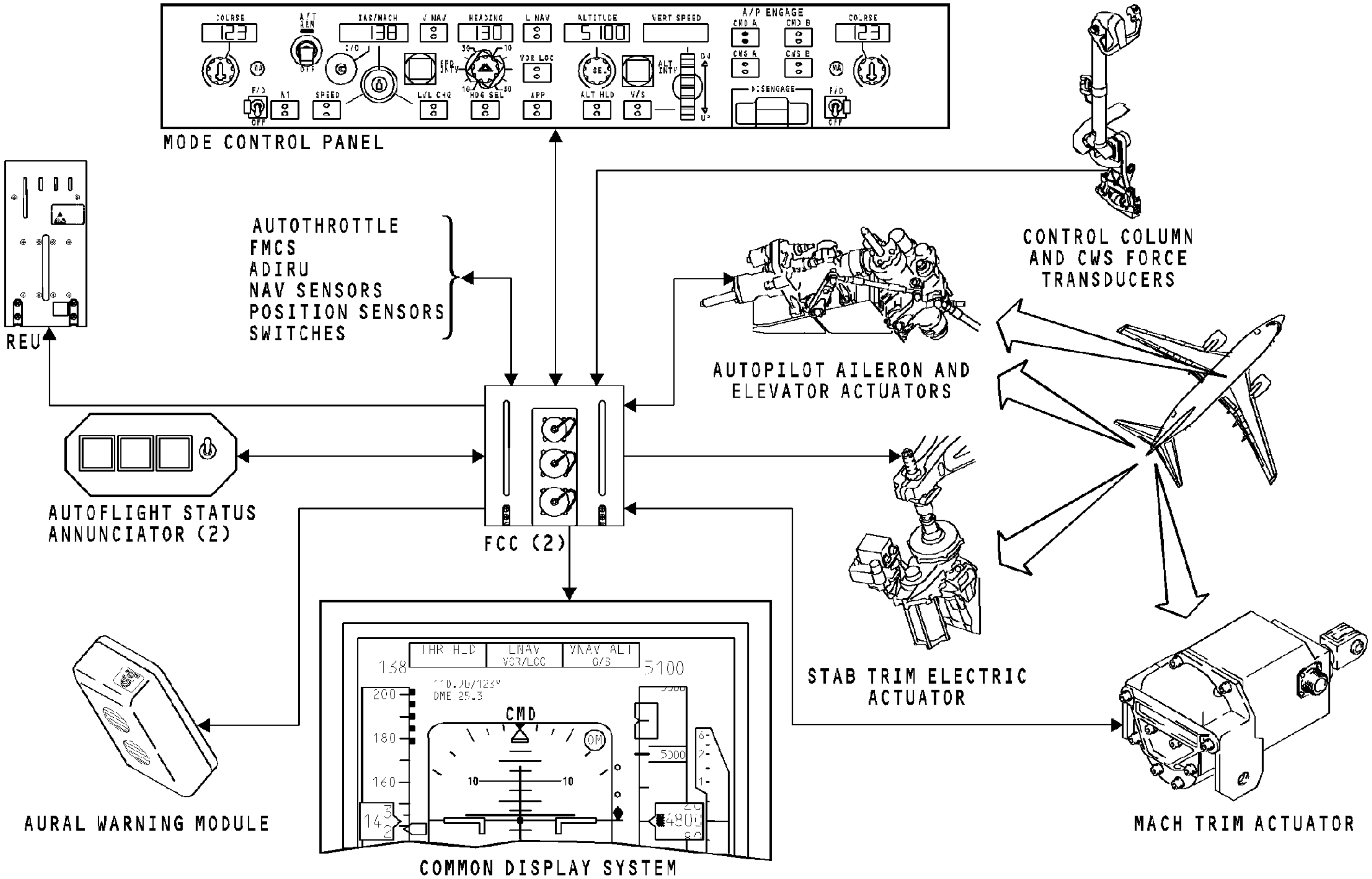
DFCS - GENERAL DESCRIPTION

Mach Trim

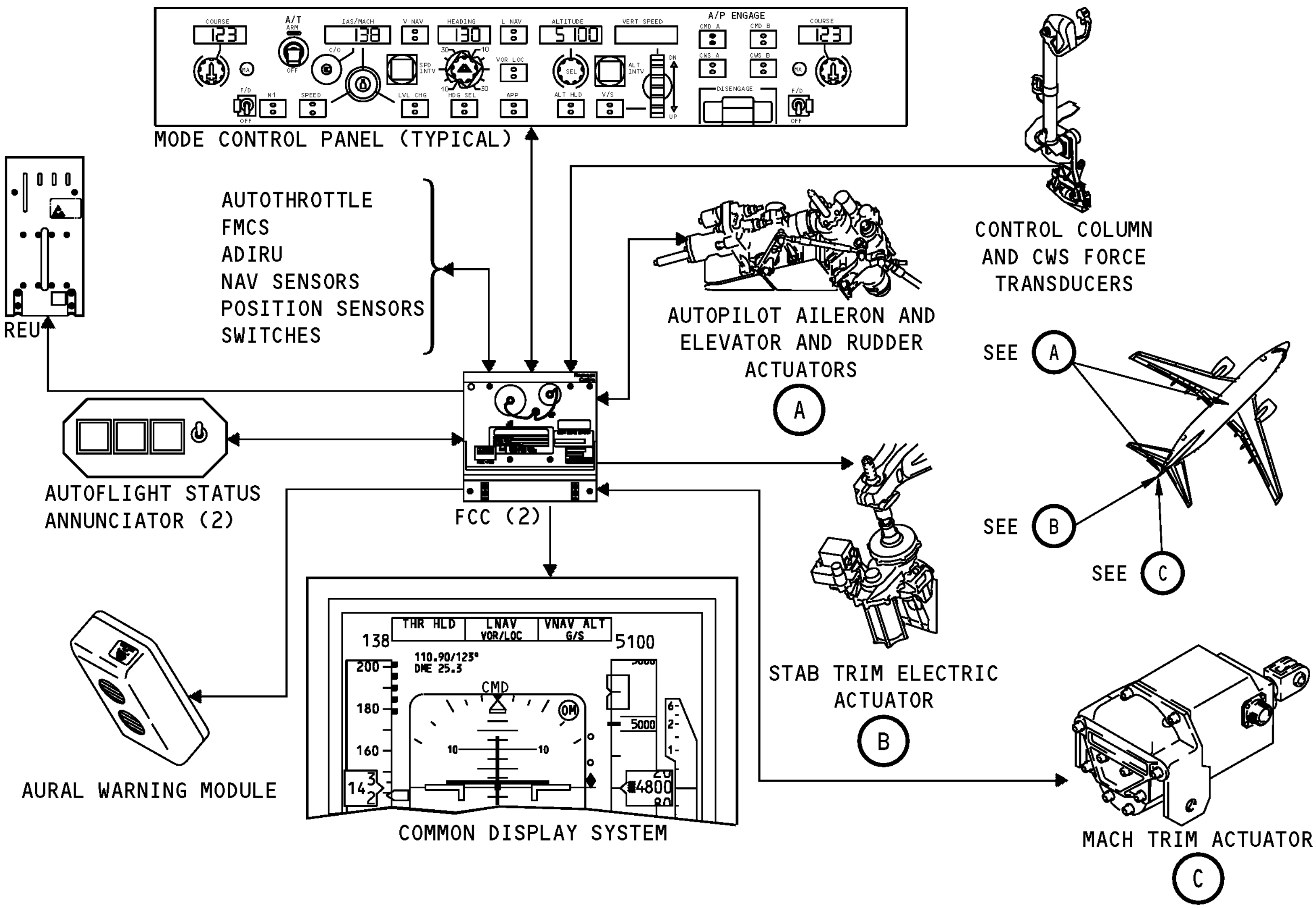
The FCCs send mach trim signals to a mach trim actuator to control the elevator movements. As the mach trim actuator output shaft moves, it turns the feel and centering unit which moves the input to the elevator PCUs. This moves the elevator. The mach trim signal keeps the nose up at high air speeds. The mach trim actuator also causes the elevator to be in a more nose down position during takeoff which allows the pilots to move the stabilizer to a more nose up position. This allows a more nose up attitude if there is an engine failure during takeoff and is called the FCC controlled neutral shift enable (FCNSE) region.

Built-In-Test-Equipment (BITE)

The DFCS has interfaces with the FMCS to show the BITE condition on the control display units (CDU). The BITE function helps find failures.



DFCS - GENERAL DESCRIPTION



DFCS - GENERAL DESCRIPTION

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DFCS - FLIGHT COMPARTMENT COMPONENT LOCATION

Flight Compartment

The mode control panel (MCP) is on the P7 glareshield.

The captain autopilot disengage switch is on the captain control wheel. The first officer autopilot disengage switch is on the first officer control wheel.

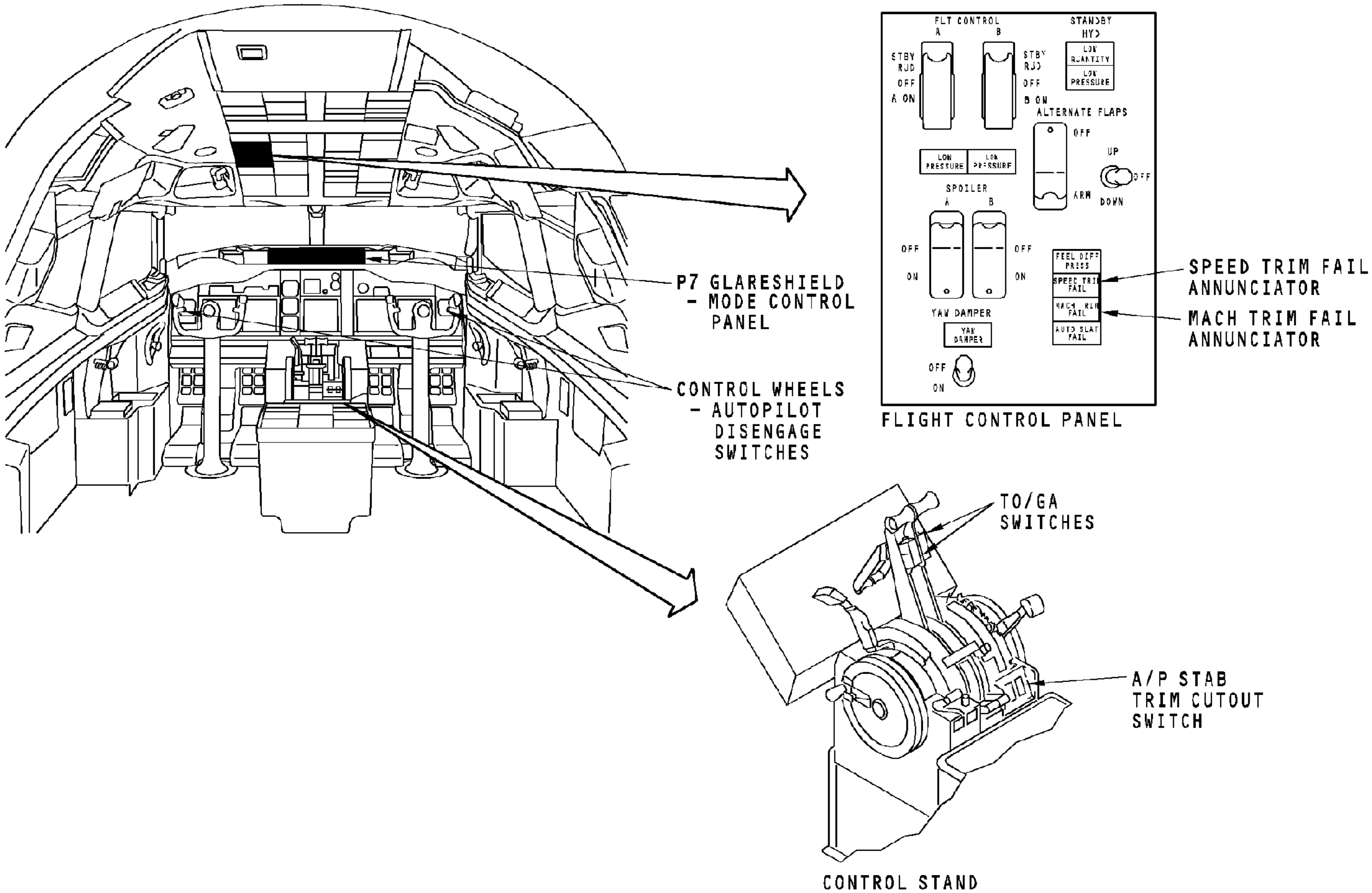
Flight Control Panel

The speed trim fail and mach trim fail annunciators have interface with the digital flight control system (DFCS). They are on the flight control panel.

Control Stand

The captain and first officer takeoff/go-around (TO/GA) switches are on the thrust levers. The thrust levers are on the control stand.

The autopilot (A/P) stab trim cutout switch has interface with the DFCS. It is on the control stand.



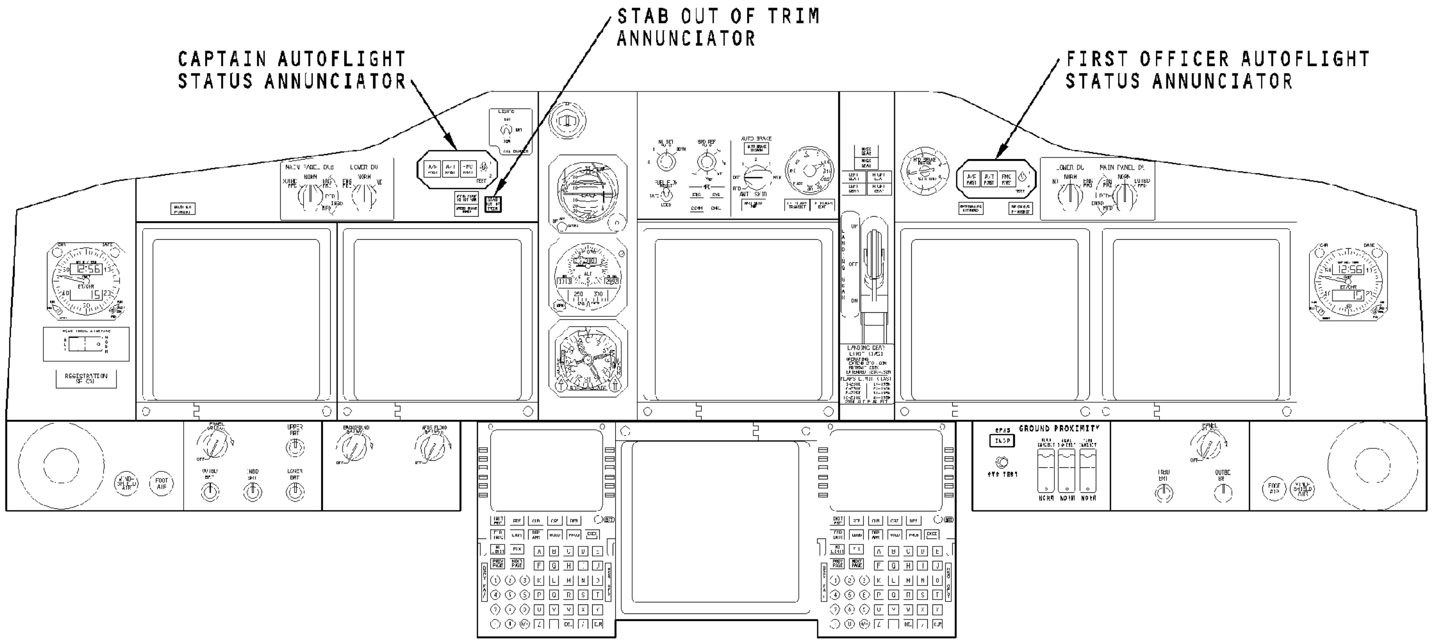
DFCS - FLIGHT COMPARTMENT COMPONENT LOCATION

DFCS - INSTRUMENT PANEL COMPONENT LOCATIONS

Instrument Panel

The stab out of trim annunciator has interface with the DFCS.

The stab out of trim annunciator and the captain autoflight status annunciator (ASA) are on the P1-3 panel. The first officer ASA is on the P3-1 panel.



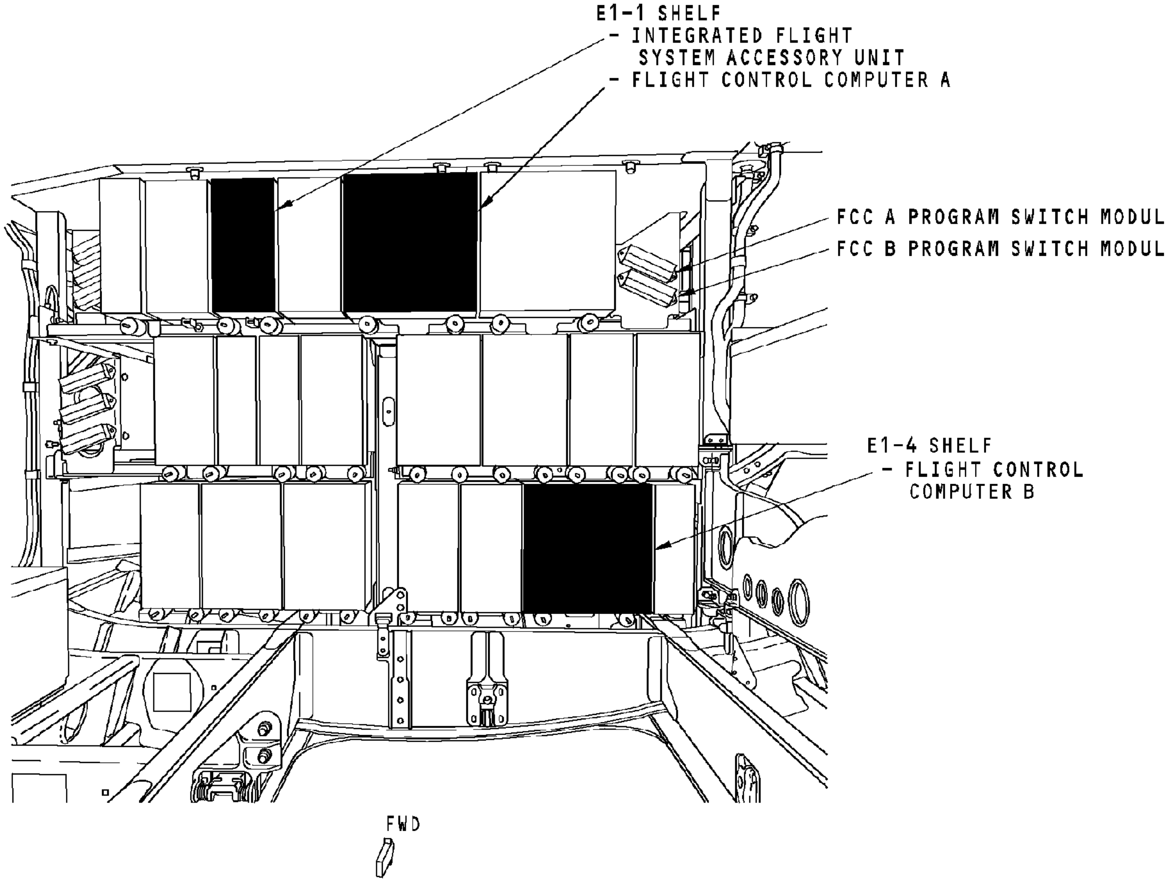
DFCS - INSTRUMENT PANEL COMPONENT LOCATIONS

22-11-00-048

DFCS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

E-1 Rack

The integrated flight system accessory unit (IFSAU) is on the E1-1 shelf. The flight control computer (FCC) A is also on the E1-1 shelf. The FCC B is on the E1-4 shelf. The program switch modules for FCC A and FCC B are also on the E1 rack.



DFCS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

DFCS - TAILCONE COMPONENT LOCATION

Tailcone Component Locations

The autopilot elevator actuators are on the left side of the forward bulkhead of the tail cone.

The elevator position sensor is on the lower right side of the bulkhead in the tail cone.

Stabilizer position sensor B is on the right side of the elevator feel and centering unit. It shows on the graphic. Stabilizer position sensor A is on the left side of the elevator feel and centering unit and is not shown.

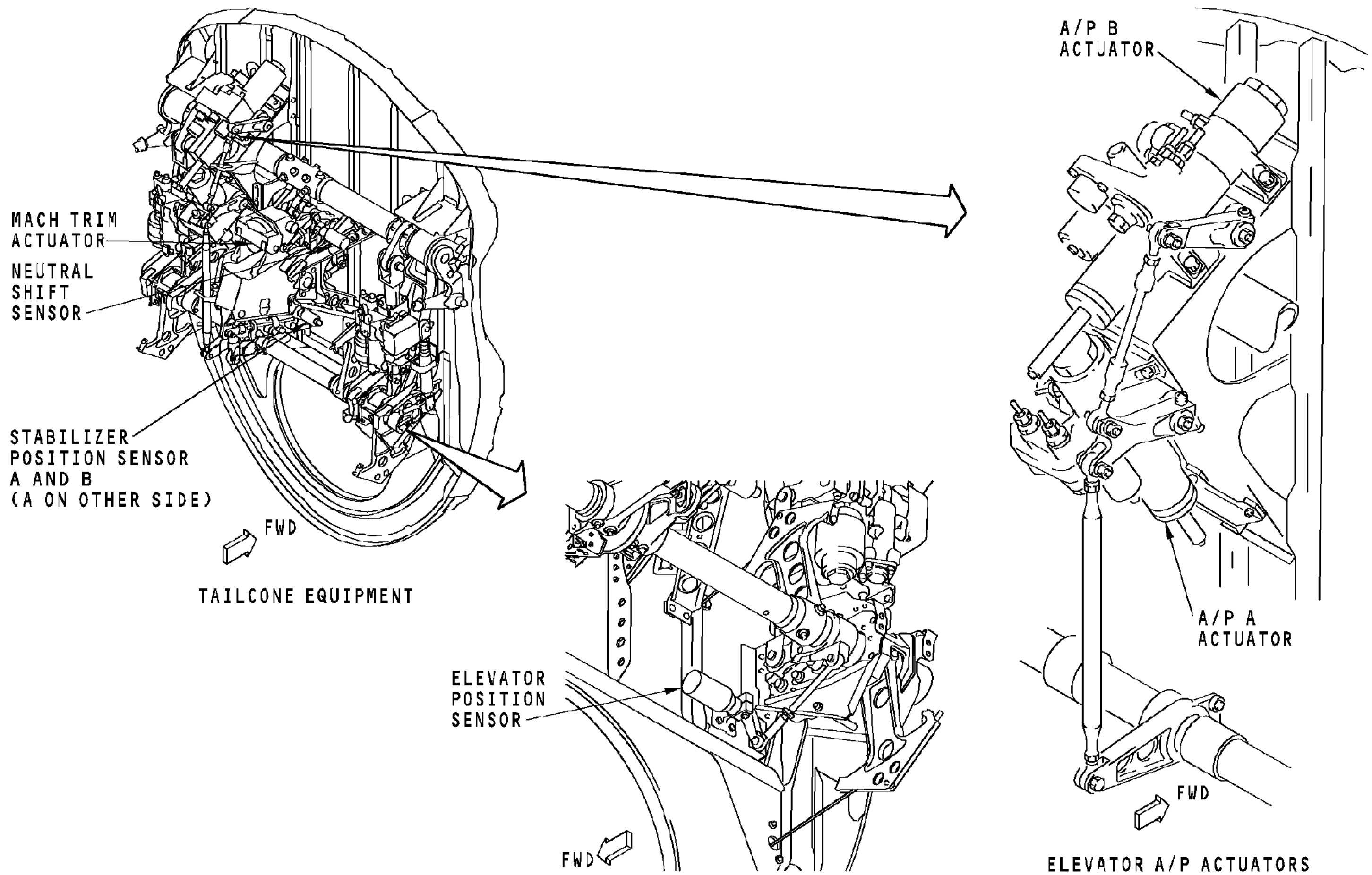
The mach trim actuator is on top of the elevator feel and centering unit.

The neutral shift sensor is on the right side of the elevator feel and centering unit.

Training Information Point

When you install the neutral shift sensor, follow the instructions in this caution.

CAUTION: PUT THE CRANK ARM IN THE CORRECT UP DIRECTION. THE CRANK ARM NOT IN THE CORRECT UP DIRECTION CAN CAUSE DAMAGE TO EQUIPMENT.



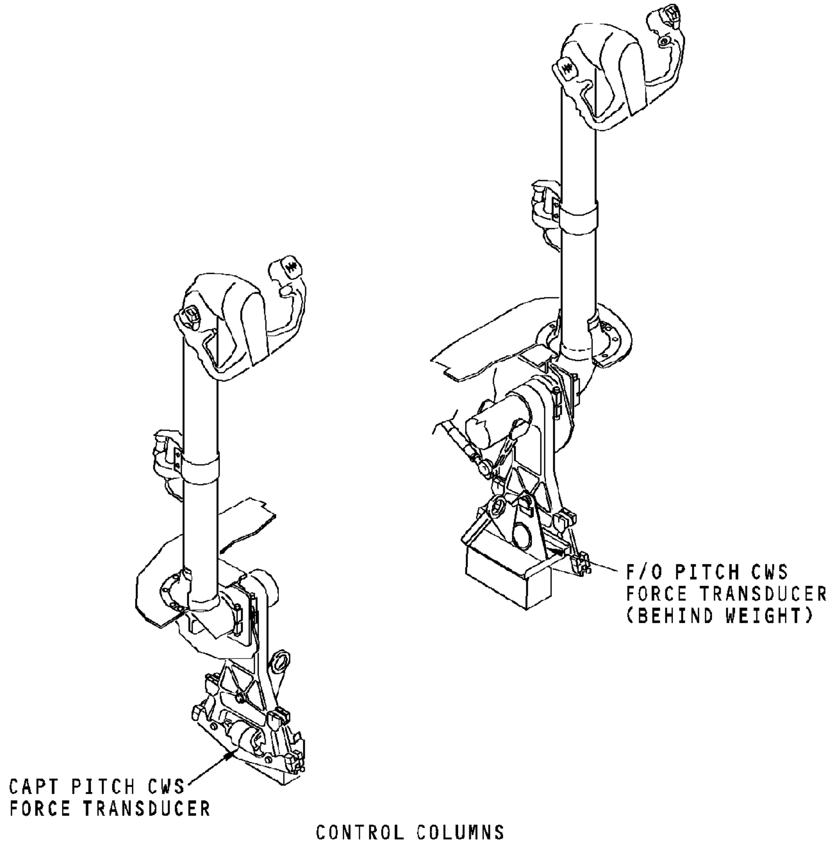
DFCS - TAILCONE COMPONENT LOCATION

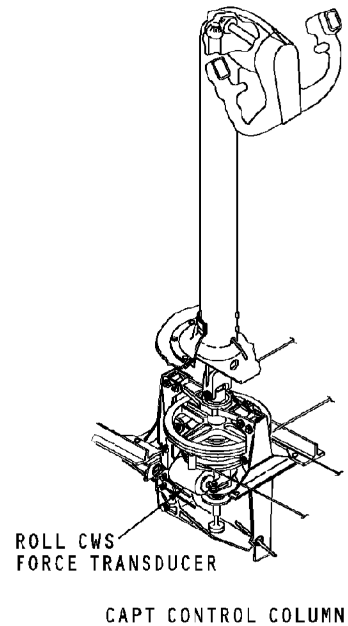
DFCS - FORWARD EQUIPMENT COMPARTMENT COMPONENT LOCATIONS

Lower Control Column Component Locations

The captain's and first officer's pitch CWS force transducers are between the support and the forward quadrants on the torque tube. The torque tube is between the captain's and first officer's control column.

The roll CWS force transducer is below the captain's control column.





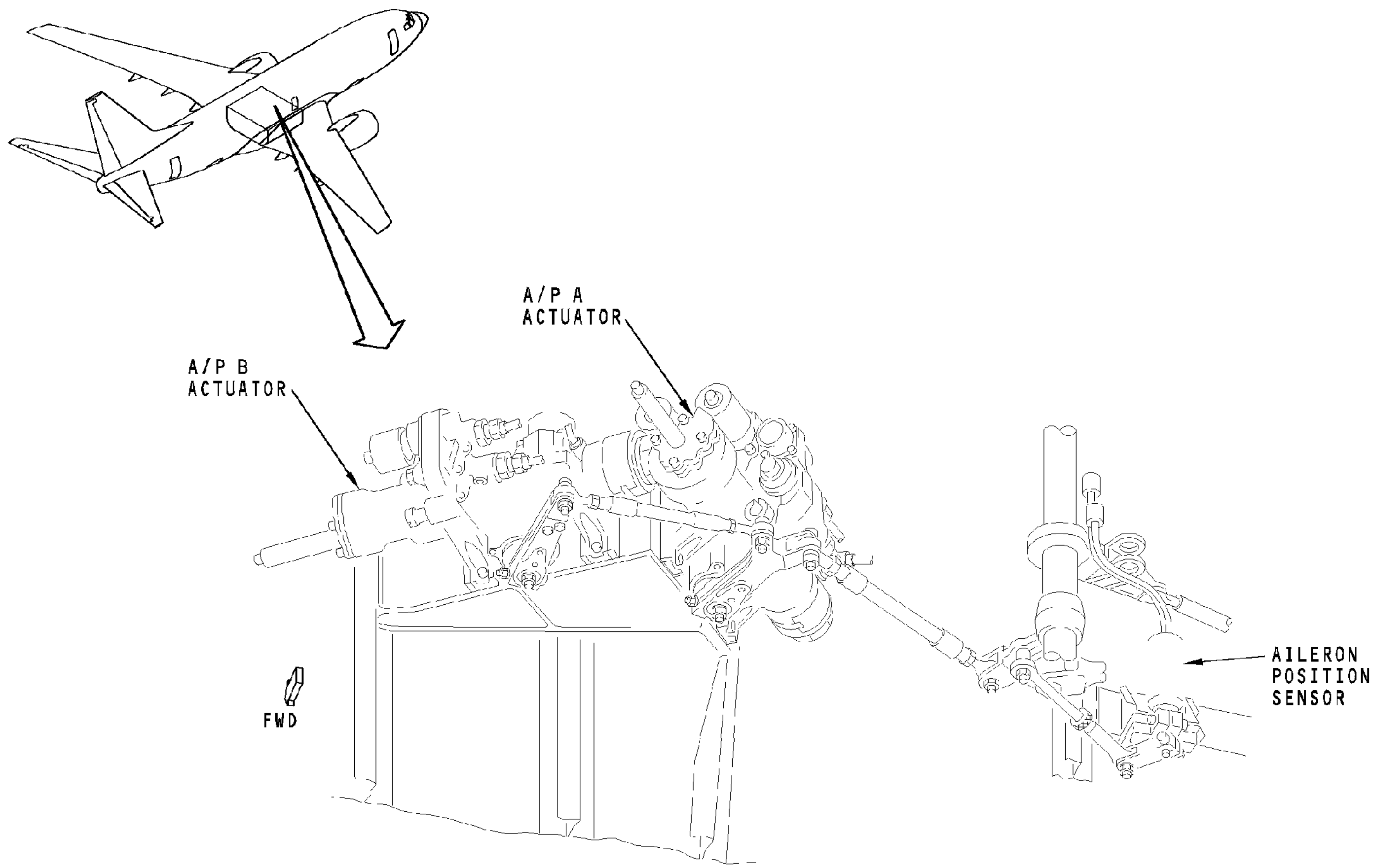
DFCS - FORWARD EQUIPMENT COMPARTMENT COMPONENT LOCATIONS

DFCS - WHEEL WELL COMPONENT LOCATIONS

Wheel Well Component Locations

The autopilot aileron actuators for systems A and B are in the main gear wheel well. They are on a support bracket on the left forward wall of the wheel well.

The aileron position sensor is on the forward wall of the main wheel well. It is between the autopilot aileron actuators and the aileron power control units (PCUs).



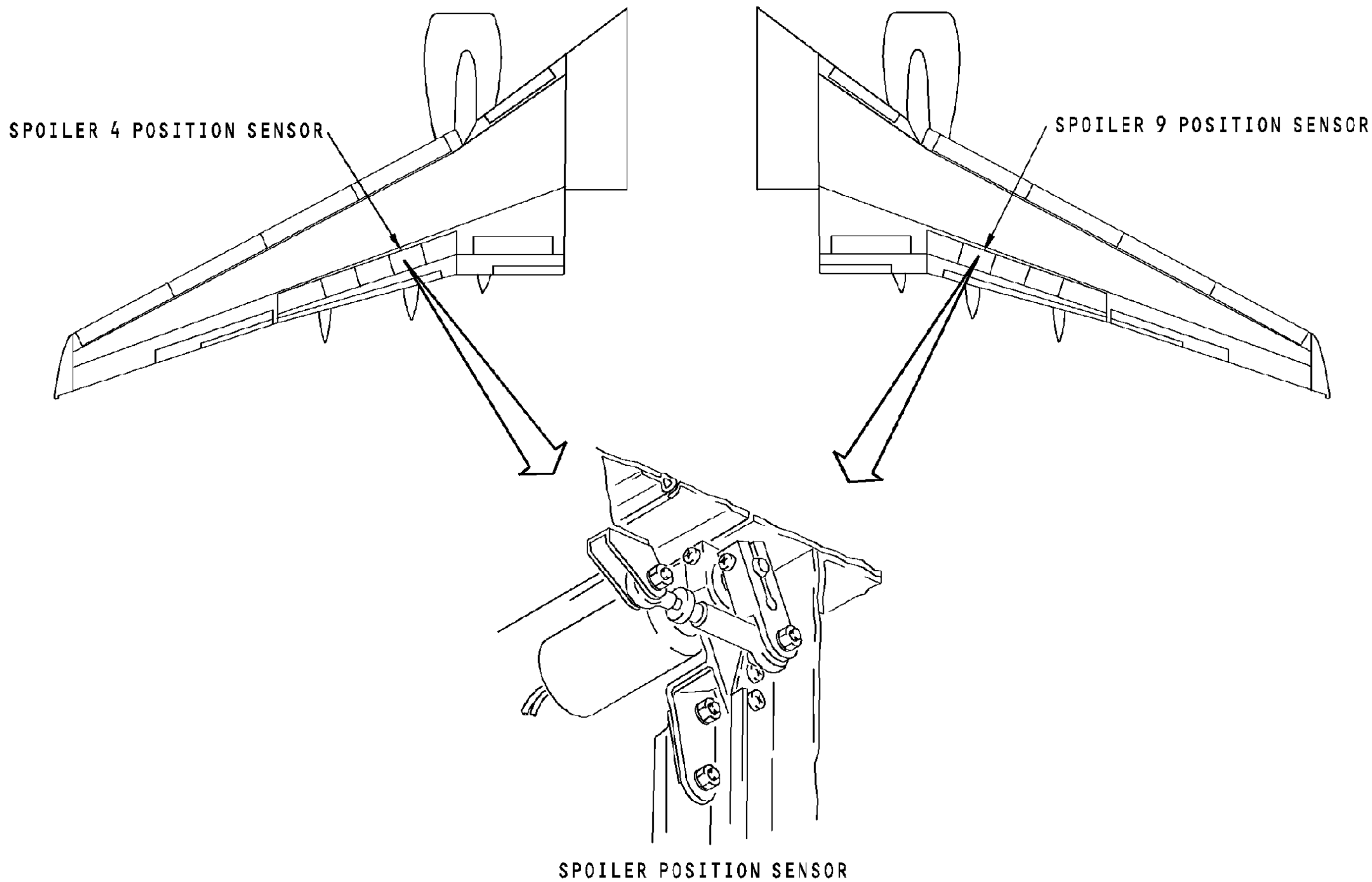
AILERON A/P ACTUATORS AND POSITION SENSOR

DFCS - WHEEL WELL COMPONENT LOCATIONS

DFCS - WING COMPONENT LOCATION

Spoiler Position Sensors Component Locations

The spoiler position sensors are on the rear wing spars. The spoiler 4 position sensor is on the left wing below spoiler 4. The spoiler 9 position sensor is on the right wing below spoiler 9.



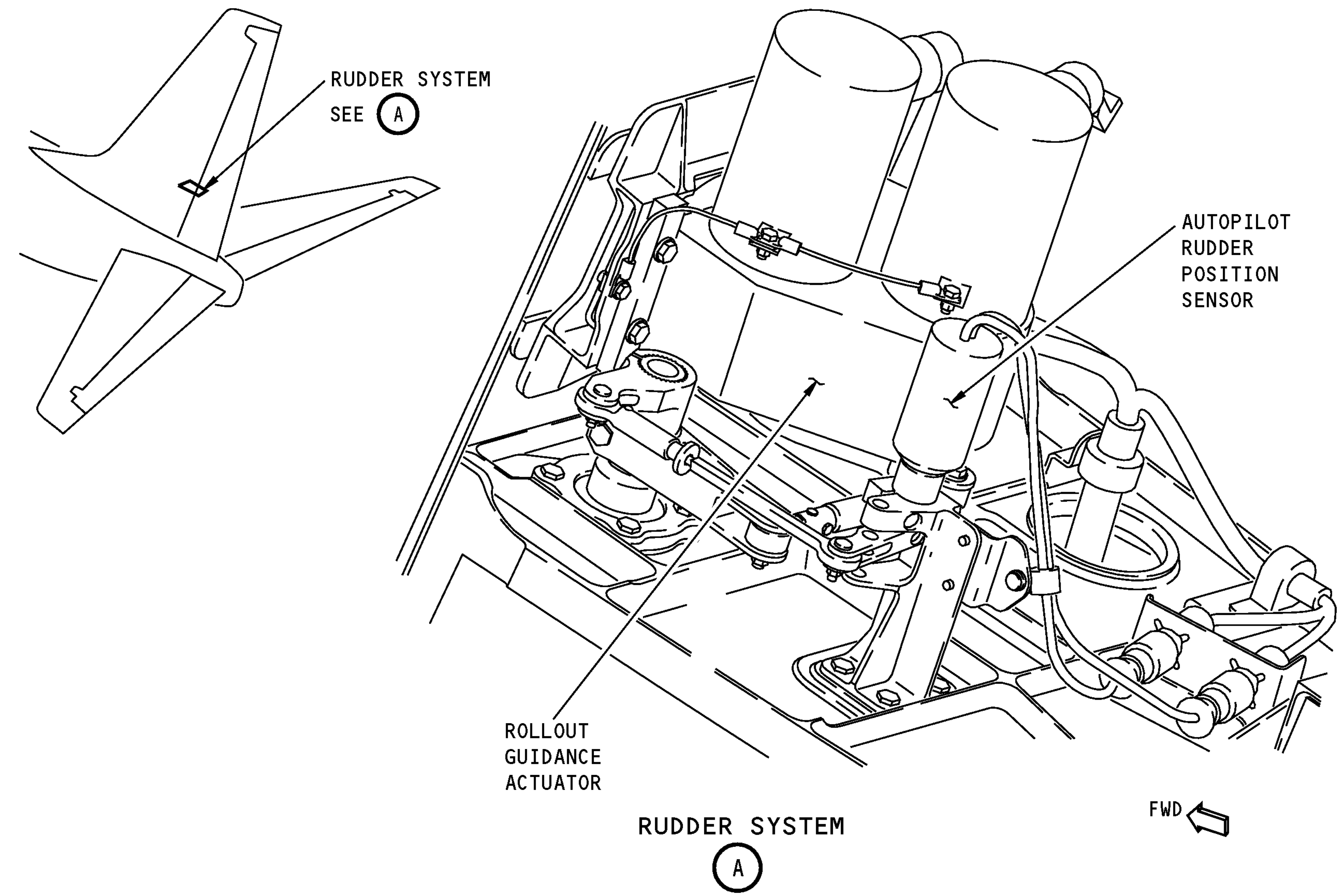
DFCS - WING COMPONENT LOCATION

DFCS - VERTICAL FIN COMPONENT LOCATION

Vertical Fin Component Locations

The rudder rollout guidance actuator is in the vertical fin. It is mounted on a bracket on the vertical fin rear spar.

The autopilot rudder position sensor is mounted aft of the rear spar.



DFCS - VERTICAL FIN COMPONENT LOCATIONS

22-11-00-147

EFFECTIVITY
HAP 038, 042-046, 048, 051-053, 104-999

DFCS - POWER INTERFACE INTRODUCTION

General

There are several circuit breakers that supply power to the flight control computers (FCC). Much of the power goes through other switches and circuits before the FCCs.

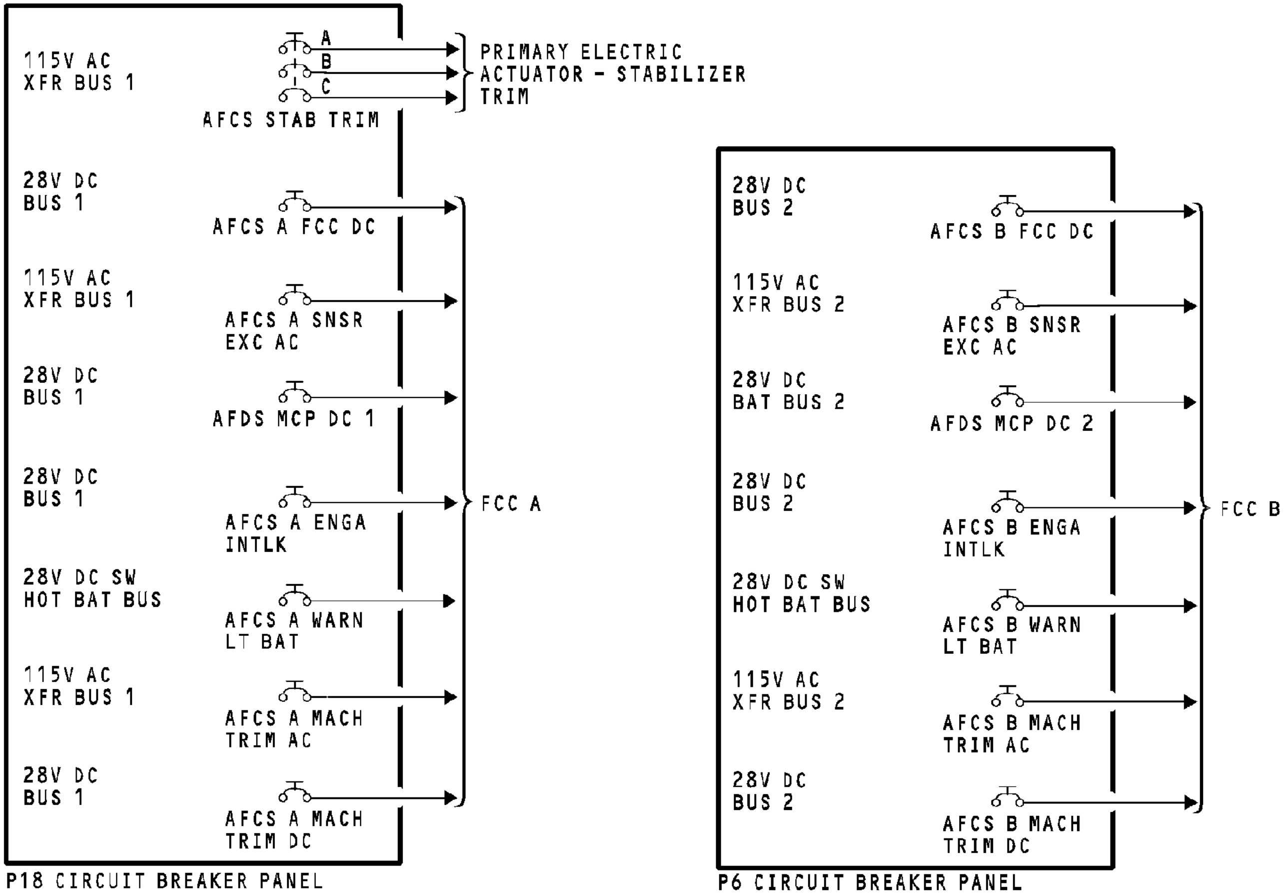
Training Information Point

It is possible that a valid FCC could fail the power-up test if some of the circuit breakers are not closed in the correct sequence. If the AFCS A(B) FCC DC circuit breaker is closed before the AFDS MCP DC 1(2) circuit breaker, the FCC may do an in-air power up. The FCC may fail to power up successfully under this condition.

Therefore, the best procedure to apply power to the DFCS system after maintenance is to close the AFCS A(B) FCC DC circuit breaker last.

DC Power Interruptions and Voltage Transients

If the 28 VDC power interruption is less than 40 msec, there will be no changes in the mode or output of the DFCS. If the interruption is more than 40 msec, but less than 7 seconds, the autopilot will disengage but other functions (F/D modes, trim functions, and warnings) will continue. If the interruption is more than 7 seconds, the DFCS will initialize to its initial power setup.



DFCS - POWER INTERFACE INTRODUCTION

DFCS - POWER INTERFACE

Stabilizer Trim Electric Actuator Power

The 115v ac transfer bus 1 supplies three phase ac power to the stabilizer trim electric actuator.

FCC Power

The 28v dc buses 1 and 2 supply power to their onside flight control computers (FCC). The 115v ac transfer buses 1 and 2 supply power to the integrated flight system accessory unit (IFSAU).

The IFSAU uses transformers to change each 115v ac to a 26v ac sensor excitation power supply. The IFSAU supplies this power to the onside FCC as a reference voltage for the CWS force transducers and flap position transmitters.

HAP 038, 042-046, 048, 051-053, 104-999

Rudder Actuator Power

The 28v dc buses 1 and 2 supply power to their onside FCC. The FCC uses this power to operate the motor in the rudder actuator during approach, landing, rollout and go-around.

HAP ALL

Mode Control Panel (MCP) Power

The 28v dc buses 1 and 2 supply power to the MCP.

Sensor Excitation Power

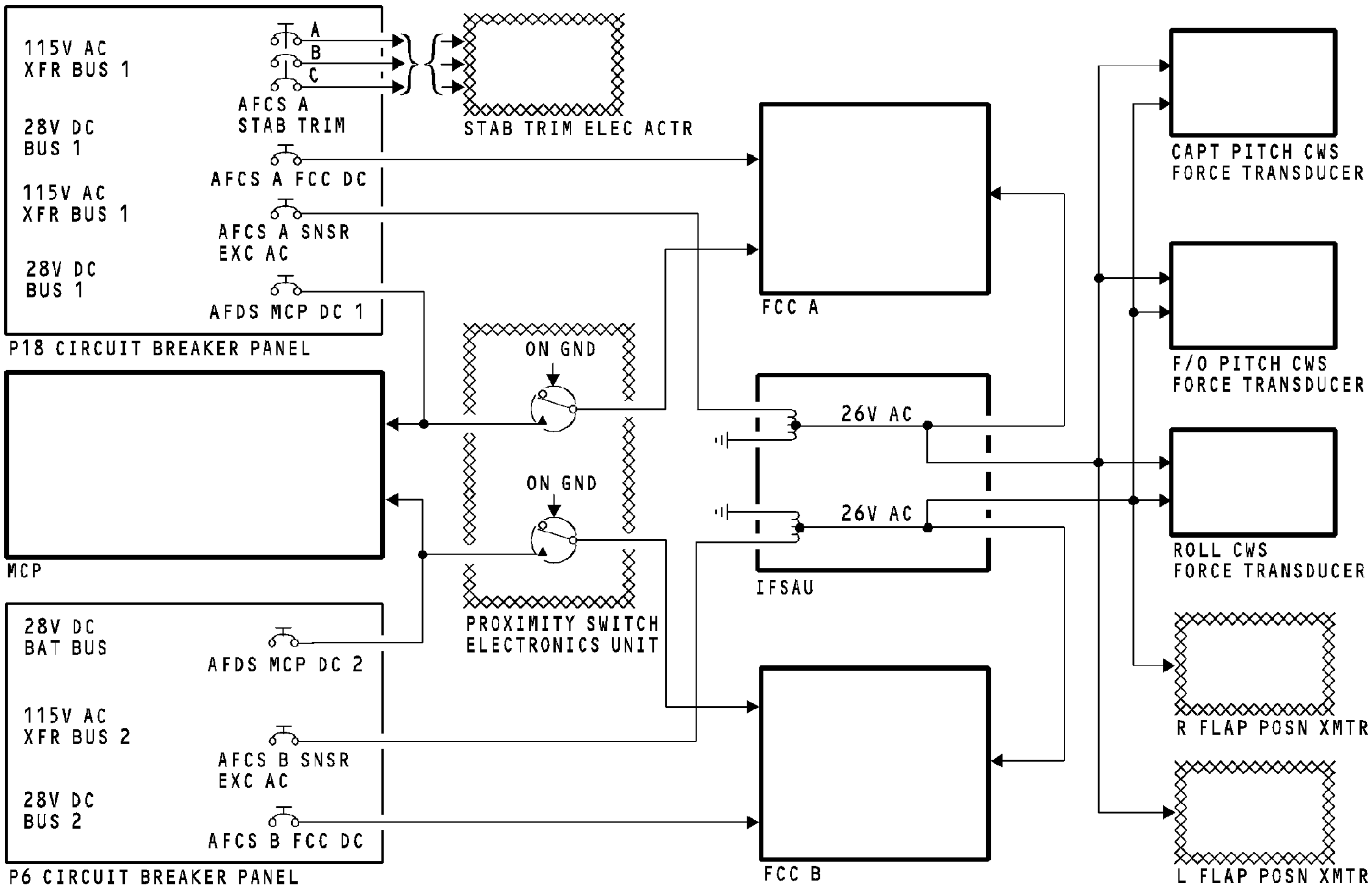
The IFSAU supplies excitation power to these sensors:

- Captain pitch control wheel steering (CWS) force transducer
- First officer pitch CWS force transducer
- Roll CWS force transducer
- Right flap position transmitter
- Left flap position transmitter.

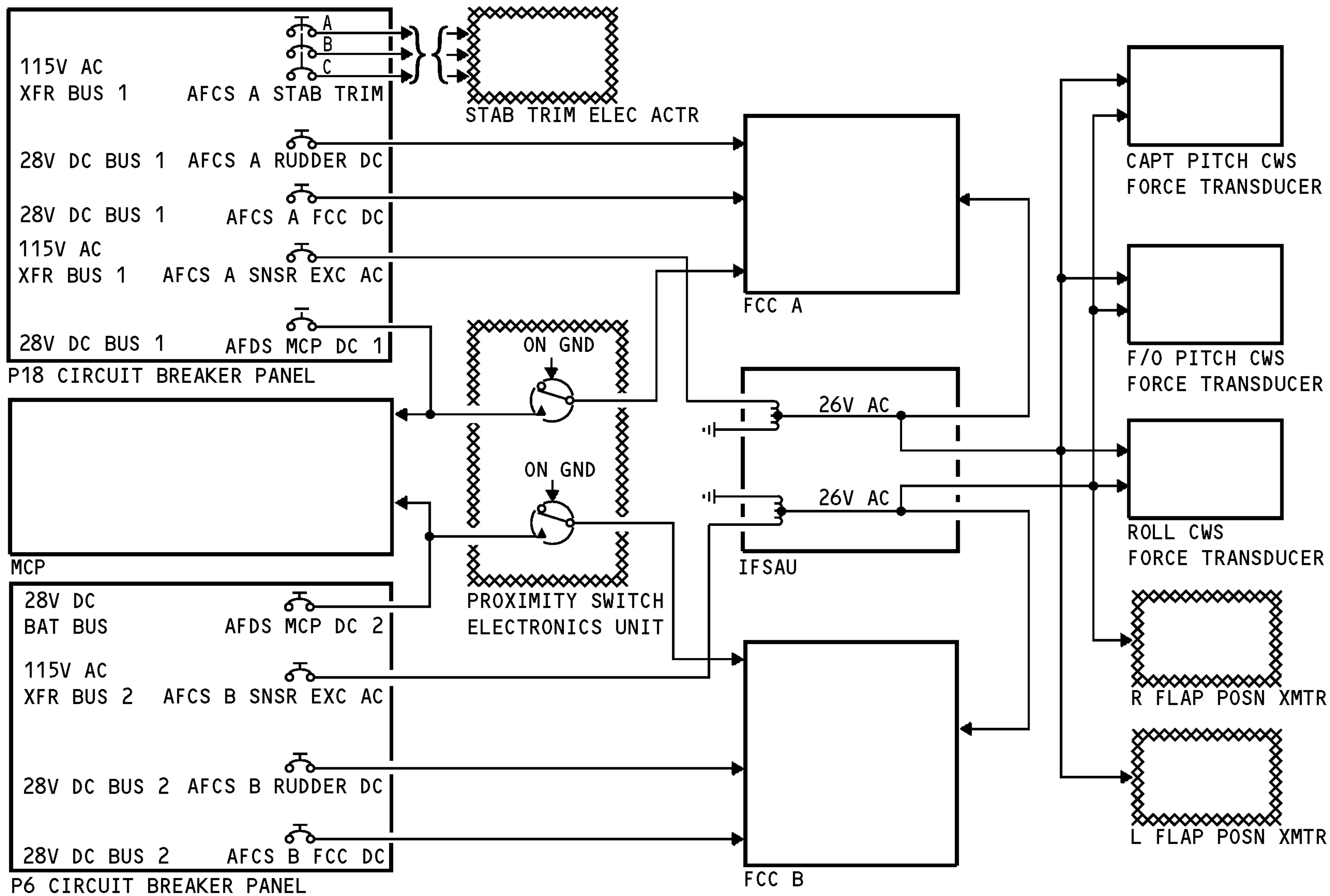
The CWS force transducers get excitation power from both 26v ac transformers. The flap position sensors only get 26v ac power from their onside transformer.

On Ground Signal

If the airplane is on the ground, the proximity switch electronics unit (PSEU) sends the 28v dc on ground signal to the FCCs. The FCCs use this signal to find if the airplane is on the ground or in the air.



DFCS - POWER INTERFACE



DFCS - POWER INTERFACE

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DFCS - SENSOR AND ACTUATOR EXCITATION POWER

Autopilot Actuator Excitation Power

The FCCs supply 14v ac, 1800 Hz pitch and roll excitation power to the autopilot actuators. Each aileron and elevator autopilot actuator gets excitation power from its onside FCC.

Sensor Excitation Power

The FCCs supply roll excitation power to these sensors:

- Spoiler 4 position sensor
- Spoiler 9 position sensor
- Aileron position sensor.

The FCCs supply pitch excitation power to these sensors:

- Neutral shift sensor
- Elevator surface position sensor

HAP 038, 042-046, 048, 051-053, 104-999

- Rudder Position sensor.

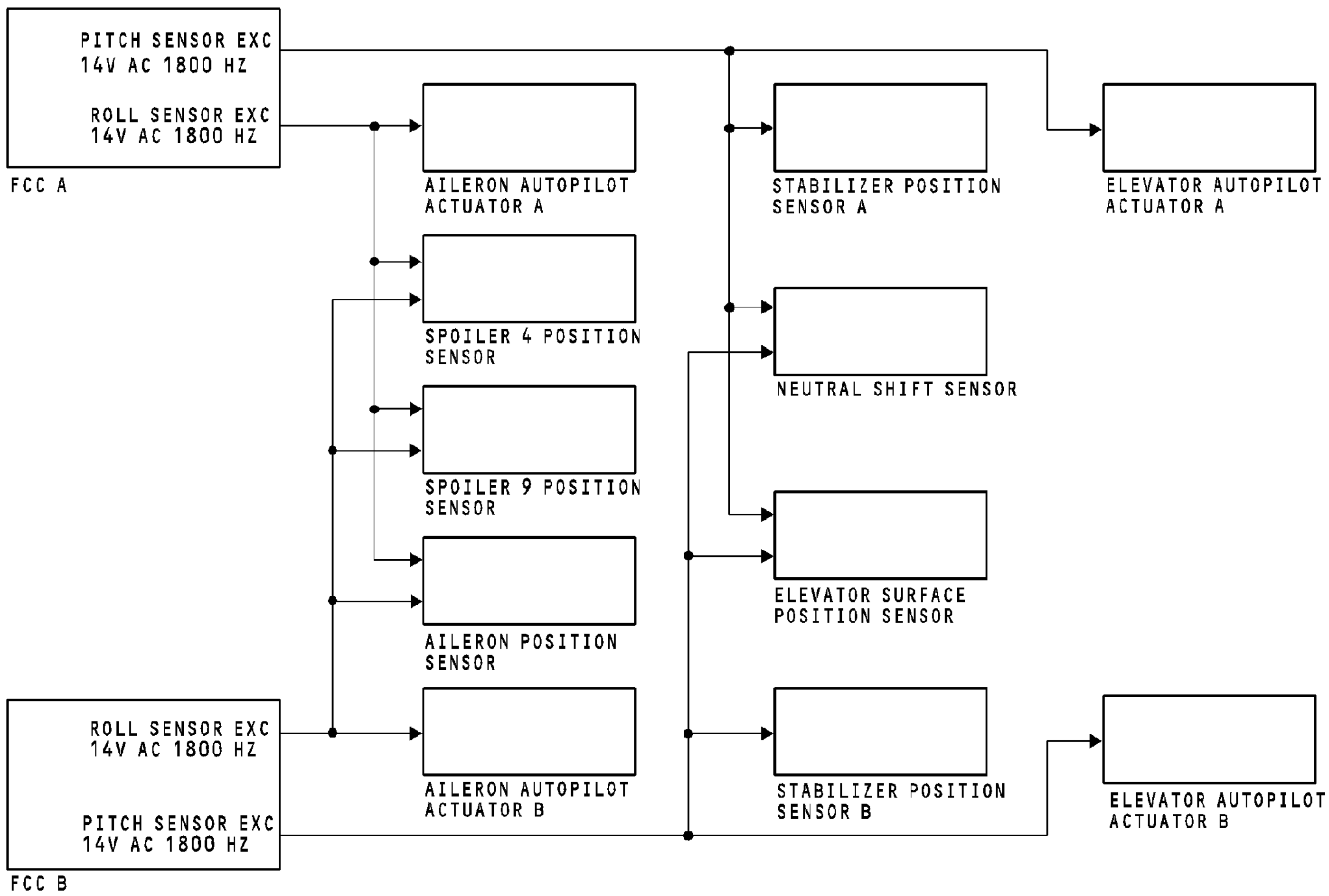
HAP ALL

The stabilizer position sensor A gets pitch excitation power from FCC A. The stabilizer position sensor B gets pitch excitation power from FCC B.

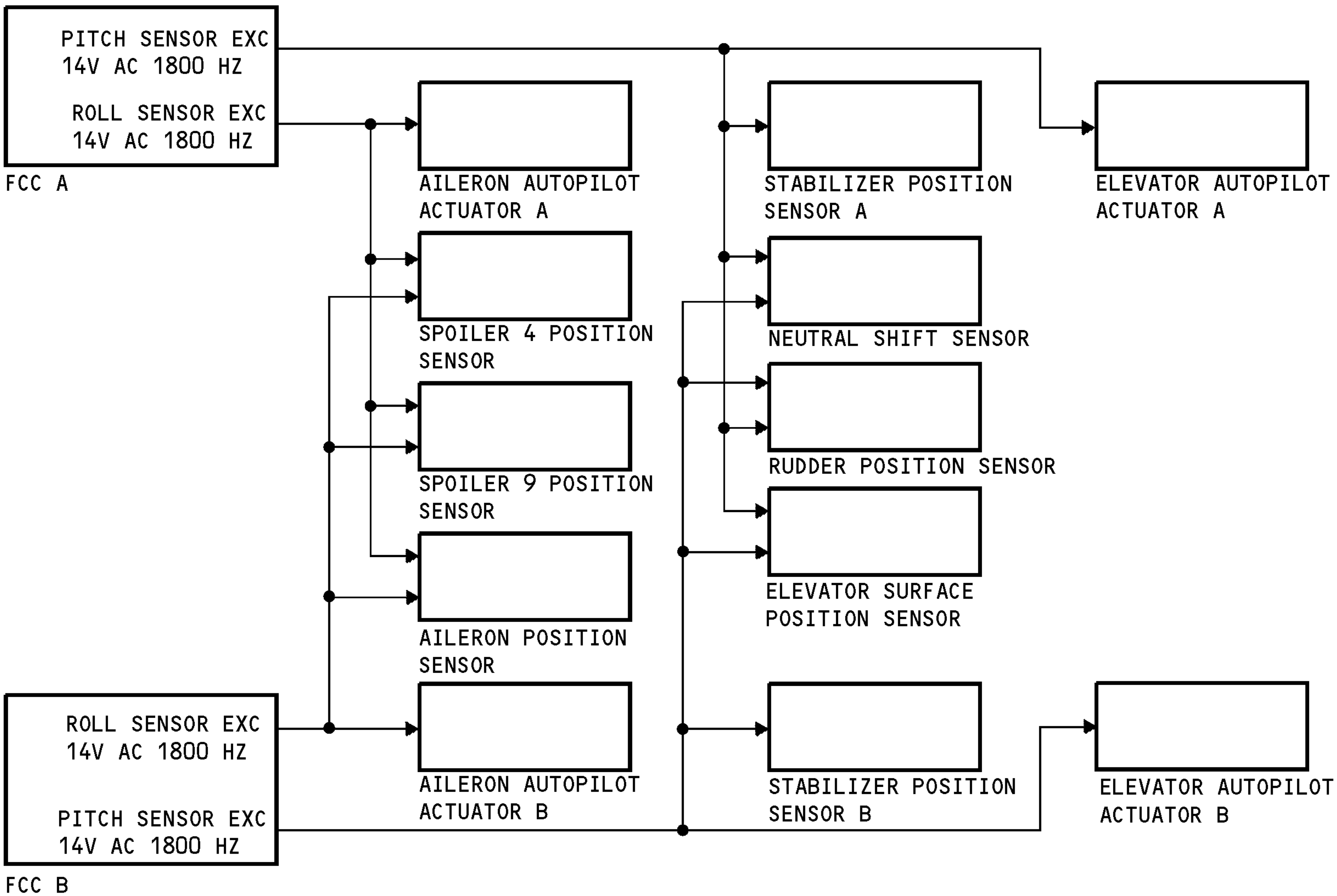
HAP 038, 042-046, 048, 051-053, 104-999

The autopilot rudder position sensor is a dual sensor. FCC A gives pitch excitation power to the rudder position sensor for FCC A rudder position feedback. FCC B gives pitch excitation power to the rudder position sensor for FCC B rudder position feedback.

HAP ALL



DFCS - SENSOR AND ACTUATOR EXCITATION POWER



DFCS - SENSOR AND ACTUATOR EXCITATION POWER

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DFCS - SYSTEM INTERLOCK POWER INTERFACE-1

General

The FCCs monitor signals from these components to determine if they can engage the autopilots (A/Ps):

- Hydraulic pressure switches on the aileron and elevator A/P actuators A and B
- Auto speed brake module
- Capt A/P disengage switch.

Power

The 28v dc buses 1 and 2 send engage interlock power to these components:

- Hydraulic pressure switches on the aileron and elevator A/P actuators A and B
- Auto speed brake module
- F/O A/P disengage switch
- Radio Altimeter (R/A) < 10 feet relays A and B
- FCC A and B.

Hydraulic Pressure Switches

Each A/P actuator has a hydraulic pressure switch. When the hydraulic pressure is high, the switches close and send 28v dc to the FCCs. The switch must be open to show no pressure to engage the autopilot. The switch must close within 3.5 seconds to show the actuator has hydraulic pressure to keep the autopilot engaged.

Auto Speed Brake Module

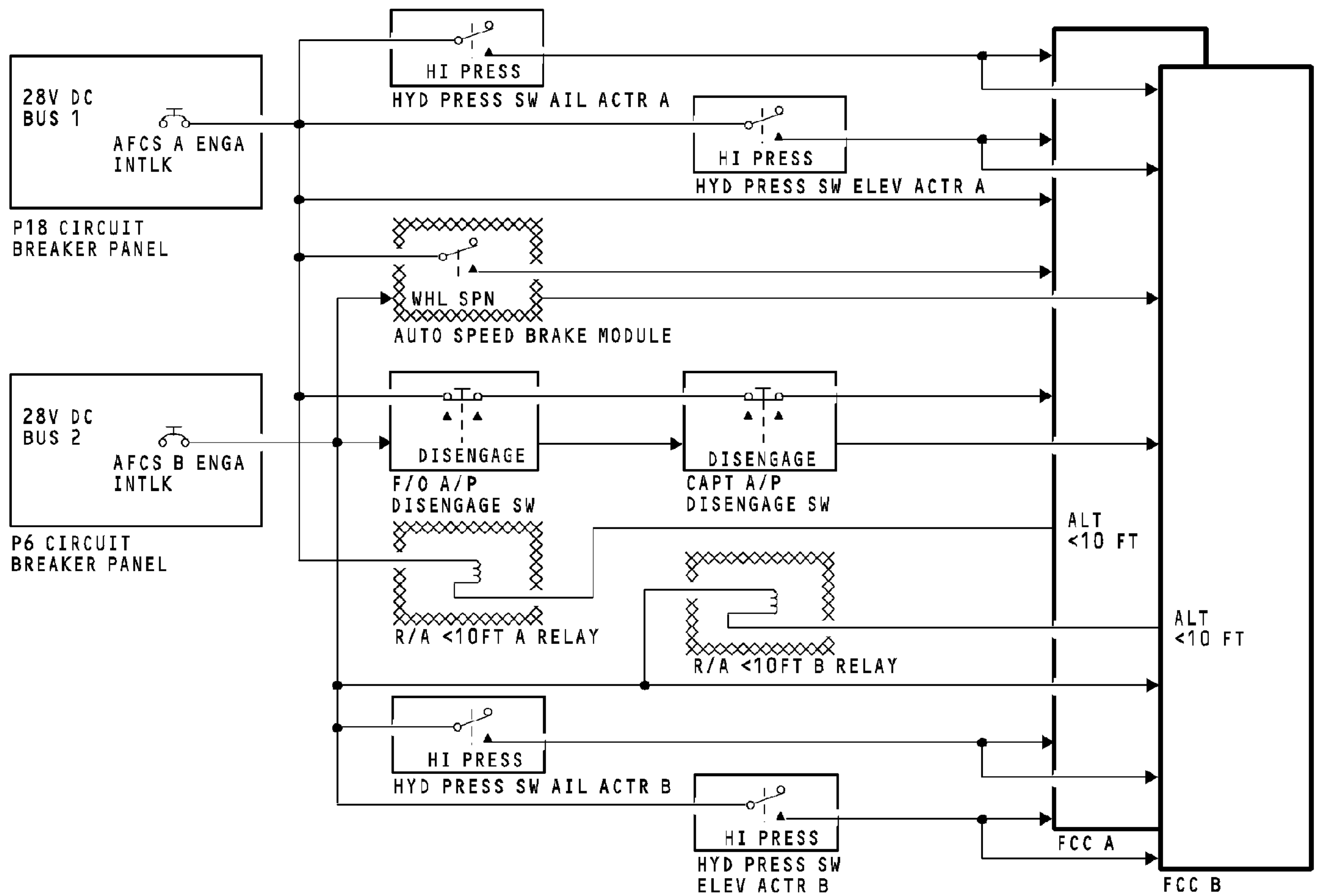
When the wheels spin up during landing and the speed is more than 60 knots, the auto speed brake module sends 28v dc to the FCCs. The FCCs use this signal to disengage the autopilot if go-around is started after the airplane touches down.

A/P Disengage Switches

Normally, 28v dc goes through both A/P disengage switches to the FCCs. If either the captain or the first officer pushes the A/P disengage switch, 28v dc does not go to the FCCs. This will disengage the autopilots or remove the disengage warning if the autopilots are disengaged.

Speed Brake Deployment Signal

When the FCC calculates that the radio altitude is less than 10 feet, it sends a ground to the R/A < 10 FT relay. This relay is an input to the speed brake deployment circuit.



DFCS - SYSTEM INTERLOCK POWER INTERFACE-1

DFCS - SYSTEM INTERLOCK POWER INTERFACE-2

General

These components also get power from the engage interlock circuit breakers:

- MCP

HAP 001-013, 015-026, 028-030

- IFSAU

HAP ALL

- Annunciator and dim module.

HAP 031-054, 101-999

The IFSAU gets 28 VDC power from the AFCS INTLK 2 circuit breaker.

HAP ALL

IFSAU

The IFSAU has isolation diodes that let the engage interlock power go to these components:

- Main electric stabilizer trim relay
- Autopilot stabilizer trim cutout relay.

Main Electric Stabilizer Trim Relay

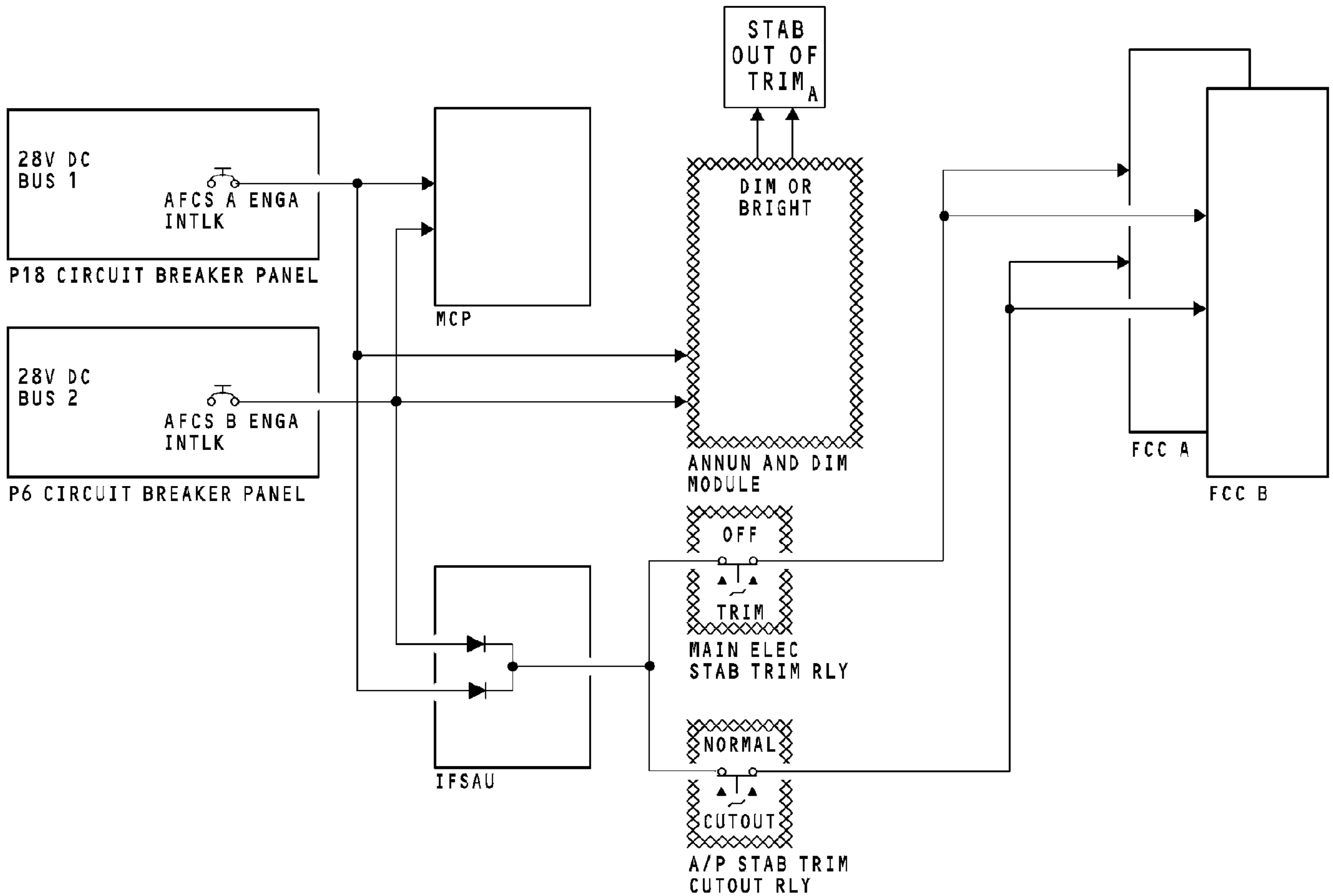
When the trim relay is in the off position, the AFCS engage interlock power goes to the FCCs. This signal tells the FCC that the manual electric trim is not operating. When the manual electric trim switches operate, the relay goes to the trim position and the power does not go to the FCCs. This causes the autopilot to disengage.

Autopilot Stabilizer Trim Cutout Relay

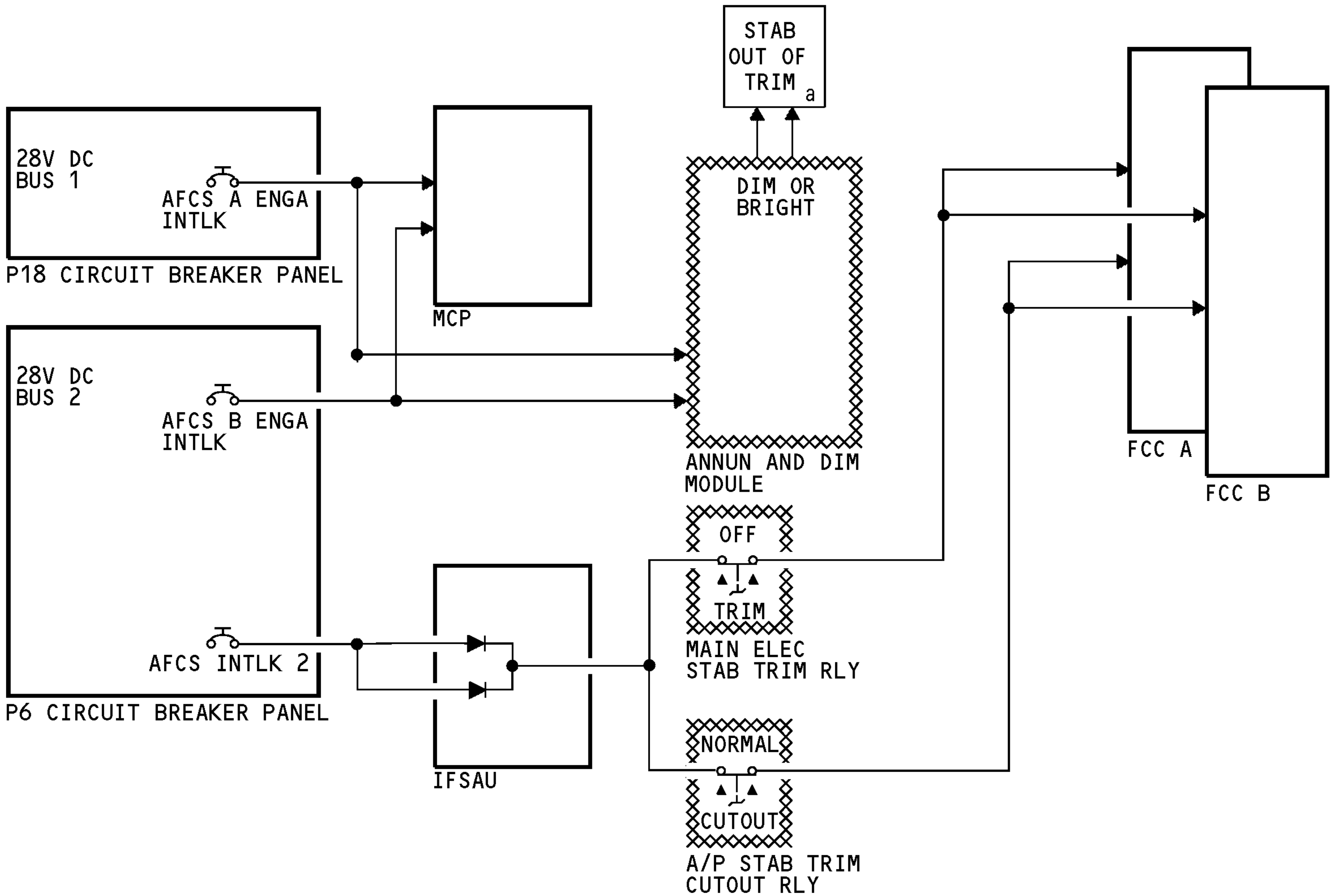
When the cutout relay is in the normal position, the AFCS engage interlock power goes to the FCCs. This lets the autopilot engage. If the relay is in the cutout position, the power does not go to the FCCs and the autopilot cannot engage.

Annunciator and Dim Module

The annunciator and dim module uses the AFCS engage interlock power for the stab out of trim annunciator light.



DFCS - SYSTEM INTERLOCK POWER INTERFACE-2



DFCS - SYSTEM INTERLOCK POWER INTERFACE-2

DFCS - ANNUNCIATION AND WARNING POWER INTERFACE

General

These components have an interface with the FCC annunciation and warning circuits:

- Capt and F/O A/P disengage switches
- IFSAU
- MCP
- FCC A and B
- Capt and F/O autoflight status annunciators (ASA)
- Aural warning module
- Flight data acquisition unit (FDAU)
- A/T computer
- Remote electronics unit (REU).

Power

The 28v dc switched hot battery bus supplies power for the autopilot warning circuits. The circuit breaker for the A system supplies power to these components:

- FCC A
- Capt and F/O A/P disengage switches
- IFSAU
- Capt ASA.

The circuit breaker for the B system supplies power to these components:

- FCC B
- IFSAU
- F/O ASA.

A/P Disengage Switches

When you push the A/P disengage switch once, the switch stops 28v dc power from going to these components:

- FCC A
- FCC B
- MCP.

This signal disengages the active autopilot.

When you push the A/P disengage switch a second time, the switch stops the disengage aural warning. It also turns off the A/P red flashing warning light on the ASAs.

IFSAU

The power from the two circuit breakers go to the IFSAU where it goes through isolation diodes to give 28v dc power to the MCP.

FCC

The FCC A sends an airspeed warning signal to the capt ASA to cause the amber A/T light to flash. FCC B sends an airspeed warning signal to the F/O ASA to cause the amber A/T light to flash. This signal occurs if the FCC finds that the A/T system cannot hold the airspeed.

The two FCCs send an altitude alert aural warning signal to the REU. This gives the alert tone in the headsets and the speakers.

DFCS - ANNUNCIATION AND WARNING POWER INTERFACE

The FCCs send an A/P warning signal to the capt and F/O ASAs and to the FDAU to turn the red A/P lights on steady. This signal occurs if any of these conditions are present:

- The two FCCs are not compatible
- The DFCS is in BITE
- The stab trim warning is active and the FCC is in dual approach below 800 feet.

MCP

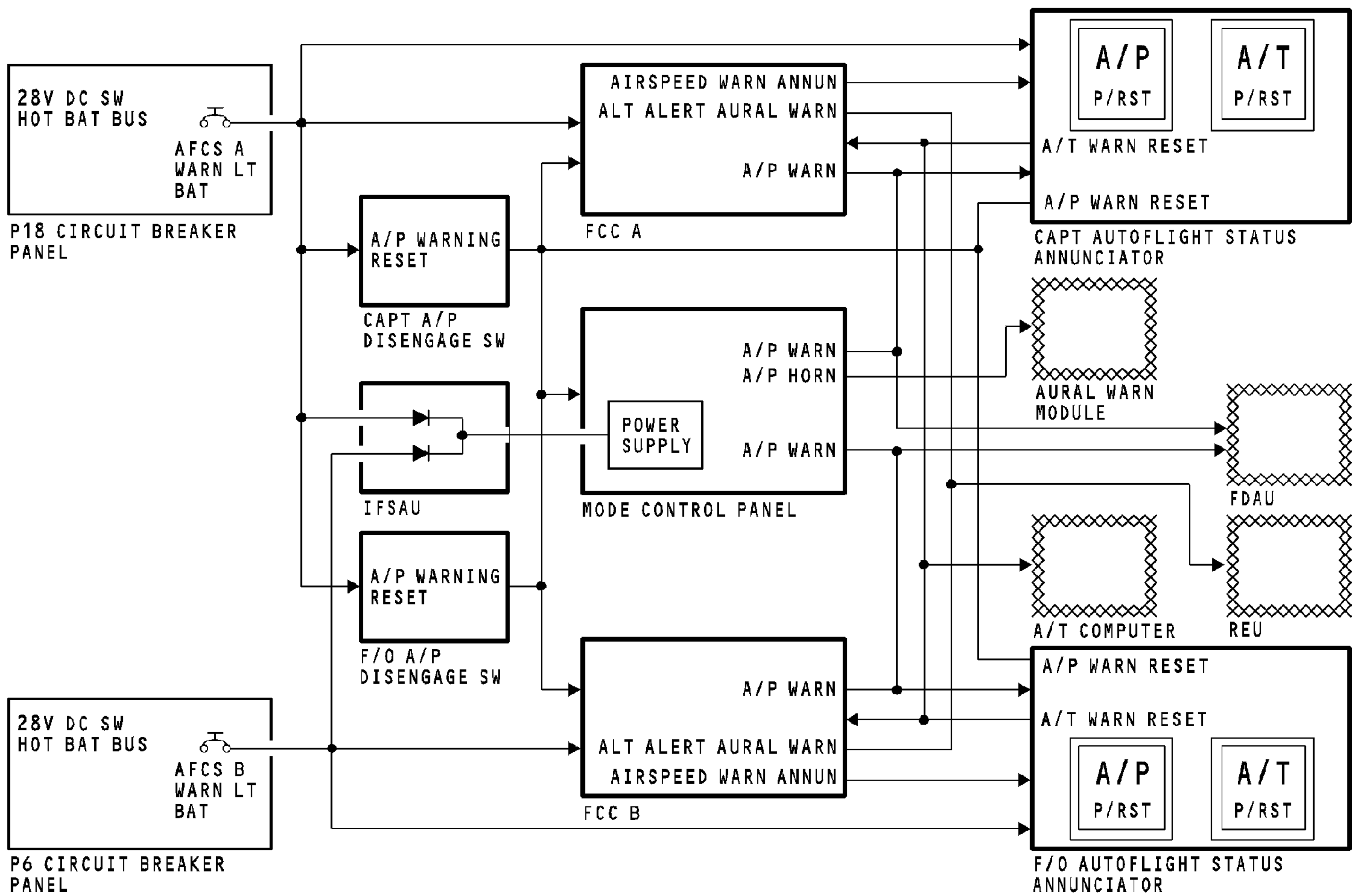
The MCP sends an A/P warning signal to the capt and F/O ASAs to turn the flashing red A/P lights on when the A/P disconnects. It sends an A/P warning signal to both ASAs to turn the steady red A/P lights on when these conditions occur:

- An FCC fails the power up test on the ground
- During A/P go-around the FCC cannot acquire the MCP altitude
- The MCP bus fails during A/P pitch go-around.

The MCP also sends the A/P warning signal to the FDAU. The MCP sends an A/P horn signal to the aural warning module to give the A/P disconnect aural warning.

Autoflight Status Annunciators

When you push the A/P light on either ASA, it sends an autopilot (A/P) warning reset signal to both FCCs and to the MCP. When you push the A/T light on either ASA, it sends an autothrottle (A/T) warning reset signal to the FCCs and to the A/T computer.



DFCS - ANNUNCIATION AND WARNING POWER INTERFACE

22-11-00-013

DFCS - POWER TRANSFER INTERFACE

General

During a dual channel operation, each FCC must be on an isolated power source. FCC A gets dc power from DC bus 1 and FCC B gets dc power from DC bus 2. Normally, the two dc buses are connected with the bus tie relay. If either FCC is in the active G/S mode, it will cause the bus tie relay to open. This will separate the DC power sources to the two FCCs.

These components are part of the circuit that controls the bus tie relay:

- FCC A and B
- Bus power control unit
- IFSAU
- Standby power control unit.

Power

The hot battery bus supplies 28v dc power to one side of the bus tie relay.

FCC

When either FCC A or FCC B is in the active G/S mode, it sends a DC bus isolation signal to the IFSAU. This signal engages a relay to the G/S engage position.

Standby Power Control Unit

When power is normal, the tie close signal energizes an electronic switch. This switch supplies a ground to the IFSAU.

IFSAU

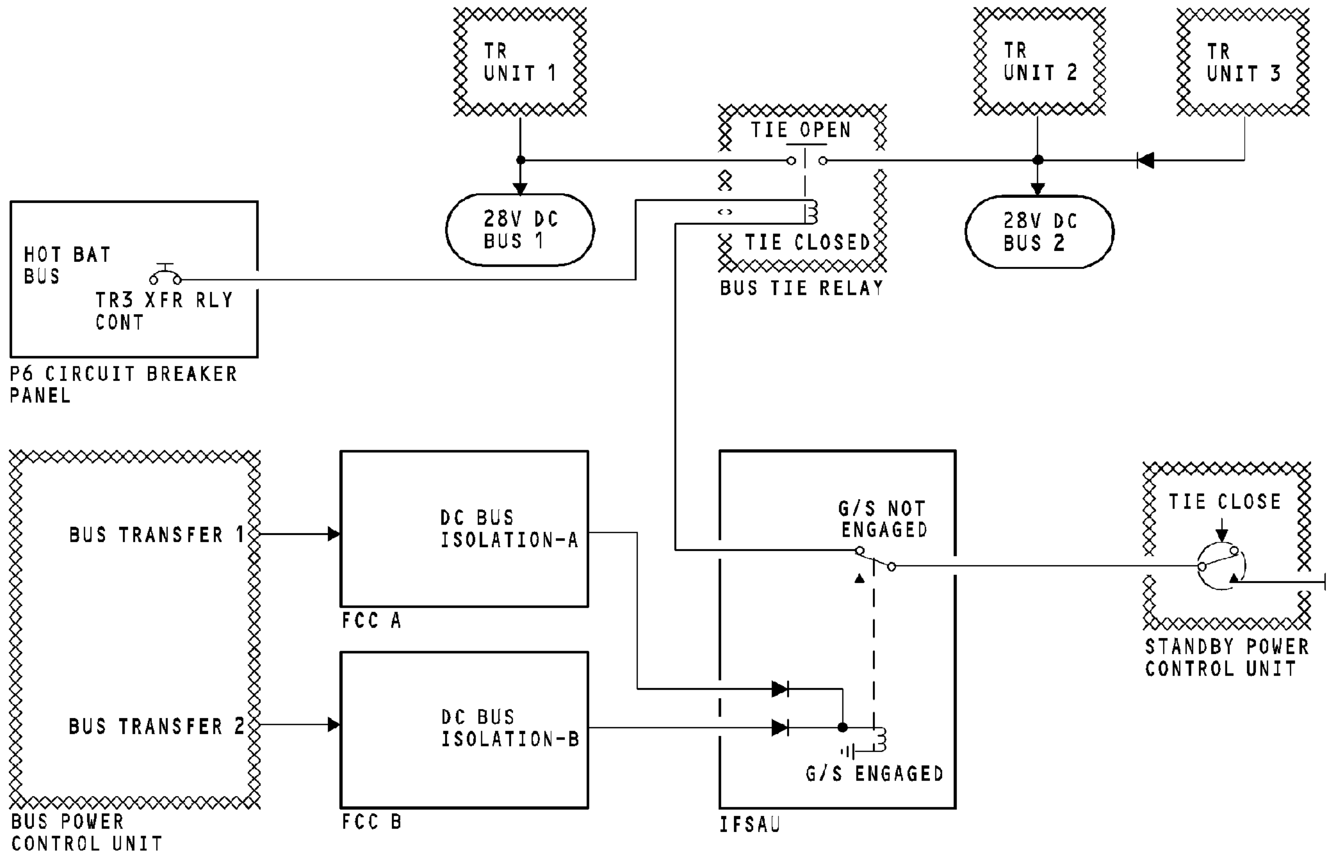
When the IFSAU relay is in the G/S not engaged position, the ground from the bus transfer switch goes to the bus tie relay. If a G/S engaged signal comes from an FCC, the IFSAU relay goes to the G/S engaged position and the ground goes away from the bus tie relay.

Bus Tie Relay

When a ground comes from the IFSAU, the relay closes. This connects the two 28v dc buses together. If there is no ground from the IFSAU, the relay is not energized. Therefore, the two 28v dc buses are isolated.

Bus Power Control Unit

Normally the transformer rectifier (TR) units get their power from different 115v ac generator buses. If a transfer occurs so that the TRs get their power from the same generator, the 28v dc buses are not isolated. The bus power control unit knows this transfer has occurred and sends a bus transfer signal to each FCC. The signal tells the FCCs that the DC buses cannot be isolated so the dual autopilot mode is not allowed.



DFCS - POWER TRANSFER INTERFACE

DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-1

General

These components send digital data to the FCCs:

- MMR 1 and 2
- VOR/MB 1 and VOR 2
- DME 1 and 2.

HAP 001-013, 015-026, 028-036, 038-054, 101-999

MMR

The FCCs receive digital data from MMR receivers 1 and 2. The MMR receivers send ILS localizer and glideslope deviation data to the FCCs to calculate the roll and pitch commands during the approach mode. The FCCs use localizer deviation data to calculate the roll commands during a localizer only approach.

HAP 037

MMR

The FCCs receive digital data from MMR receivers 1 and 2. The MMR receivers send ILS or GLS localizer and glideslope deviation data to the FCCs to calculate the roll and pitch commands during the approach mode. The FCCs use localizer deviation data to calculate the roll commands during a localizer only approach.

HAP ALL

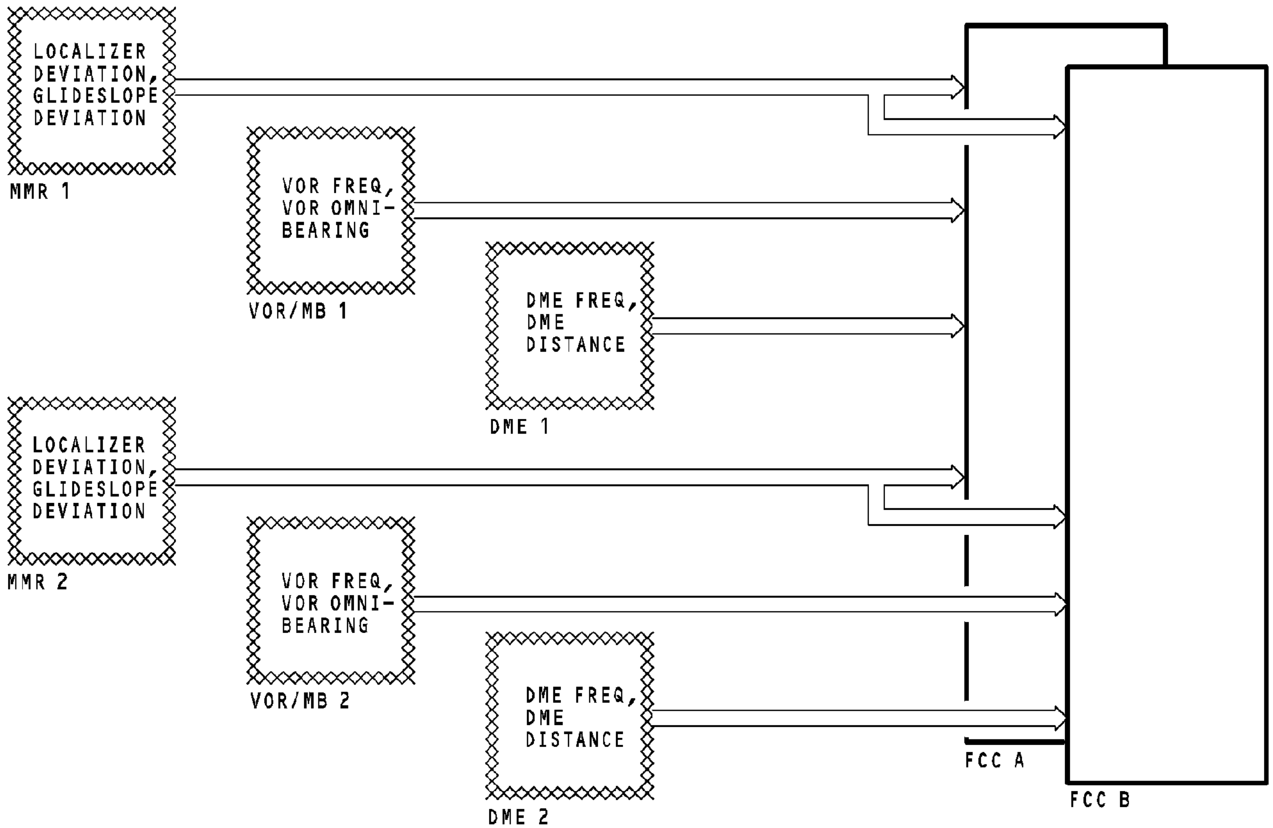
VOR/MB

FCC A receives digital data from the VOR/MB 1 receiver. FCC B receives digital data from the VOR/MB 2 receiver. The VOR receivers send VOR frequency and VOR omnibearing data to the FCCs. The FCC uses this data to capture and track a VOR course during the VOR mode.

DME

FCC A receives digital data from the DME 1 interrogator. FCC B receives digital data from the DME 2 interrogator. The DME interrogators sends DME frequency and DME distance data to the FCCs. The FCCs use the DME frequency to identify the correct channel and then use the DME distance sent directly after the correct frequency. The FCCs use DME distance to calculate a capture point for the VOR course and to determine if the airplane is over the VOR station.

If DME data is not available, the FCCs will use VOR data to do the same calculations.



DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-1

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General

These components also send digital data to the FCCs:

HAP 001-013, 015-026, 028-036
- Flight management computer (FMC) 1

HAP 037-054, 101-999
- Flight management computers (FMC) 1 and 2

HAP ALL
- Radio altimeters (RA) 1 and 2
- Stall management yaw damper (SMYD) 1 and 2.

FMC

HAP 001-013, 015-026, 028-036

The FMCS transfer relays are in the BOTH ON L positions. In this configuration, the FMC sends digital data to FCC A through FMCS transfer relay 1. The FMC sends digital data to FCC B through FMCS transfer relay 2. The FMC sends this data to the FCCs:

- FMC target altitude to calculate VNAV commands
- FMC target airspeed to calculate VNAV commands
- FMC target mach to calculate VNAV commands
- Vertical speed command to calculate VNAV commands
- Greenwich mean time and date to record time of faults in BITE
- Horizontal command signal to calculate LNAV commands
- Flight number to record inflight faults in BITE
- FMC discrete data to control the DFCS and A/T in VNAV and LNAV
- BITE test word for BITE information.

HAP 037-054, 101-999

If the FMCS transfer relays are in the BOTH ON L positions, FMC 1 sends digital data to FCC A and B. If the FMCS transfer relays are in the BOTH ON R positions, FMC 2 sends digital data to FCC A and B. If the FMCS transfer relays are in the NORMAL positions, FMC 1 sends digital data to FCC A and FMC 2 sends digital data to FCC B. The FMC sends this data to the FCCs:

- FMC target altitude to calculate VNAV commands
- FMC target airspeed to calculate VNAV commands
- FMC target mach to calculate VNAV commands
- Vertical speed command to calculate VNAV commands
- Greenwich mean time and date to record time of faults in BITE
- Horizontal command signal to calculate LNAV commands
- Flight number to record inflight faults in BITE
- FMC discrete data to control the DFCS and A/T in VNAV and LNAV
- BITE test word for BITE information.

HAP ALL

RA

RA 1 sends radio altitude data to FCC A. RA 2 sends radio altitude to FCC B. The FCCs use radio altitude to calculate these:

- Localizer gains
- Glideslope gains
- Air/ground discrete
- A/T command during flare

DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-2

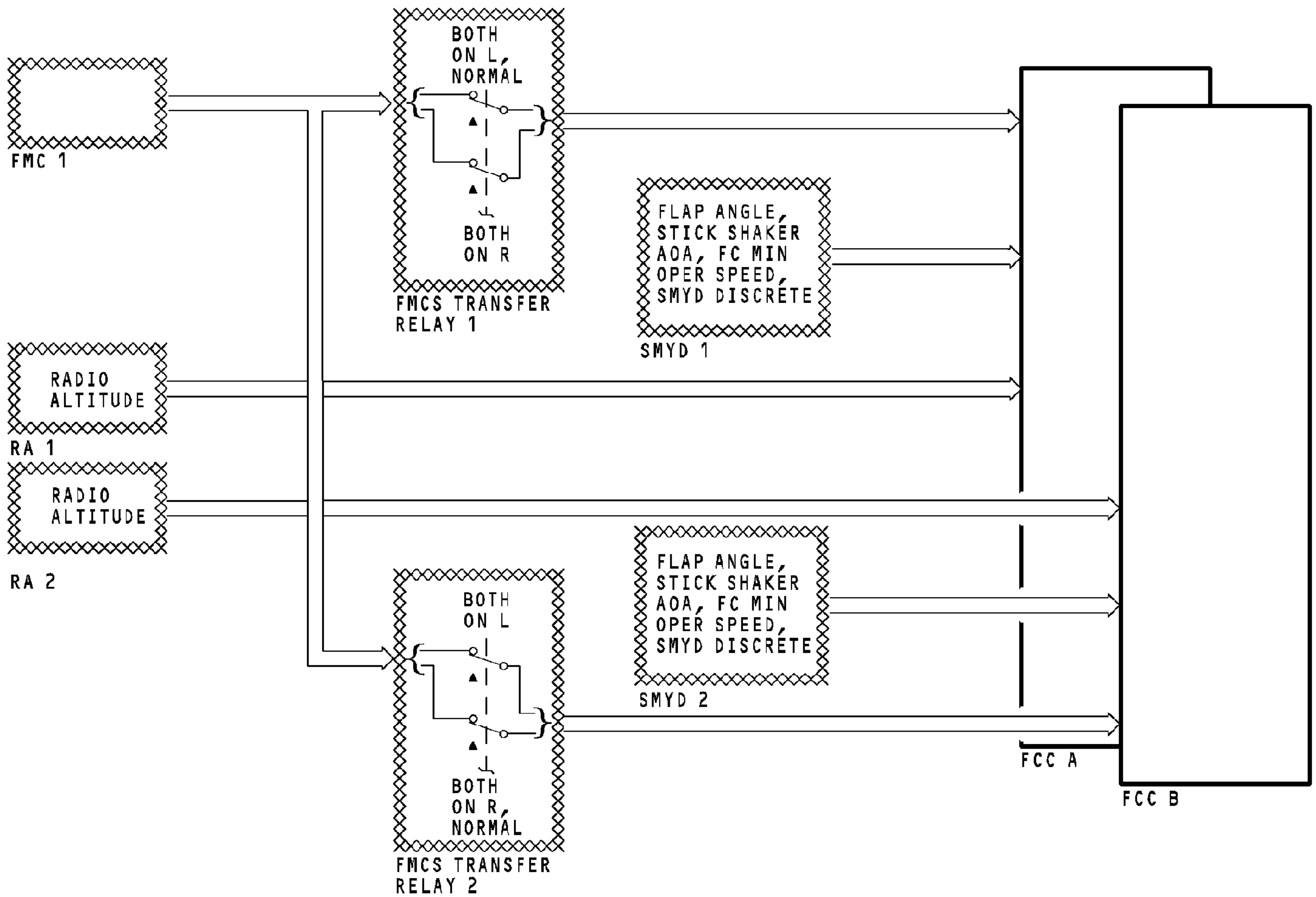
- Altitude trip points
- When you can engage the A/P.

SMYD

SMYD 1 sends this data to FCC A:

- Flap angle to compare with flap position data from the flap position transmitter
- Stick shaker AOA to help calculate the F/D TO/GA command
- FC minimum operating speed to calculate the alpha floor speed
- SMYD discrete data to show when a stall warning occurs.

SMYD 2 sends the same data to FCC B.



DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-2

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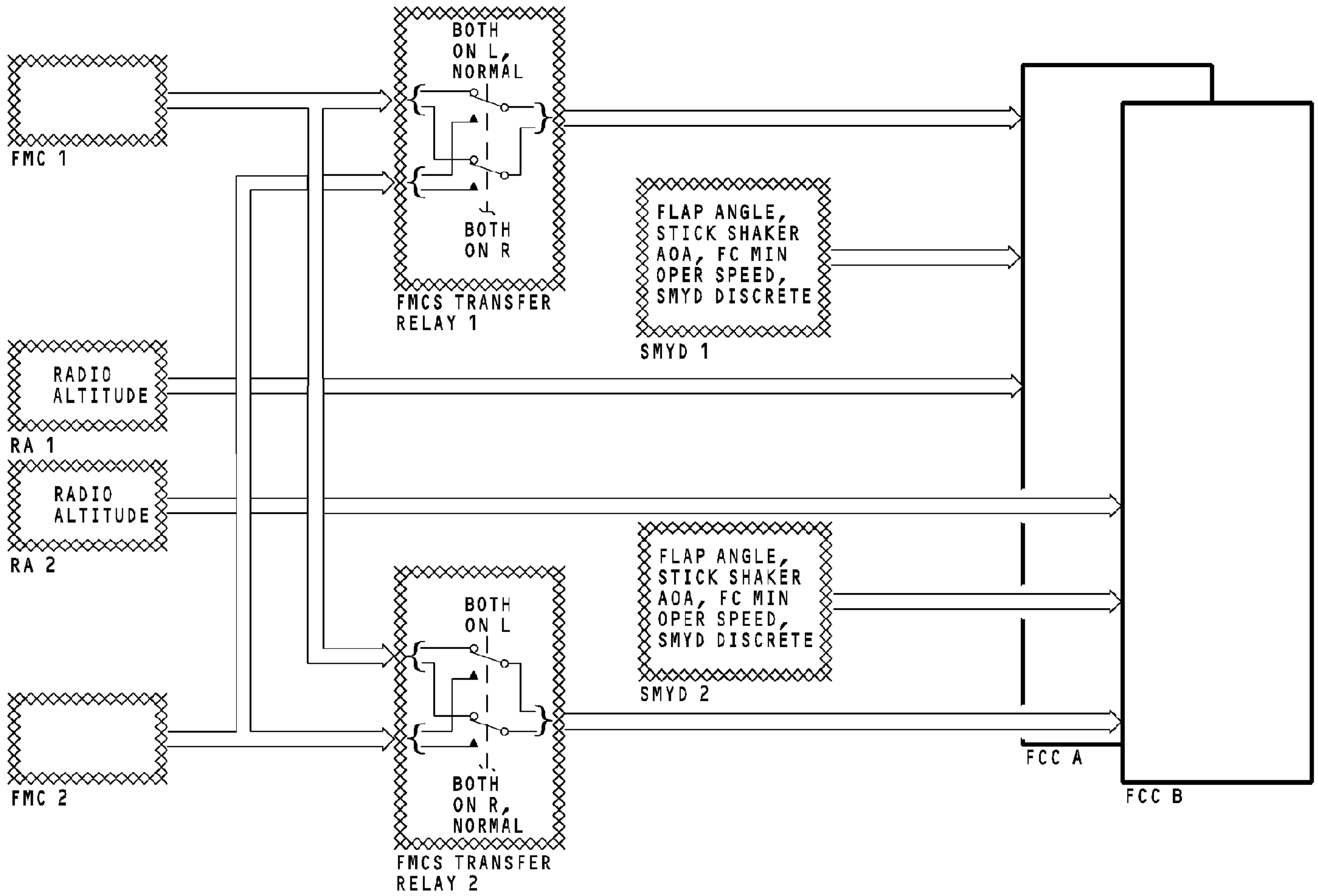
EFFECTIVITY
HAP 001-013, 015-026, 028-036



DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-2

DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-3

General

These components also send digital data to the FCCs:

HAP 001-013, 015-026, 028-030
- Autothrottle (A/T) computer

HAP 031-054, 101-999
- Autothrottle (A/T) function in FCC A

HAP ALL
- Display electronic units (DEU) 1 and 2
- Left and right air data inertial reference units (ADIRU).

HAP 001-013, 015-026, 028-030

A/T Computer

The A/T computer sends A/T discrete digital data to both FCCs. The FCCs use this data to determine the mode the A/T is in and to which modes it will allow a change.

HAP 031-054, 101-999

FCC-A Autothrottle Function

The autothrottle function in FCC A sends A/T discrete digital data to both FCCs. The FCCs use this data to determine the mode the A/T is in and to which modes it will allow a change.

HAP 038, 042-046, 048, 051-053, 104-999

Integrated Standby Flight Display

The Integrated Standby Flight Display (ISFD) sends inertial data to the FCCs. The FCCs use this data during CAT IIIB approaches, landings and go-around.

HAP ALL

DEU

The DEUs send the engine N1 signal data to the FCCs to calculate the speed trim fade-out gain and the maximum alpha angle for go-around. The DEUs also send discrete data to the FCCs to tell the FCCs which DEU sends data to which display unit.

ADIRU

Each ADIRU sends these air data reference (ADR) signals to its onside FCC:

- Uncorrected altitude
- Baro corrected altitude number 1
- Baro corrected altitude number 2
- Mach
- Computed airspeed
- Maximum allowable airspeed (VMO/MMO)
- True airspeed
- Static pressure
- Total pressure
- Indicated angle of attack.

DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-3

Each ADIRU sends these inertial reference (IR) signals to the two FCCs:

- Ground speed
- True track angle
- True heading
- Magnetic track angle
- Magnetic heading
- Flight path acceleration
- Pitch angle
- Roll angle
- Body longitudinal acceleration
- Body lateral acceleration
- Pitch attitude rate
- Roll attitude rate
- Inertial altitude
- Vertical acceleration
- Inertial vertical speed.

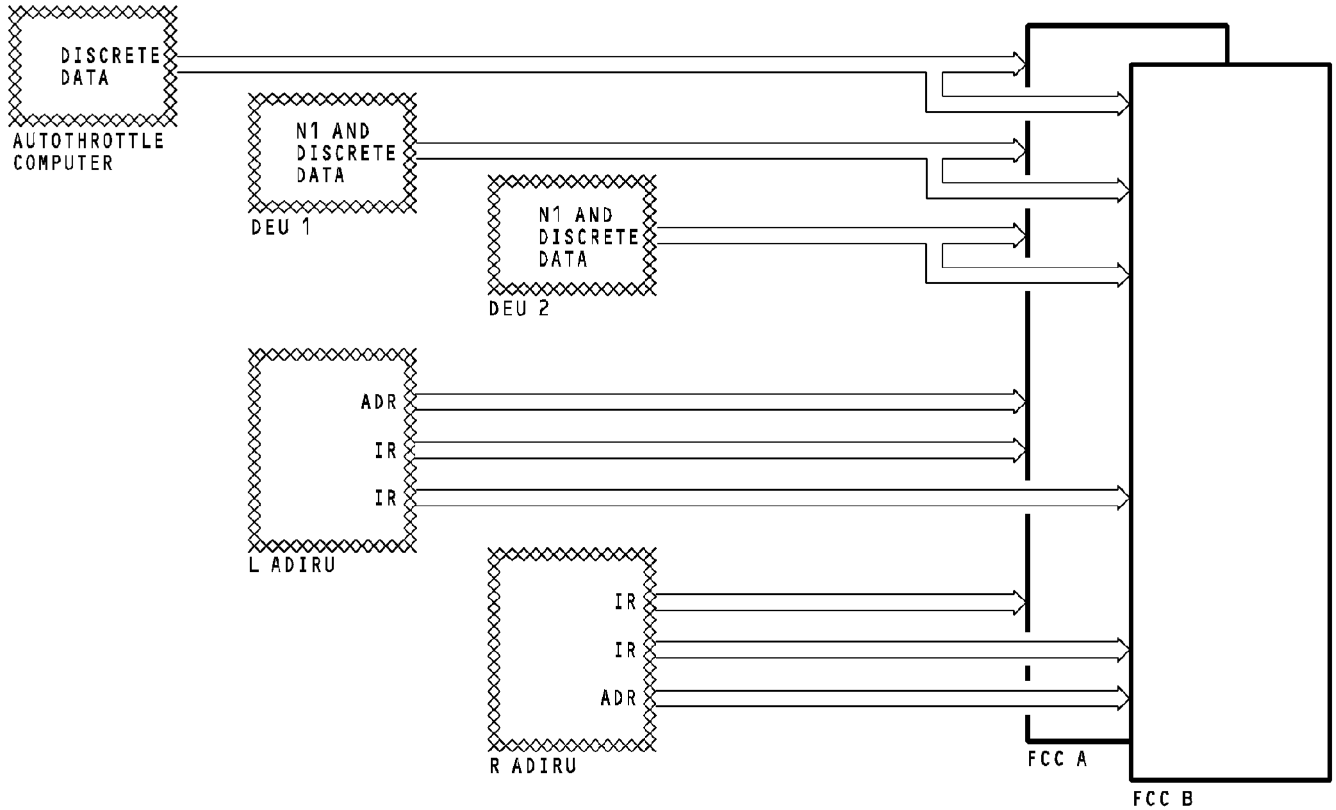
HAP 001-013, 015-026, 028-030

The FCCs use the ADIRU data to calculate many different commands. To see what DFCS functions use the ADIRU data, look at the functional description pages for the autopilot, flight director, speed trim, mach trim, and altitude alert.

HAP 031-054, 101-999

The FCCs use the ADIRU data to calculate many different commands. To see what DFCS functions use the ADIRU data, look at the functional description pages for the autopilot, flight director, speed trim, mach trim, altitude alert, and autothrottle.

HAP ALL



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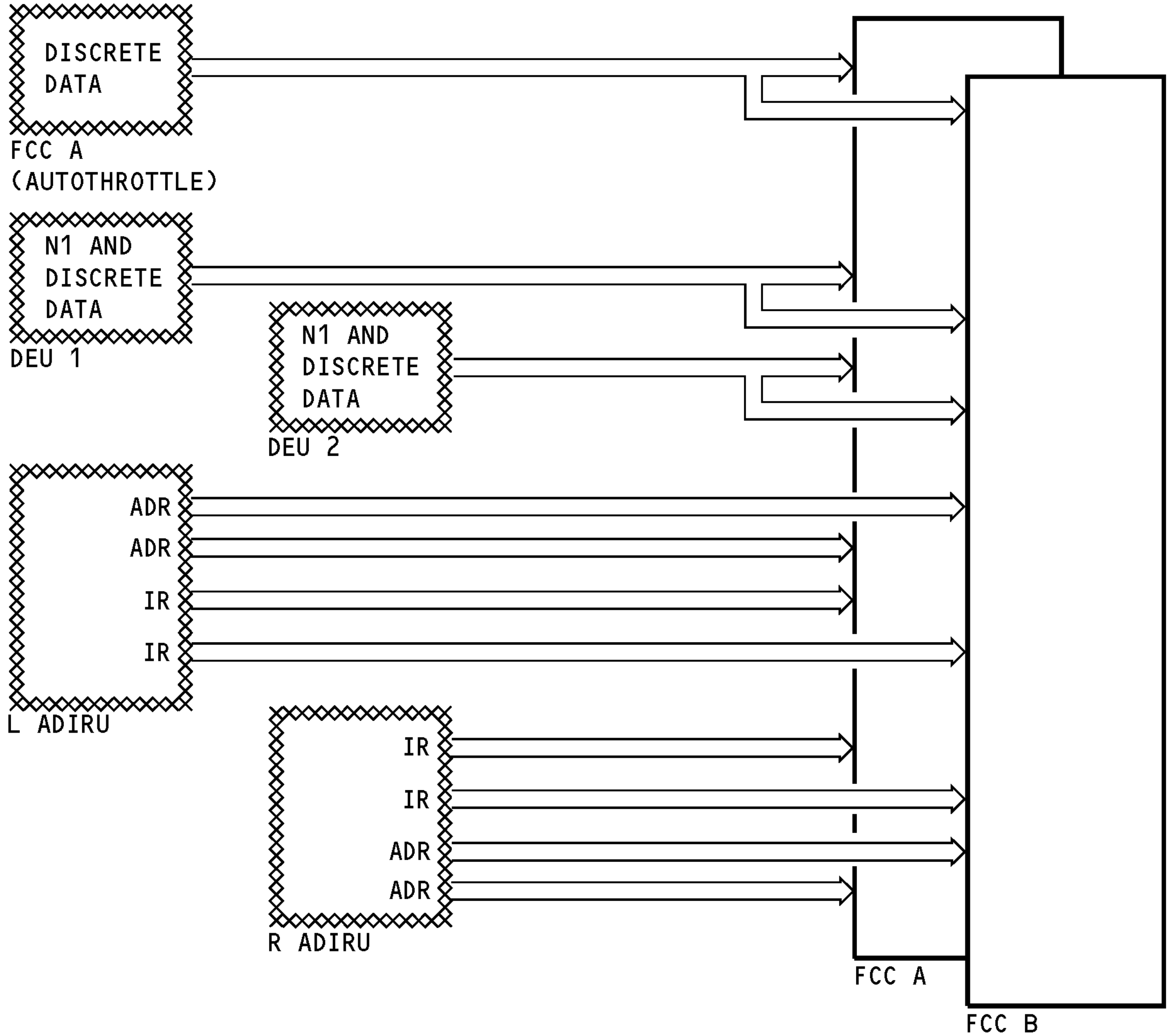
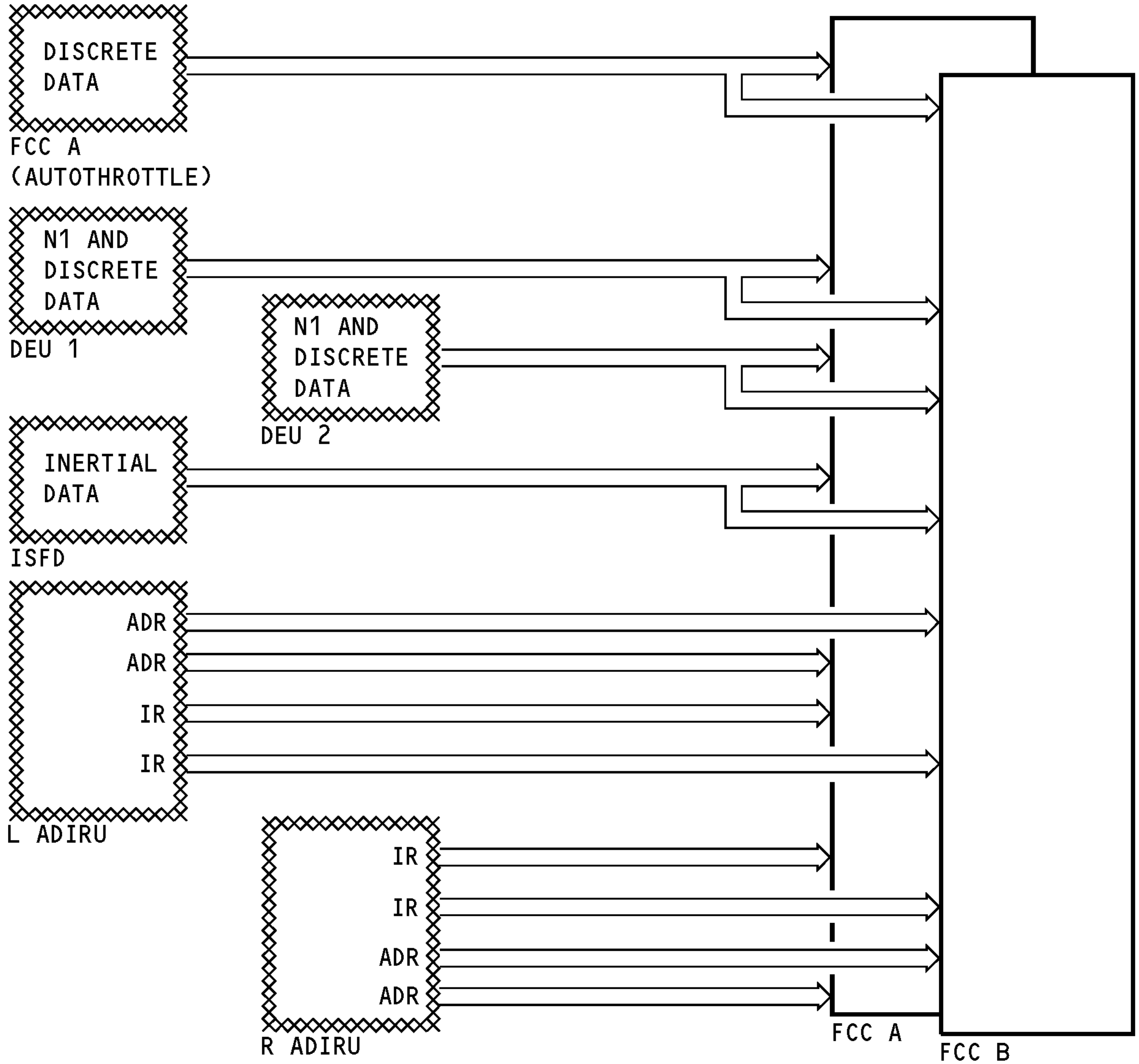
DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-3



DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE-3



DFCS - FLIGHT CONTROL COMPUTER DIGITAL INPUT INTERFACE - 3

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DFCS - FLIGHT CONTROL COMPUTER DIGITAL OUTPUT INTERFACE

General

The FCCs send digital data to these components:

- Mode control Panel (MCP)
- DEUs 1 and 2
- Flight data acquisition unit (FDAU).

Each FCC also sends cross-channel digital data and BITE data to the other FCC. The cross-channel digital data includes several items so the two FCCs can compare and synchronize data. These are some of the items:

- Flight director data
- Dual autopilot synchronization data
- Mode status data.

MCP

Each FCC sends digital data to the MCP. This data includes these parameters:

- Target mach
- Target airspeed
- Selected course number 1
- Selected course number 2
- Selected heading
- Selected altitude
- Selected airspeed
- Selected vertical speed
- Selected mach
- Flap position
- Flight director roll command
- Flight director pitch command
- Airspeed bug drive
- Spoiler 4 position
- Spoiler 9 position
- Flight path angle rate
- AFDS discrete word 1, 2, 3, and 4
- DFCS BITE response.

The MCP uses the data from the master FCC to display in the MCP windows and light the MCP mode select pushbuttons. The MCP also passes the master FCC data to other systems which shows in the next pageset.

DEU

Each FCC sends digital data to the two DEUs. This data includes these parameters:

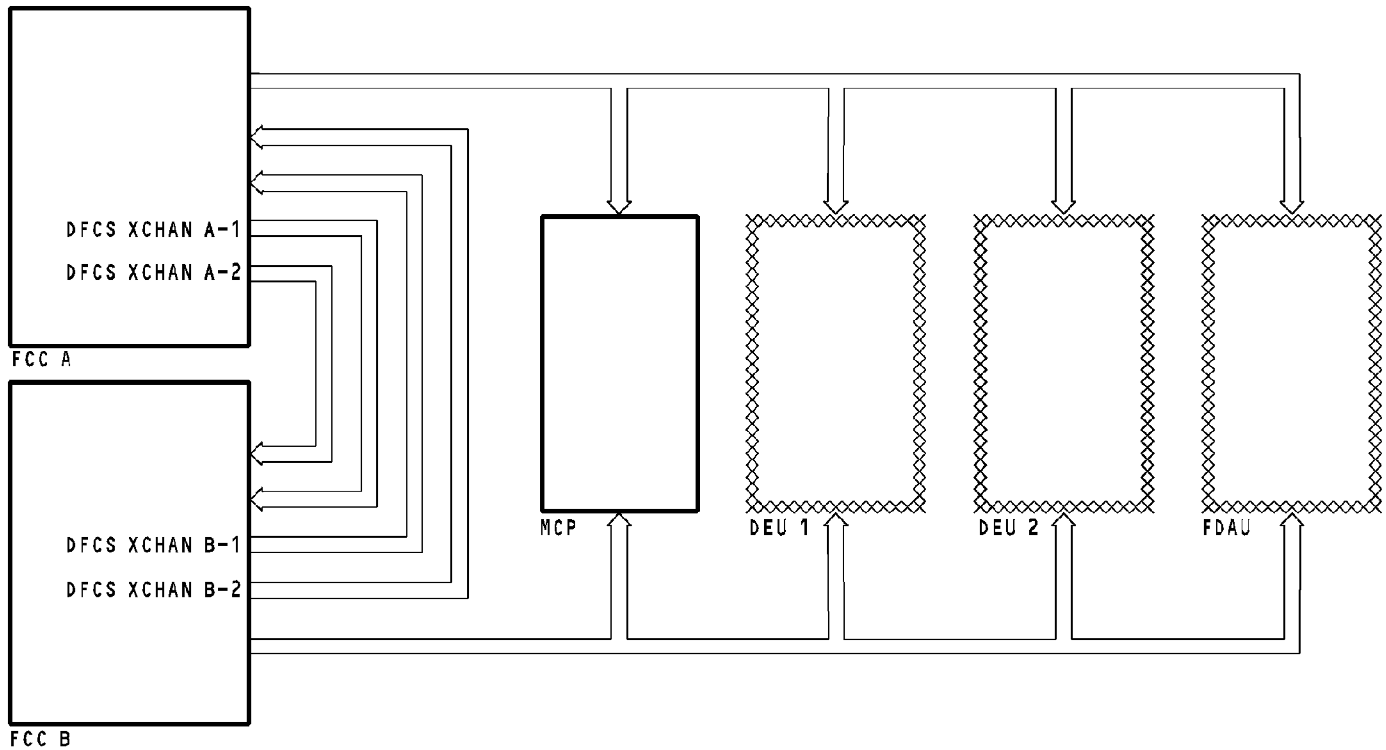
- Selected course number 1
- Selected course number 2
- Selected heading
- Selected altitude
- Flight director roll command
- Flight director pitch command
- Airspeed bug drive
- AFDS discrete word 2 and 4 to give flight mode annunciation data, altitude alert warnings, and localizer and glideslope deviation warnings.

The DEUs send these data to the display units to show flight director commands and DFCS status to the crew.

DFCS - FLIGHT CONTROL COMPUTER DIGITAL OUTPUT INTERFACE

FDAU

The FCCs send digital data to the FDAU to save in the flight recorder.



DFCS - FLIGHT CONTROL COMPUTER DIGITAL OUTPUT INTERFACE

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DFCS - MODE CONTROL PANEL DIGITAL OUTPUT INTERFACE

General

The MCP sends digital data to these components:

- FCC A and B
- DEU 1 and 2
- Ground proximity warning computer (GPWC).
- Autothrottle (A/T)
- SMYD 1 and 2

HAP 001-013, 015-026, 028-036

- FMC.

HAP 037-054, 101-999

- FMC 1 and 2.

HAP ALL

FCC

When the flight crew selects mode commands and flight path variables on the MCP, the data goes to the FCCs on a digital data bus. These are the data that go to the FCCs:

- Selected heading that the crew chose
- Selected course number 1 and 2 that the crew chose
- Altitude window wrap that shows the altitude that the crew chose
- MCP maintenance discrete to indicate the type of MCP in the airplane
- MCP discrete to show the modes that the crew chose
- MCP display change to show when a change is made on one of the MCP controls
- MCP identification to show the type of MCP.

DEU

The MCP sends selected heading and selected course data to each DEU to show on the display units.

GPWC

The MCP sends the selected course to the GPWC for use by the envelop modulation function.

MCP Bus 3

The MCP gets data from both FCCs and also a signal to show which FCC is the master FCC. The MCP then sends all of the master FCC data out on MCP bus 3 to these systems:

- Autothrottle
- SMYD 1 and 2

HAP 001-013, 015-026, 028-036

- FMC 1

HAP 037-054, 101-999

- FMC1 and 2.

HAP ALL

Autothrottle

The MCP sends this data to the Autothrottle:

- Target mach
- Target airspeed
- Selected altitude
- Spoiler 4 position

- Spoiler 9 position
- Flight path angle rate
- AFDS discrete word 1, 2, and 3 which show the DFCS mode and status.

The Autothrottle uses this data to compute the thrust lever servo rates for the A/T servo motors.

SMYD

The MCP sends AFDS discrete word 4 to the SMYDs to show if either or both autopilots are engaged in the CMD or CWS mode.

FMC

HAP 001-013, 015-026, 028-036

The MCP sends this data to the FMC:

- Selected course number 1 and 2
- selected airspeed
- selected mach
- Selected altitude
- Flap position
- AFDS discrete word 1 and 3 to give DFCS mode and status
- Digital flight control system (DFCS) BITE response.

HAP 037-054, 101-999

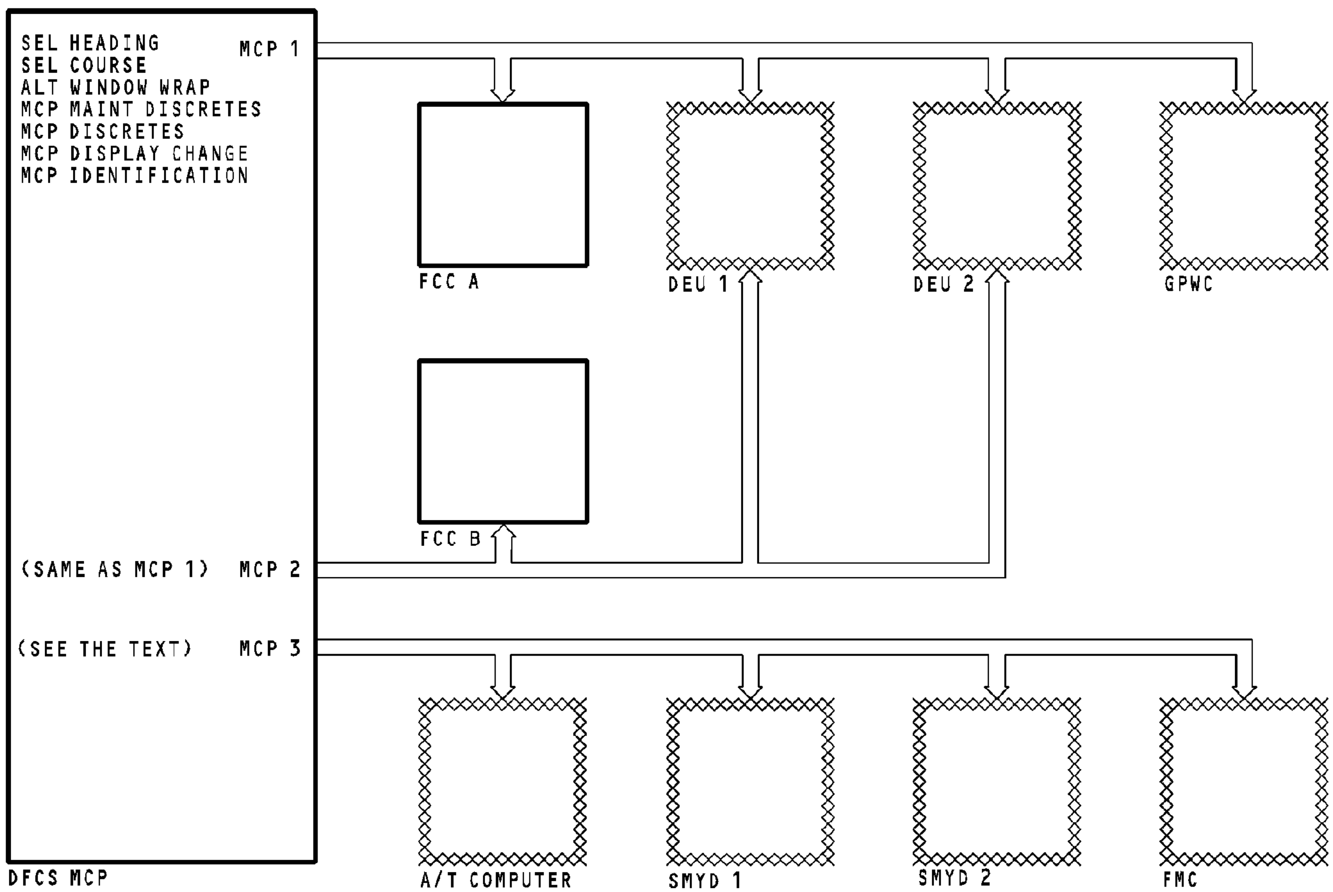
The MCP sends this data to FMC 1 and 2:

- Selected course number 1 and 2
- selected airspeed
- selected mach
- Selected altitude
- Flap position
- AFDS discrete word 1 and 3 to give DFCS mode and status
- Digital flight control system (DFCS) BITE response.

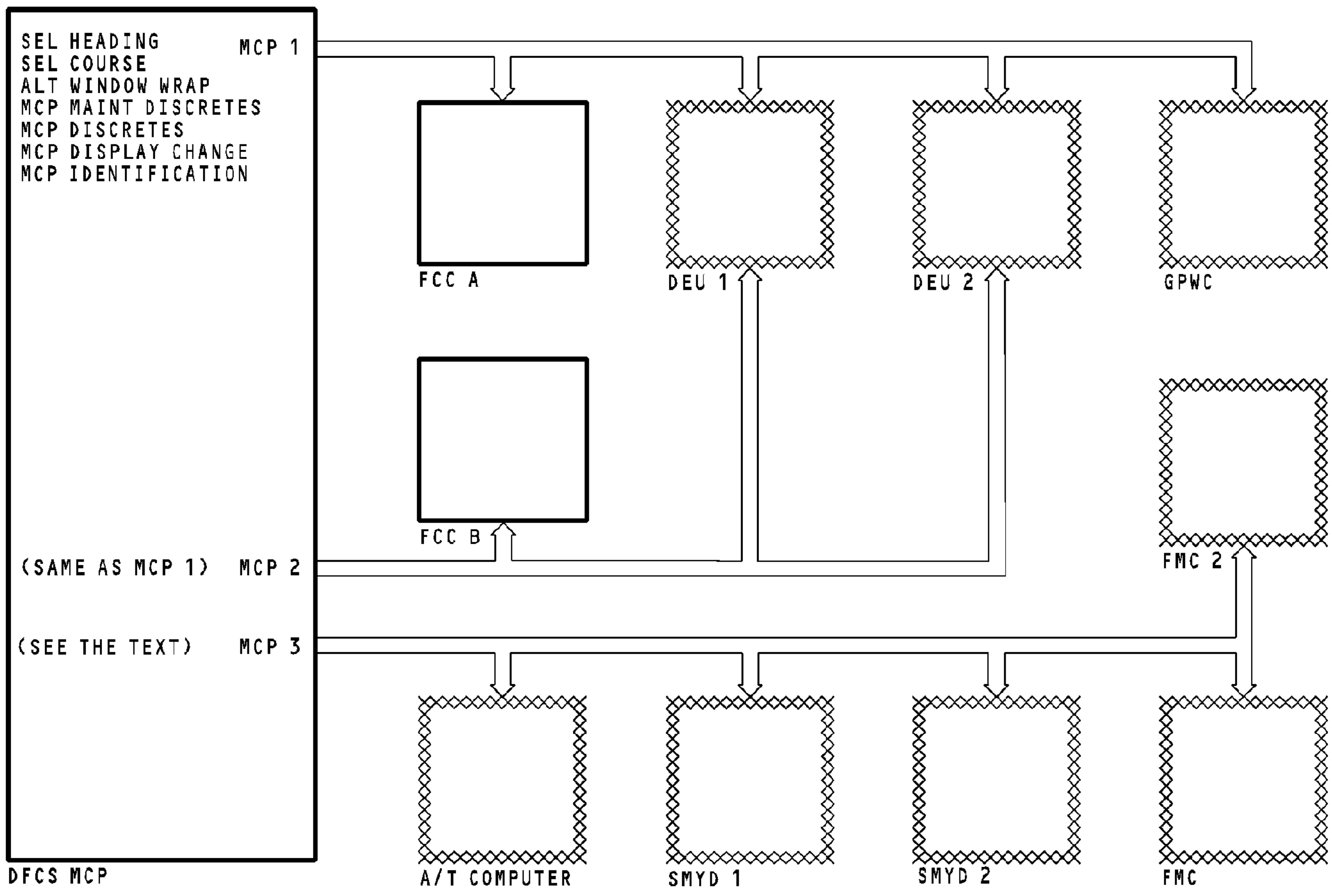
HAP ALL

The FMC uses this data to determine the status and mode of the DFCS and it also uses this data to show the BITE data.

The FMC uses this data to determine the status and mode of the DFCS and it also uses this data to show the BITE data. When the crew uses the speed and altitude intervention buttons, the FMC uses this data to modify the VNAV path and speed.



DFCS - MODE CONTROL PANEL DIGITAL OUTPUT INTERFACE



DFCS - MODE CONTROL PANEL DIGITAL OUTPUT INTERFACE

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DFCS - MODE CONTROL PANEL ANALOG INTERFACE

MCP

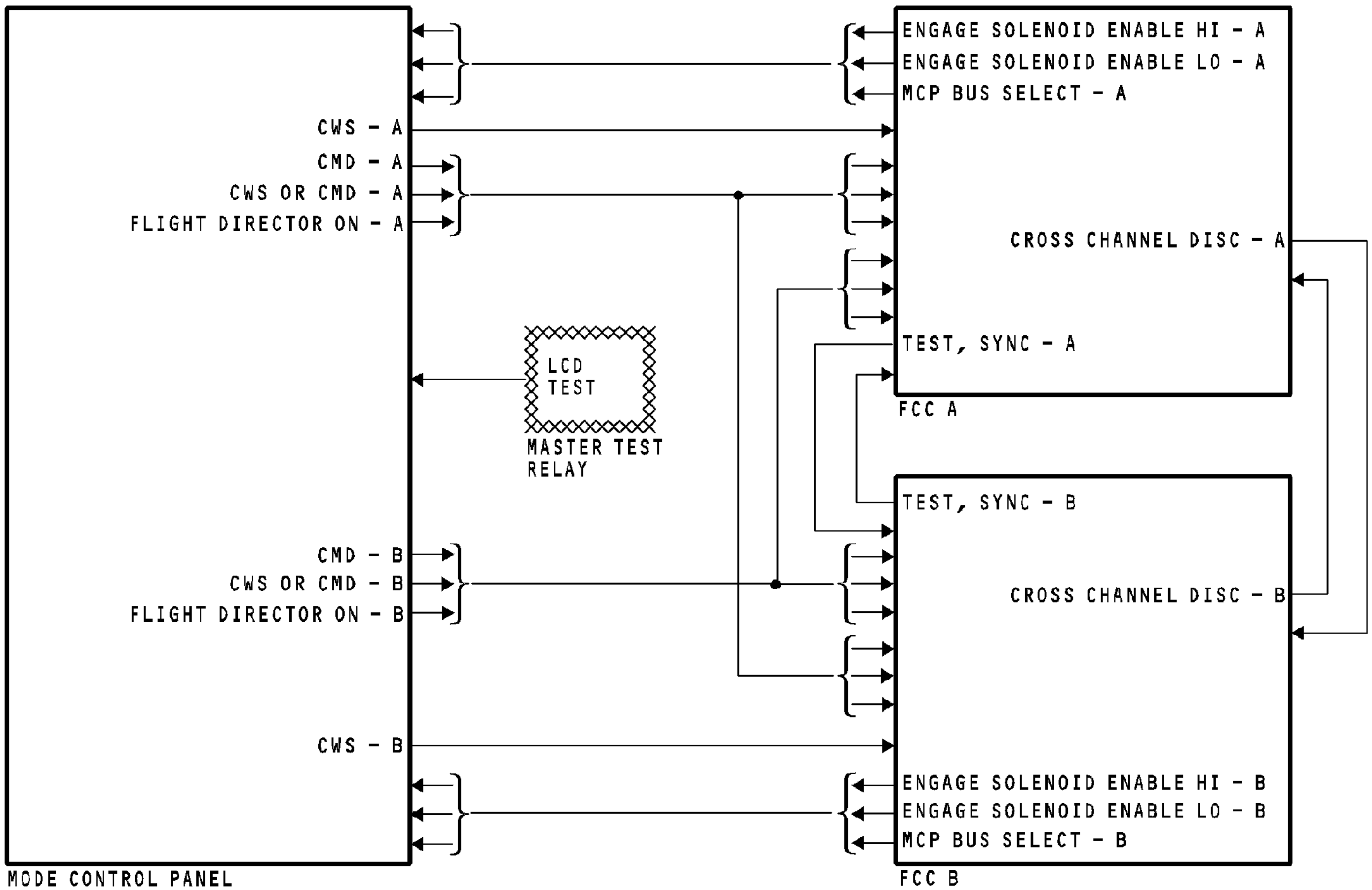
When the flight crew engages either autopilot in command (CMD) or control wheel steering (CWS), the MCP sends engage signals go to the FCCs. When the crew turns on either flight director, the MCP sends F/D turn on signals to the FCCs.

You energize the master test relay when the master test switch is in the test position. This sends 28v dc to do a test of the MCP light emitting diodes (LEDs).

FCC

Each FCC sends data to the MCP to tell the MCP if it can engage the A/Ps. To engage an A/P, the FCC must send an engage solenoid enable high signal and an engage solenoid enable low signal. The enable high signals shows that CPU 1 in the FCC is valid. The enable low signals shows that CPU 2 in the FCC is valid. Each FCC also tells the MCP which FCC is the master FCC. The MCP uses data from the master FCC and also sends the master FCC data on to other systems.

The FCCs send test, synchronization, and autopilot disconnect signals between each other.



DFCS - MODE CONTROL PANEL ANALOG INTERFACE

DFCS - ROLL SENSOR ANALOG INTERFACE

General

The FCCs and MCP have an interface with these components when a roll mode is active for the autopilot:

- A/P aileron actuators A and B
- Roll CWS force transducer
- Aileron position sensor
- Spoilers 4 and 9 position sensors.

Aileron A/P Actuators

The A/P aileron actuators send the aileron actuator position data to the onside FCC. This position data comes from the linear variable differential transformer (LVDT).

MCP

When you engage the A autopilot to CMD or CWS, the MCP sends an engage signal to A/P aileron actuator A. This lets A hydraulic fluid into the actuator. The MCP also sends this signal to FCC A. The FCC then commands the actuator main piston to synchronize to the aileron position. When you engage the B autopilot to CMD or CWS, the MCP sends an engage signal to A/P aileron actuator B. This lets B hydraulic fluid into the actuator. The MCP also sends this signal to FCC B. The FCC then commands the actuator main piston to synchronize to the aileron position.

Roll CWS Force Transducer

The roll CWS force transducer sends a signal to the FCCs. This signal is in proportion to the turning force on the control wheels.

Aileron Position Sensor

The aileron position sensor measures the position of the ailerons. It sends a signal in proportion to this position to the FCCs.

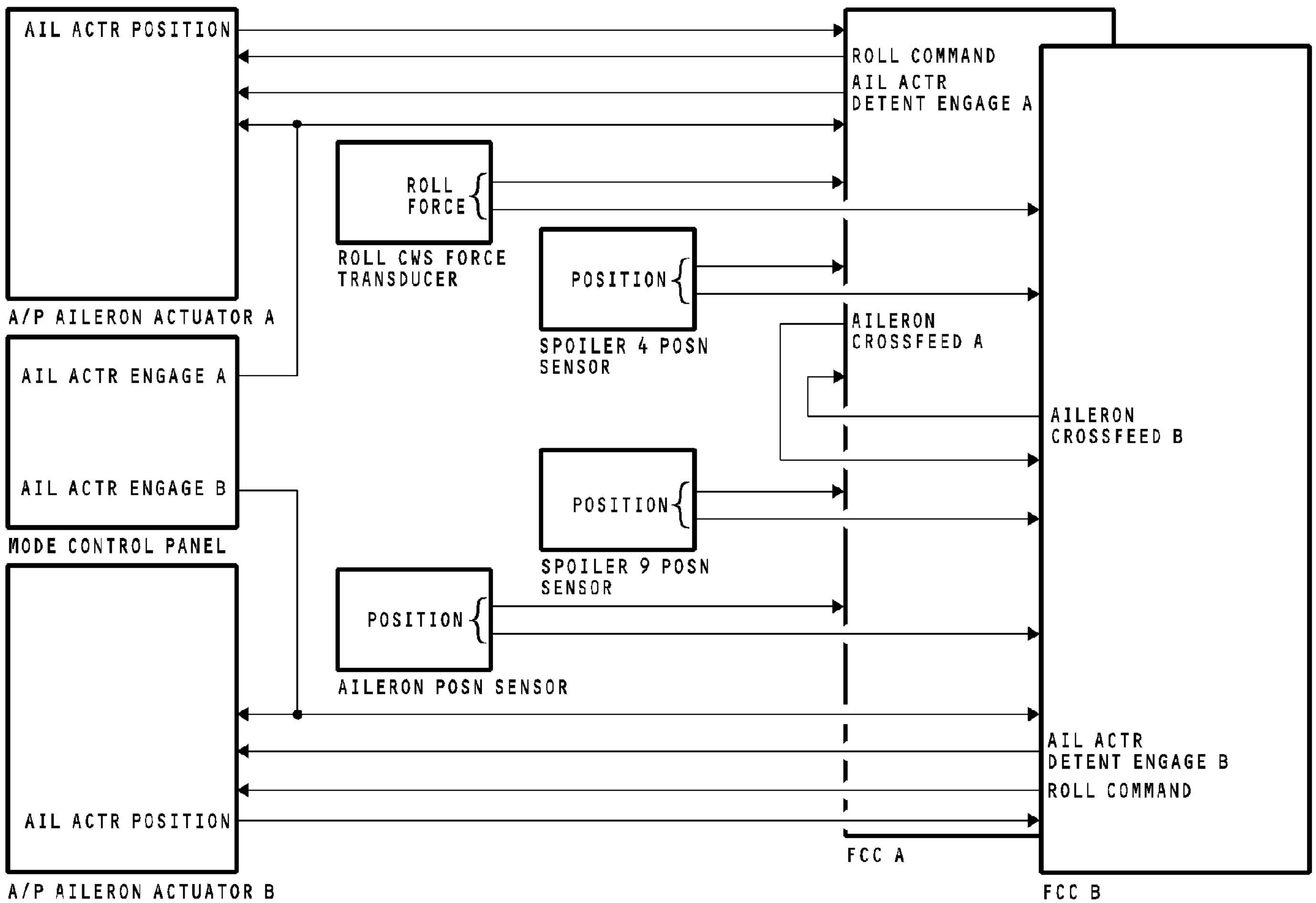
Spoiler Position Sensors

One spoiler position sensor measures the position of spoiler 4. Another spoiler sensor measures the position of spoiler 9. The sensors send position signals to the FCCs.

FCC

The FCC A sends a signal to A/P aileron actuator A to engage the detent solenoid valve. This pressurizes the main piston and locks it to the output shaft. It also sends the roll command signals to this actuator. The FCC B sends a signal to A/P aileron actuator B to engage the detent piston. This pressurizes the main piston and locks it to the output shaft. It also sends the roll command signals to this actuator.

Each FCC sends its onside aileron position data to the other FCC.



DFCS - ROLL SENSOR ANALOG INTERFACE

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DFCS - PITCH SENSOR ANALOG INTERFACE

General

The FCCs and MCP have an interface with these components when a pitch mode is active for the autopilot (A/P):

- A/P elevator actuators A and B
- Captain pitch CWS force transducer
- First officer pitch CWS force transducer
- Left and right flap position transmitters
- Stabilizer position sensors A and B
- Neutral shift sensor
- Elevator position sensor.

A/P Elevator Actuators

The A/P elevator actuators send the elevator actuator position data to its onside FCC. This position data comes from the linear variable differential transformer (LVDT).

MCP

When you engage the A autopilot to CMD or CWS, the MCP sends an engage signal to A/P elevator actuator A. This lets A hydraulic fluid into the actuator. The MCP also sends this signal to FCC A. The FCC then commands the actuator main piston to synchronize to the elevator position. When you engage the B autopilot to CMD or CWS, the MCP sends an engage signal to A/P elevator actuator B. This lets B hydraulic fluid into the actuator. The MCP also sends this signal to FCC B. The FCC then commands the actuator main piston to synchronize to the elevator position.

Captain Pitch CWS Force Transducer

The captain pitch CWS force transducer sends a signal to the FCCs. This signal is in proportion to the force on the captain control column.

Flap Position Transmitters

The left flap position transmitter sends the left flap position data to FCC A. The right flap position transmitter sends the right flap position data to FCC B.

Elevator Position Sensor

The elevator position sensor measures the position of the elevators. It sends a signal in proportion to this position to both FCCs.

First Officer Pitch CWS Force Transducer

The first officer pitch CWS force transducer sends a signal to both FCCs. This signal is in proportion to the force on the first officer control column.

Stabilizer Position Sensors

The stabilizer position sensors measure the position of the stabilizer. Stabilizer position sensor A sends a position signal to FCC A and to the flight data acquisition unit (FDAU). Stabilizer position sensor B sends a position signal to FCC B.

DFCS - PITCH SENSOR ANALOG INTERFACE

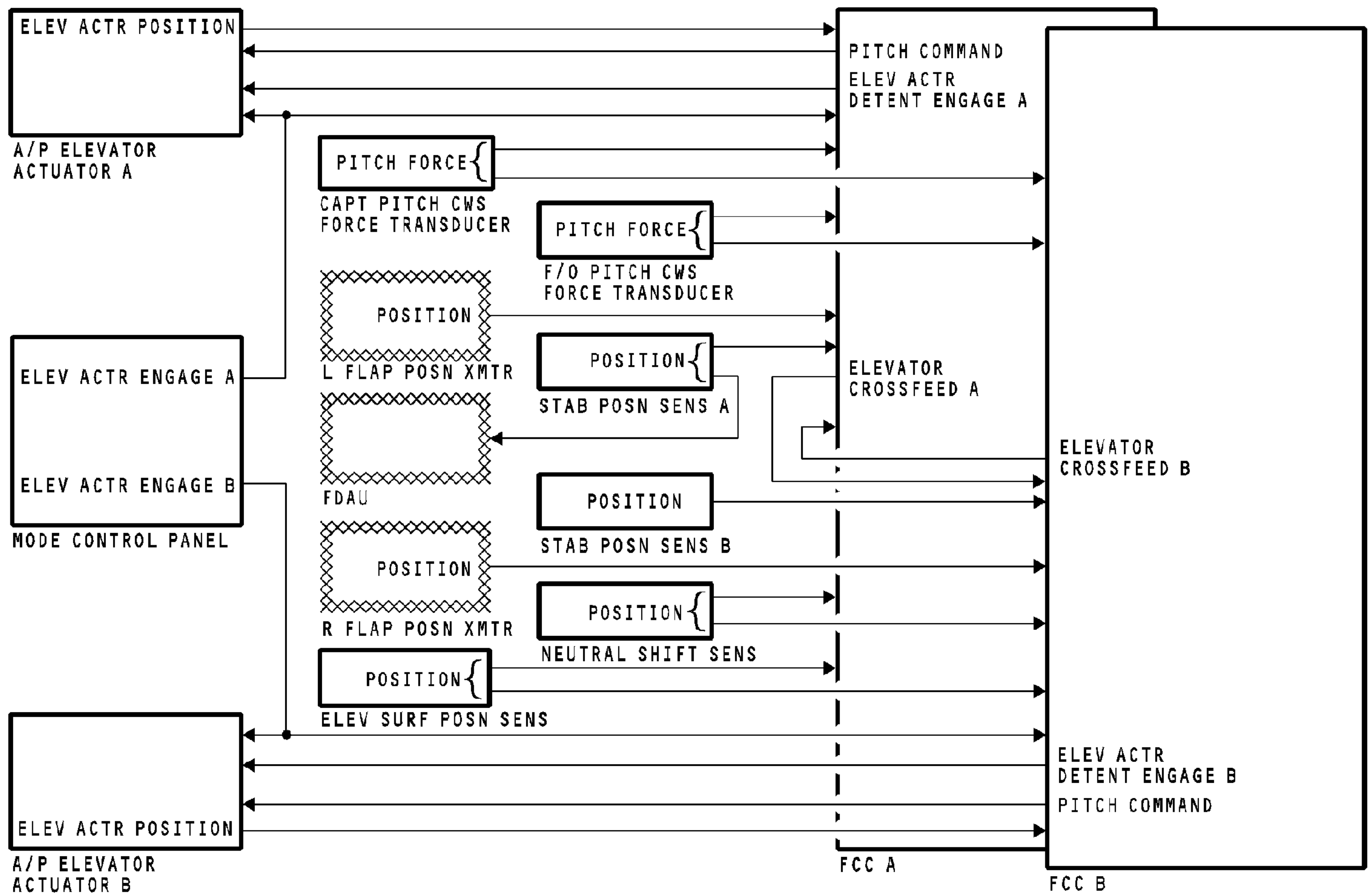
Neutral Shift Sensor

The neutral shift sensor measures the relative position between the stabilizer and the elevator. It sends this signal to both FCCs.

FCC

The FCC A sends a signal to A/P elevator actuator A to engage the detent piston. This pressurizes the main piston and locks it to the output shaft. It also sends the pitch command signals to this actuator. The FCC B sends a signal to A/P elevator actuator B to engage the detent piston. This pressurizes the main piston and locks it to the output shaft. It also sends the pitch command signals to this actuator.

Each FCC sends its onside elevator position data to the other FCC.



DFCS - PITCH SENSOR ANALOG INTERFACE

DFCS - RUDDER COMMAND AND CONTROL ANALOG INTERFACE

General

The FCCs have an interface with these components when rudder commands are in operation for the autopilot (A/P):

- Rudder servo assembly
- Rudder position sensor.

FCC Rudder Drive

The FCC rudder drive gives automatic rudder control during:

- Approach
- Landing
- Go-around
- Landing rollout.

A rudder servo assembly gives the torque for movement.

Rudder Servo Assembly

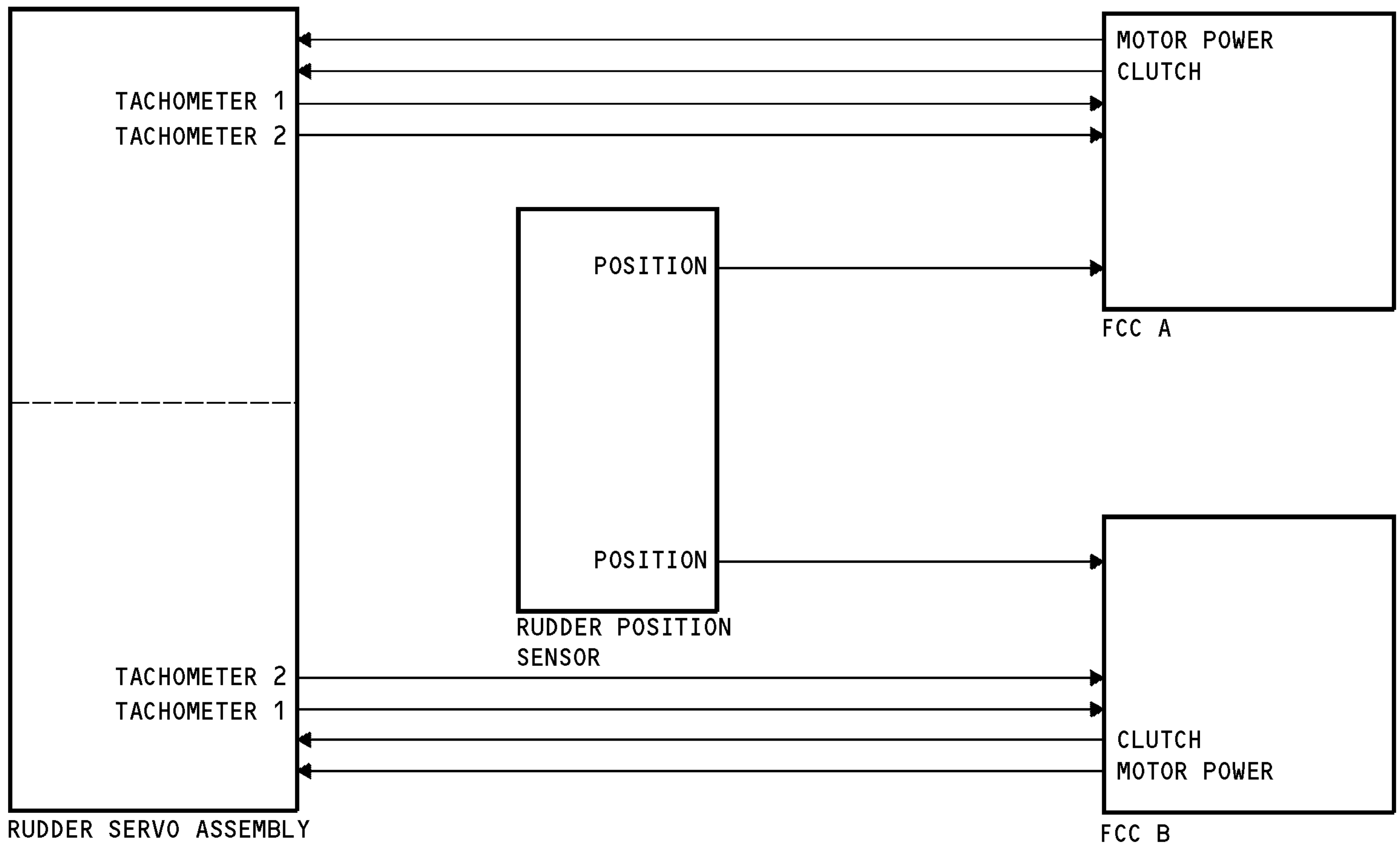
The rudder servo assembly has two rudder servos. The rudder surface moves by dc induction motors in the rudder servo assembly. FCC A gives the drive to one of the servo motors and FCC B gives the drive to the other servo motor.

Each servo has an engage clutch for which engage logic from the FCC is necessary. There is FCC logic if the process lanes of the FCC are valid.

Tachometer feedback of the servo motor goes to lane 1 and 2 of the onside FCC.

Rudder Position Sensor

The dual channel rudder position sensor measures motion of the rudder. The position data goes to FCC A and FCC B.



DFCS - RUDDER COMMAND AND CONTROL ANALOG INTERFACE

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DFCS - SPEED AND STAB TRIM ANALOG INTERFACE

General

The speed and stabilizer trim functions of the FCC have an interface with these components:

- Stab trim warning light
- Column switching module A/P cruise trim and stab trim cutout switches
- Flight control panel
- Stab nose up and down limit switches
- Left elevator tab solenoid valve
- Stabilizer trim electric actuator.

FCC

The FCCs send stabilizer trim actuator clutch and nose up and down trim signals to the column switching module. The FCCs also send a flap down signal to the stabilizer trim electric actuator. This signal controls the speed of the stabilizer trim electric actuator. When the flaps are down, the speed is three times the speed when the flaps are up.

Stab Trim Warning Light

If either FCC calculates that the stabilizer is out of trim, it sends a stabilizer out of trim warning signal to the stab trim warning light to turn it on.

Column Switching Module

The column switching module sends signals to the FCCs to show when the control column moves to the forward or aft position. If the control column moves opposite of the stab trim command, the column switching module will stop the trim signal. The column switching module sends a clutch engage signal through the A/P cruise trim cutout switch to the stabilizer trim actuator. It also sends the trim up and trim down drive signals to the stab trim cutout relay. These signals then go through the stab nose limit switches to the stabilizer trim actuator.

Flight Control Panel

The flight control panel receives a speed trim warning signal from each FCC. Both FCCs must send a fail signal to turn on the speed trim fail annunciator.

Recall signals from the master caution annunciators and reset signals from the master caution lights go to the flight control panel. These signals turn on the speed trim fail light if only one FCC speed trim fails.

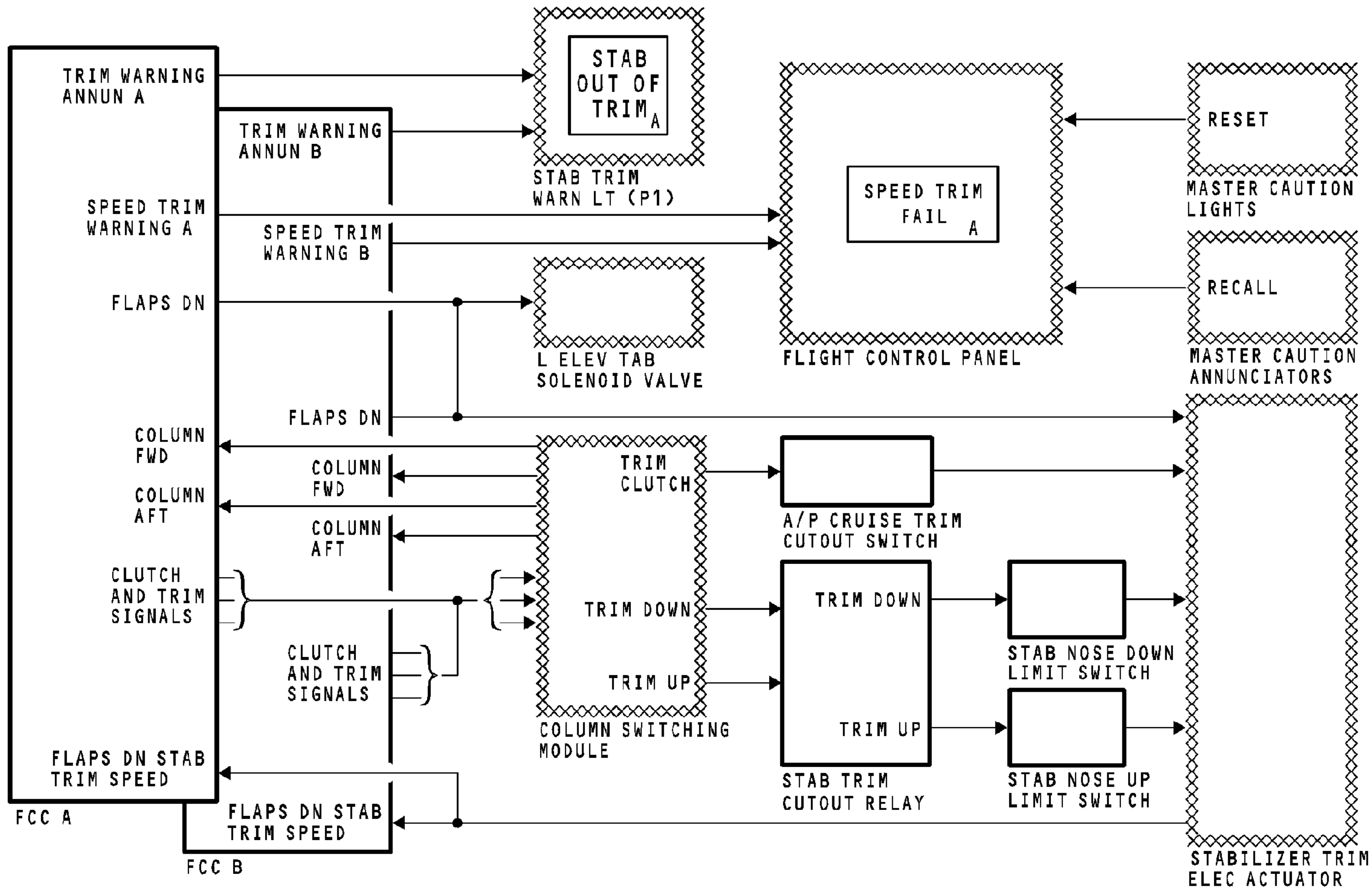
DFCS - SPEED AND STAB TRIM ANALOG INTERFACE

Left Elevator Tab Solenoid Valve

When the flaps are one unit or more (FLAPS DN) and the hydraulics are on, the elevator tabs move in the same direction as the elevator. This gives an increase in the elevator performance for an engine-out takeoff condition. The FCCs supply the FLAPS DN signal to the left elevator tab solenoid valve.

Stabilizer Trim Electric Actuator

The stabilizer trim electric actuator sends a signal to the FCCs that tells if the actuator is in the low or high speed. The position of the flaps cause the speed of the actuator to change.



22-11-00-023

DFCS - SPEED AND STAB TRIM ANALOG INTERFACE

DFCS - MACH TRIM ANALOG INTERFACE

General

The mach trim function of the FCC interfaces with these components:

- Mach trim actuator
- Integrated flight system accessory unit (IFSAU)
- Flight control panel.

Power

The 115v ac transfer bus 1 and 28v dc bus 1 send mach trim power to FCC A. The 115v ac transfer bus 2 and 28v dc bus 2 send mach trim power to FCC B. The 28v dc bus 2 also sends power to the IFSAU.

Mach Trim Actuator

The mach trim actuator sends the mach trim position signal to the FCCs.

IFSAU

Only one FCC can control the mach trim actuator at a time. The IFSAU receives the FCC select signal from FCC B. This signal controls a relay in the IFSAU to find which FCC will give the mach trim actuator signals. The IFSAU sends the mach trim select status signal to the FCCs to show which FCC is in control. The IFSAU then sends mach trim power and motor drive signals to the mach trim actuator.

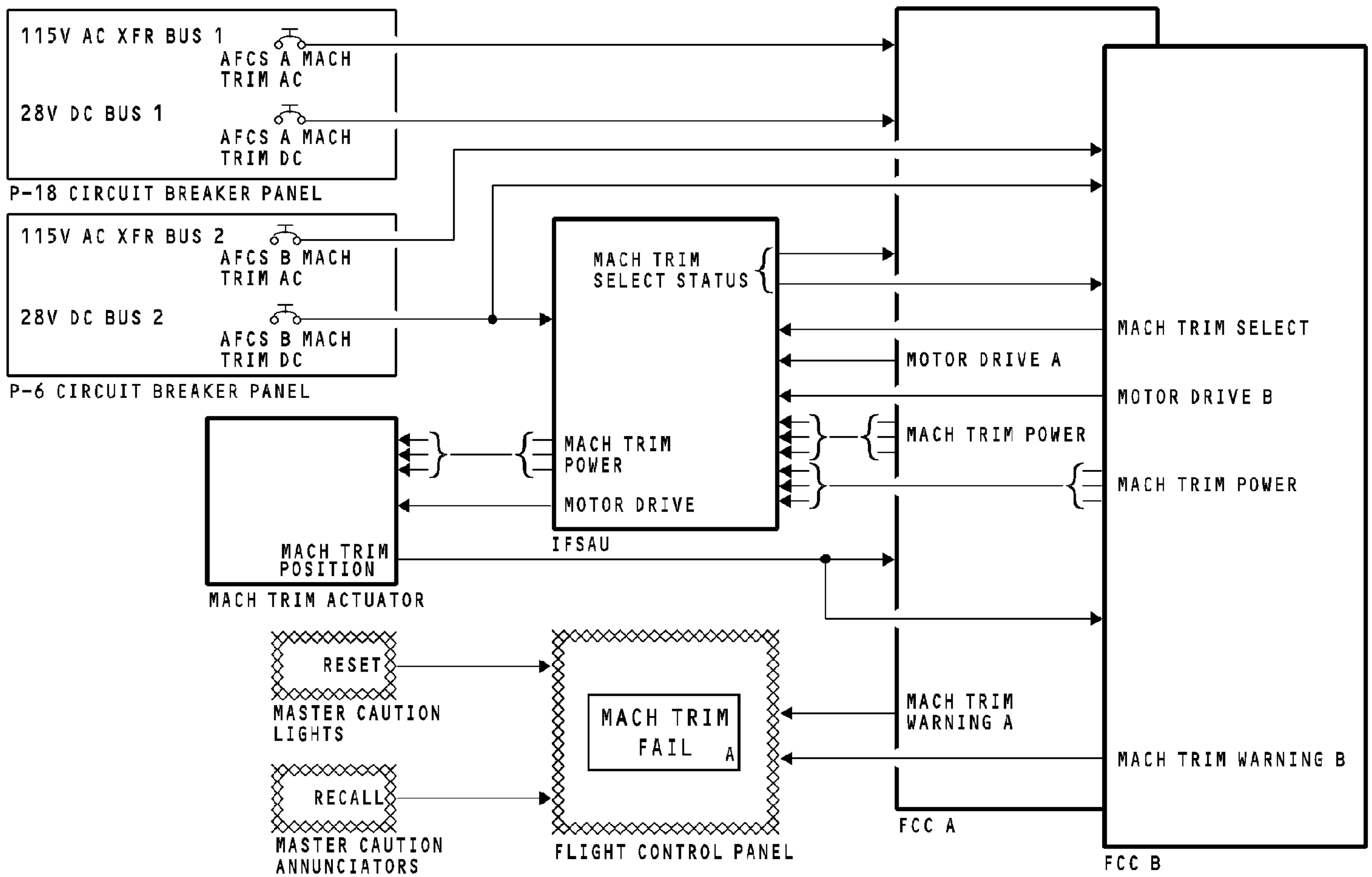
Flight Control Panel

The flight control panel receives a mach trim warning signal from each FCC. Both FCCs must send a fail signal to turn on the mach trim fail annunciator.

Recall signals from the master caution annunciators and reset signals from the master caution lights go to the flight control panel. These signals can turn on the mach trim fail light if only one FCC mach trim fails.

FCC

The FCCs send mach trim power and motor drive signals to the IFSAU. FCC B sends a signal to the IFSAU to set which FCC will supply mach trim data to the mach trim actuator. Each time the airplane lands, the FCCs switch control of the mach trim actuator.



DFCS - MACH TRIM ANALOG INTERFACE

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DFCS - VHF NAVIGATION ANTENNA SWITCHING ANALOG INTERFACE

General

These components have an interface with the FCCs to select the VHF navigation antennas. They also prevent a change in frequency of the multi-mode receivers (MMR) during an autopilot approach mode:

- Dual VOR/LOC antenna
- Dual Localizer antenna
- RF power dividers 1 and 2
- Localizer antenna switches 1 and 2
- IFSAU
- MMR receivers 1 and 2
- Radio altimeters (RA) 1 and 2
- Capt and F/O navigation control panels.

VOR/LOC Antenna

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The VOR/LOC antenna receives the VOR and localizer signals and sends them through the RF power dividers to localizer antenna switches 1 and 2.

HAP 037

The VOR/LOC antenna receives the VOR, localizer, or GLS signals and sends them through the RF power dividers to localizer antenna switches 1 and 2.

HAP ALL

Localizer Antennas

These antennas receive the localizer signal and send it directly to the localizer antenna switches.

Localizer Antenna Switches

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The localizer antenna switch selects the VOR/LOC antenna or the localizer antenna. If the FCC is in the approach or localizer mode, it sends an ILS test inhibit/antenna signal to the IFSAU. This signal energizes a switch which sends a ground to one side of the switch. If the navigation control panel selects a localizer frequency, it sends 28v dc to the other side of the switch. These signals cause the relay to energize so the receivers use the localizer antenna in the nose radome. If you do not select an ILS frequency, the receivers use the VOR/LOC antenna in the vertical stabilizer. Also, if you do not use the FCC in the approach or localizer mode, the receivers use the VOR/LOC antenna.

HAP 001-013, 015-026, 028-036, 038-054, 101-999 (Continued)

HAP 037

The localizer antenna switch selects the VOR/LOC antenna or the localizer antenna. If the FCC is in the approach or localizer mode, it sends an ILS test inhibit/antenna signal to the IFSAU. This signal energizes a switch which sends a ground to one side of the switch. If the navigation control panel selects a localizer frequency, it sends 28v dc to the other side of the switch. These signals cause the relay to energize so the receivers use the localizer antenna in the nose radome. If you do not select an ILS frequency, the receivers use the VOR/LOC antenna in the vertical stabilizer. If you do not use the FCC in the approach or localizer mode, the receivers use the VOR/LOC antenna. Also, if a GLS channel is selected, the VOR/LOC antenna is used and no switching to the localizer antenna occurs.

HAP ALL

Each switch sends a signal to its onside FCC to tell it which antenna is in use.

FCC

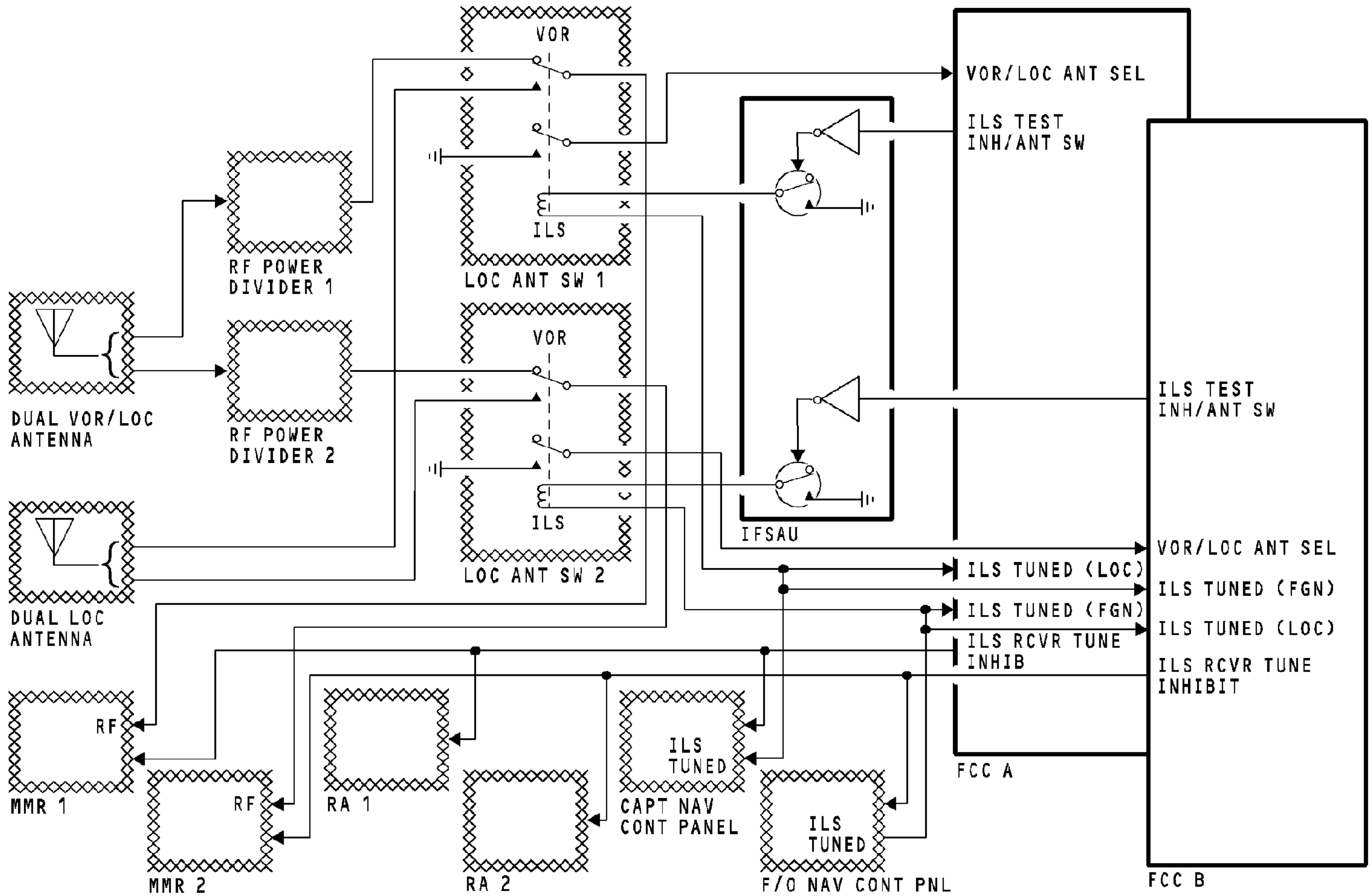
When the A system autopilot or flight director is in the approach or localizer mode, it sends an ILS test inhibit/antenna A signal the IFSAU. It also sends an ILS receiver tuning inhibit signal to these components:

- MMR 1
- RA 1
- Capt navigation control panel.

When the B system autopilot or flight director is in the approach or localizer mode, it sends an ILS test inhibit/antenna B signal the IFSAU. It also sends an ILS receiver tuning inhibit signal to these components:

- MMR 2
- RA 2
- F/O navigation control panel.

The tune inhibit signal does not let the control panel and receivers tune to an unwanted frequency unless the crew pushes the transfer switch on the nav control panel.



DFCS - VHF NAVIGATION ANTENNA SWITCHING ANALOG INTERFACE

22-11-00-025

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DFCS - TRANSFER SWITCHES ANALOG INTERFACE

General

These components have an interface with the FCCs as part of the engage and interlock circuit:

- IRS transfer switch
- VHF navigation transfer switch
- Frequency transfer switch on the Capt and F/O navigation control panels.

The DFCS monitors these switches to see if a change occurs. The sensor output that the DFCS uses for an active mode in the autopilot or flight director must show on either the instruments for the captain or first officer. If it does not, the DFCS will not allow the autopilot or flight director mode. If a switch occurs such that both autopilots and instruments on both sides receive data for the same sensor, dual autopilot and dual flight director modes can not occur.

IRS Transfer Switch

If you change the IRS functions from NORMAL to BOTH ON 1 or BOTH ON 2, the FCCs receive the change from the IRS transfer switch. When the pilots change away from one of the IRSs, out of the NORMAL position, the autopilot disengages and the flight director commands will BOV on the side that changed (channel A if BOTH ON 2).

Normally, the FCCs use pitch and heading data from the on-side IRS and roll data from the off-side IRS. The autopilot will engage only if the IRS transfer switch is in the NORMAL position. This is to prevent a possible ADIRU failure that could cause a pitch and roll hardover or a yaw damper and elevator hardover.

For dual F/D approach or TO/GA, an IRS switch out of NORMAL will cause BOV.

VHF Navigation Transfer Switch

HAP 001-013, 015-026, 028-036, 038-054, 101-999

If you change the VHF navigation receivers from NORMAL to BOTH ON 1, FCC B gets VOR/ILS transfer and VOR/ILS instrument tranfer signals to show the change. If you change the VHF navigation receivers from NORMAL to BOTH ON 2, FCC A gets VOR/ILS transfer and VOR/ILS instrument tranfer signals to show the change.

HAP 037

If you change the VHF navigation receivers from NORMAL to BOTH ON 1, FCC B gets VOR/ILS/GLS transfer and VOR/ILS/GLS instrument tranfer signals to show the change. If you change the VHF navigation receivers from NORMAL to BOTH ON 2, FCC A gets VOR/ILS/GLS transfer and VOR/ILS/GLS instrument tranfer signals to show the change.

HAP 037 (Continued)

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The DFCS cannot use VOR/ILS data that does not show on the instruments.

HAP 037

The DFCS cannot use VOR/ILS/GLS data that does not show on the instruments.

HAP ALL

VHF Navigation Control Panel

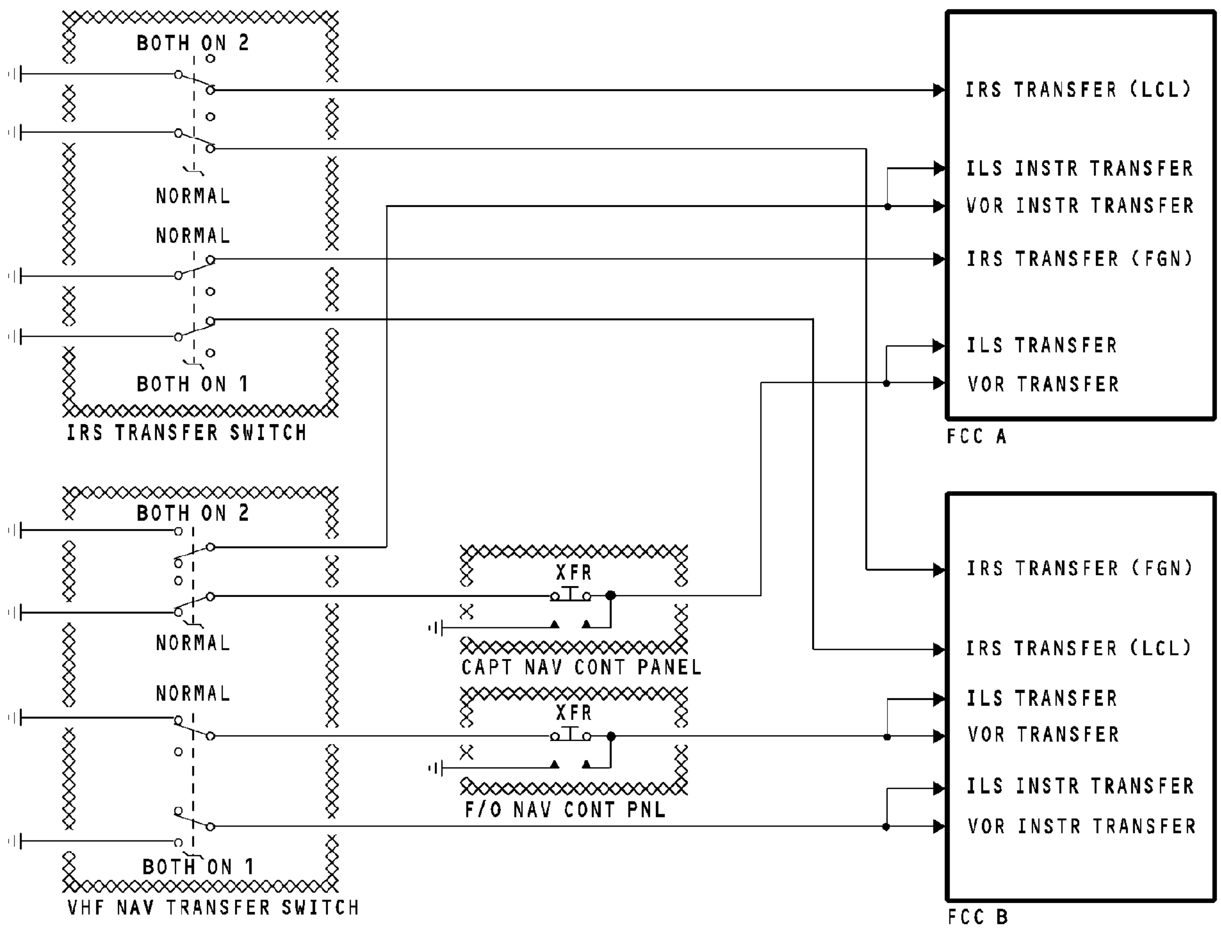
HAP 001-013, 015-026, 028-036, 038-054, 101-999

When you push the frequency transfer switch on the navigation control panel, a VOR/ILS transfer signal goes to the onside FCC to show that the VOR/LOC frequency will change. The FCC will reset the mode if the autopilot is in the VOR/LOC mode. The autopilot will disengage if it is in the approach mode. The pilot may select the VOR/LOC mode or reengage the autopilot after the frequency change.

HAP 037

When you push the frequency transfer switch on the navigation control panel, a VOR/ILS/GLS transfer signal goes to the onside FCC to show that the VOR/LOC frequency or GLS channel will change. The FCC will reset the mode if the autopilot is in the VOR/LOC mode. The autopilot will disengage if it is in the approach mode. The pilot may select the VOR/LOC mode or reengage the autopilot after the frequency change.

HAP ALL



DFCS - TRANSFER SWITCHES ANALOG INTERFACE

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DFCS - MISCELLANEOUS SYSTEMS ANALOG INTERFACE

Proximity Switch Electronics Unit

When the proximity switch electronics unit gets an input that the gear is down, it sends a ground to FCC A and B.

Takeoff/Go Around (TO/GA) Switches

When you push either TO/GA switch, a ground goes to these components:

- Stall management yaw dampers (SMYD) 1 and 2

HAP 001-013, 015-026, 028-030

- Autothrottle (A/T) computer

HAP 031-054, 101-999

- Autothrottle function in FCC A

HAP ALL

- FCC A and B.

FCC

There are several program pins that set the airplane identification and configuration of the FCC. You can ground some pins when you connect them to a burndy block. Other pins connect to program switch modules which contain dip switches.

HAP 001-013, 015-026, 028-030

There is an autopilot (A/P) system A program switch module that connects to several program pins on FCC A. There is an A/P system B program switch module that connects to several program pins on FCC B. To ground one of these program pins, you put the dip switch in the ON position. The OFF position supplies an open to the program pin.

HAP 031-054, 101-999

There are two autopilot (A/P) system A program switch modules that connect to several program pins on FCC A. There are two A/P system B program switch modules that connect to several program pins on FCC B. To ground one of these program pins, you put the dip switch in the ON position. The OFF position supplies an open to the program pin.

HAP 001-013, 015-026, 028-030

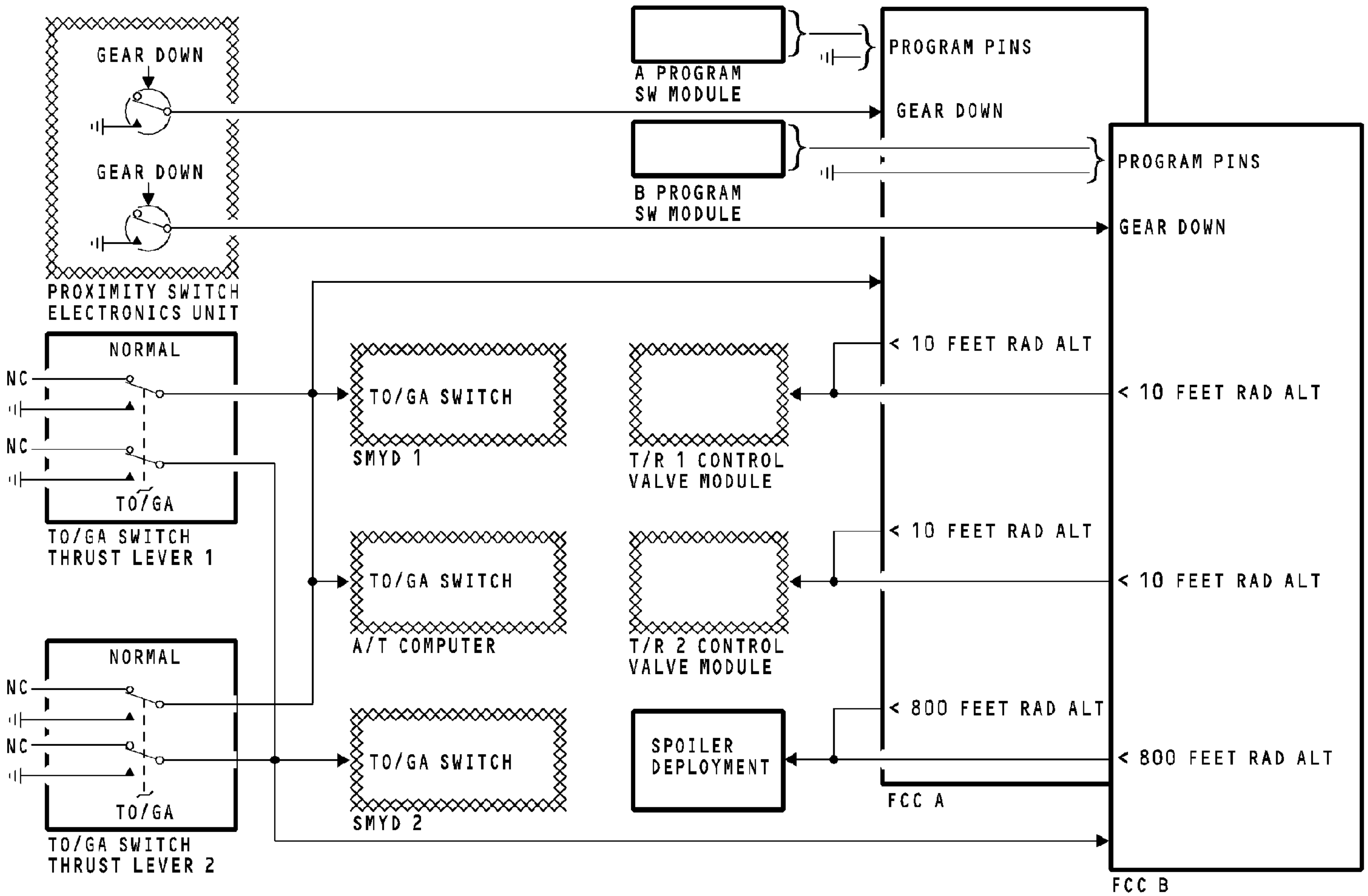
Each FCC calculates altitude trip points from the radio altimeter data. When the altitude is less than 10 feet, the FCC sends a discrete to the thrust reverser (T/R) control valve modules. When the altitude is less than 800 feet, it sends a discrete to the spoiler deployment system.

HAP 001-013, 015-026, 028-030 (Continued)

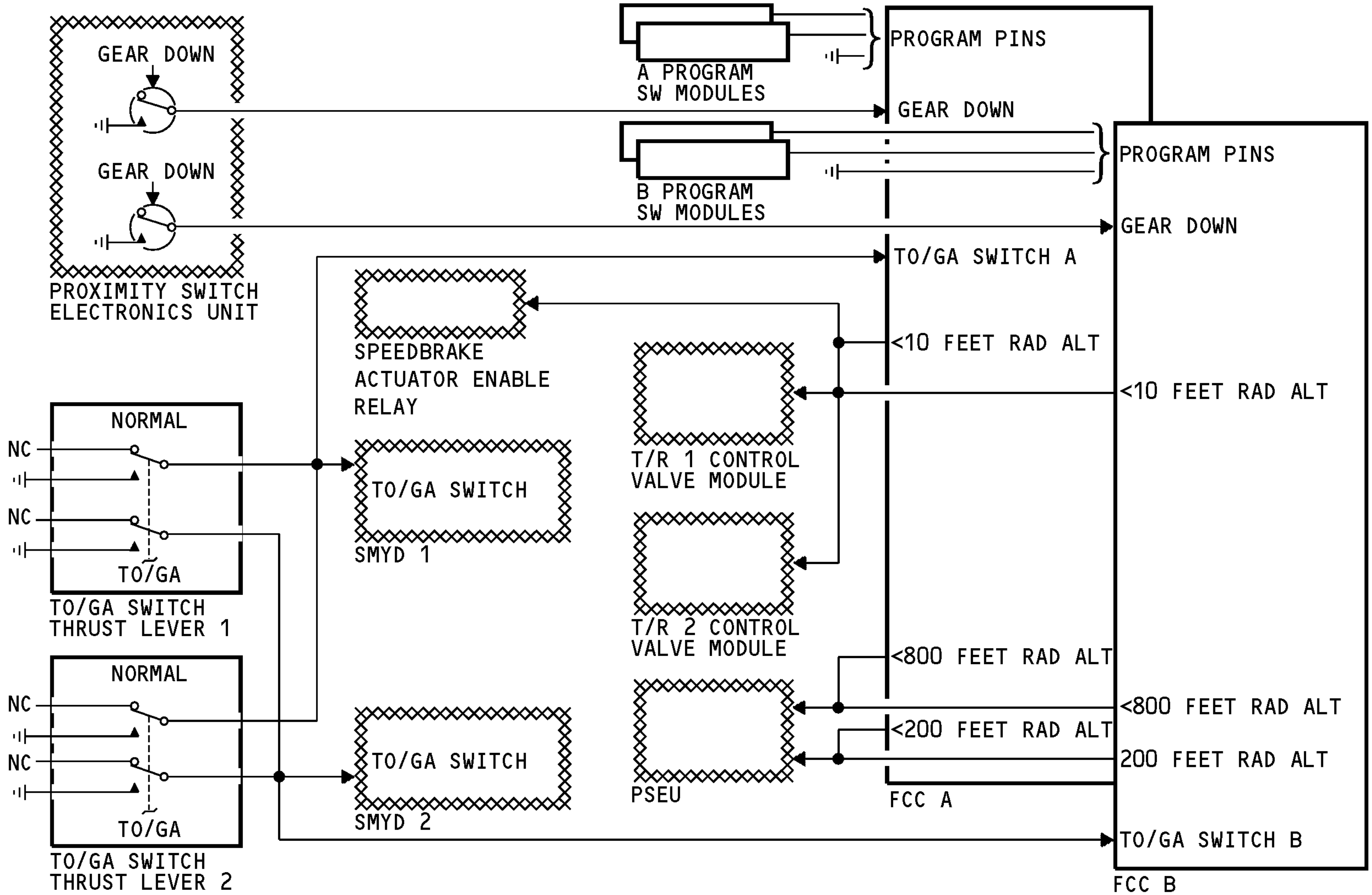
HAP 031-054, 101-999

Each FCC calculates altitude trip points from the radio altimeter data. When the altitude is less than 10 feet, the FCC sends a discrete to the thrust reverser (T/R) control valve modules and the auto speedbrake module. When the altitude is less than 800 feet, it sends a discrete to the spoiler deployment system and the landing gear system. The 800’ discrete is used for warning logic in the PSEU..

HAP ALL



DFCS - MISCELLANEOUS SYSTEMS ANALOG INTERFACE



DFCS - MISCELLANEOUS SYSTEMS ANALOG INTERFACE

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DFCS - MODE CONTROL PANEL - PHYSICAL DESCRIPTION

Purpose

The mode control panel (MCP) supplies the interface between the flight crew and the digital flight control system (DFCS). The MCP does these functions:

- Engages the autopilot
- Turns on the flight directors
- Selects the operation mode
- Arms the autothrottle
- Controls parameter selection
- Displays data.

Physical Description

The MCP weighs approximately 15 lbs. The MCP installs in the glareshield with four screws on the front of the panel. There are two screws on the bottom of the MCP that also attach to the glareshield. Three electrical receptacles on the rear of the MCP connect to the airplane wiring.

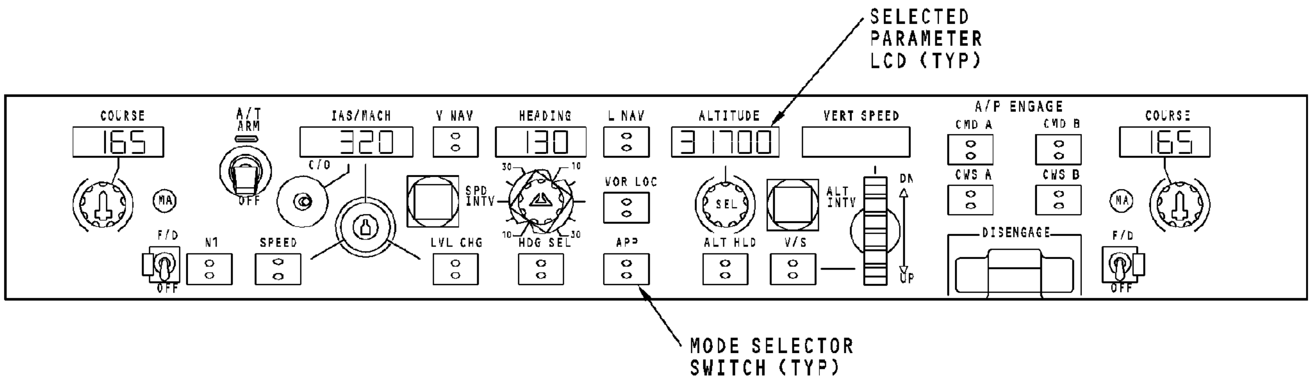
Each mode selector switch on the MCP contains six light emitting diodes (LED). The switches and the LEDs are not line replaceable units (LRUs).

There are six liquid crystal displays (LCDs). They show these selected parameter values:

- Course 1 and 2
- IAS/MACH
- Heading
- Altitude
- Vertical speed.

Three lamps give backlight to the five position LCD display. Two lamps give backlight to the three position LCD display. These lamps and the LCDs are not LRUs.

There are 52 incandescent lamps for the light plate. These lamps are also not LRUs.



DFCS - MODE CONTROL PANEL - PHYSICAL DESCRIPTION

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DFCS - MODE CONTROL PANEL - FUNCTIONAL DESCRIPTION

General

These are the major components of the mode control panel (MCP):

- ARINC 429 bus selector
- Channel A and B processors
- LCD indicators and controls
- Mode selector and A/P engage switches
- A/T switch and indicator
- A/P switches and indicators
- light sensors.

ARINC 429 Bus Selector

When an FCC becomes the master FCC and takes control of the MCP displays, it sends an MCP bus select signal to the MCP. The ARINC 429 bus selector then sends that FCC's data to the channel A processor and on to the FMC and the A/T. The MCP always uses the FCC A data unless the FCC B sends a bus select signal and the FCC A did not.

Channels A and B Processors

The MCP contains two separate microprocessors; a channel A processor and a channel B processor.

The channel A processor receives FCC data from the bus selector. The channel A processor does most of the MCP functions. The data then goes to the FCC A and to the channel B processor.

The channel B processor replaces the course 1 select data with the course 2 select data. The processor then sends all of the data on to the FCC B.

The channel B processor receives signals from the light sensors. The signals control the brightness of the LCD backlights and the mode selector switch LEDs.

The channel B processor calculates the A/P warning signal and sends it to the captain's and first officer's autoflight status annunciators (ASA).

Mode Selector and Toggle Switches

These switches send data to the channel A processor:

- F/D toggle switches
- A/P engage switches
- Mode selector switches.

The processor sends the A/P engage and mode select signals to the FCC. The FCC makes sure that all necessary conditions are satisfactory before it engages the A/P or selects the mode.

Mode Selector and Light Annunciators

The channel A processor receives engagement and mode select data from the FCC that has control. The processor then lights these annunciators:

- F/D master light LEDs

- A/P engage switch LEDs
- Mode selector switch LEDs.

LCDs and Selectors

The channel A processor receives data from these selectors. It then sends the data to the LCD display:

- Course 1 and 2 selectors
- Altitude selector
- Heading selector.

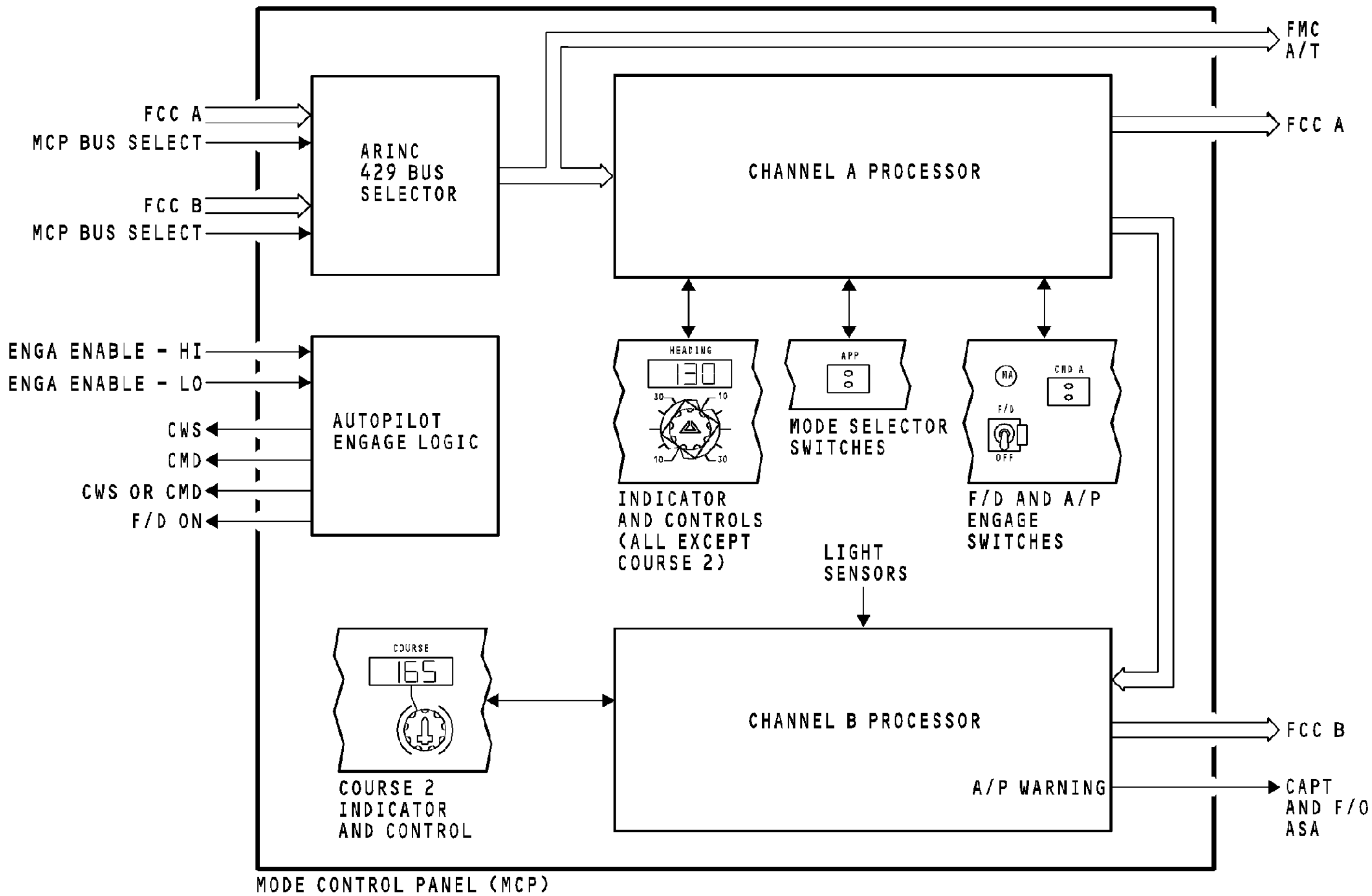
The channel A processor receives data from the IAS/MACH and vertical speed selectors and sends this data to the FCC. The FCC calculates the correct IAS/MACH and vertical speed and sends it to the MCP to show on their displays.

Autopilot Engage Logic

The engage enable signals, high and low, come from the FCCs. When the crew selects an autopilot mode, the MCP sends one of these engage signals to the FCCs:

- CWS only
- CMD only
- CWS and CMD.

The MCP also sends a signal that shows if the flight directors are on.



DFCS - MODE CONTROL PANEL - FUNCTIONAL DESCRIPTION

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DFCS - MODE CONTROL PANEL - CONTROLS AND DISPLAYS

General

There are many switches, knobs, and push-buttons on the MCP that the crew uses to control the FCC. There are also many displays to show selected parameter values.

Course Selectors

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The course selectors 1 and 2 select the instrument landing system (ILS) course or the VHF omnidirectional range (VOR) course . Course selector 1 is for the captain ILS or VOR system. Course selector 2 is for the first officer (F/O) ILS or VOR system.

HAP 037

The course selectors 1 and 2 select the instrument landing system (ILS) course, the global landing system (GLS) course, or the VHF omnidirectional range (VOR) course. Course selector 1 is for the captain ILS, GLS, or VOR system. Course selector 2 is for the first officer (F/O) ILS, GLS, or VOR system.

HAP ALL

Course Displays

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The two course displays show the VOR or ILS course you select. The display range is from 000 to 359 degrees.

HAP 037

The two course displays show the VOR, ILS, or GLS course you select. The display range is from 000 to 359 degrees.

HAP ALL

Flight Director (F/D) Switches

Two F/D switches turn on and turn off the F/D function in the FCCs. The captain F/D switch usually controls FCC A and you usually only see the F/D commands on the captain display. The F/O F/D switch usually controls FCC B and you usually only see the F/D commands on the F/O display.

Master Lights (2)

The master light shows which FCC controls the mode selection. If the master light above the captain F/D switch is on, FCC A controls the mode selection. If the master light above the F/O F/D switch is on, FCC B controls the mode selection.

Autothrottle (A/T) Arm Switch

When you put the switch to the ARM position, the A/T system arms. An electrical solenoid holds the switch in the ARM position. You disconnect the A/T if you put the switch to the OFF position.

A/T Arm Light

The light comes on when the A/T is in the arm mode.

DFCS - MODE CONTROL PANEL - CONTROLS AND DISPLAYS

IAS/MACH Selector

The IAS/MACH selector sets the MCP airspeed or mach.

IAS/MACH Display

The display shows indicated airspeed (IAS) or the mach number. The IAS shows from 100 to 399 kts in one knot increments. The mach shows from 0.60 to 0.89 mach in 0.01 mach increments.

The display has a warning flag that flashes for underspeed and overspeed conditions. The left position in the LCD shows this flag.

The IAS/MACH display is blank when the VNAV mode is active.

IAS/MACH Change/Over Switch

When you push this switch and the airspeed is more than mach 0.6, it changes the display from IAS in knots to mach or from mach to IAS in knots. If the airspeed is less than mach 0.6, the display will only show knots and the change over switch does not do anything.

Speed Intervention Push-button

The crew uses this push-button only in the VNAV mode. When you push the push-button, the IAS/MACH shows the FMC target speed. Turn the IAS/MACH selector to change the FMC target speed. This push-button then lets the crew change the FMC target speed and stay in VNAV.

Heading Selector

The heading selector changes the flight crew selected heading for the airplane.

Heading Display

The display shows the heading the flight crew selects. The display range is from 000 to 359 degrees.

Bank Angle Selector

The bank angle selector lets the flight crew set the maximum allowable bank angle. You can set the maximum bank angle to one of these angles:

- 10 degrees
- 15 degrees
- 20 degrees
- 25 degrees
- 30 degrees.

This variable bank angle only has an effect in the VOR and heading select modes.

DFCS - MODE CONTROL PANEL - CONTROLS AND DISPLAYS

Altitude Selector

The altitude selector sets the reference altitude for the DFCS. One revolution of the knob changes the altitude 6400 feet.

Altitude Display

This display shows the altitude the flight crew selects. The altitude range is from 0 to 50,000 feet.

Altitude Intervention Push-button

When you push this push-button in the VNAV mode, you can change the FMC target altitude and you can remove altitude constraints in the flight plan. You can remove up to eight restrictions with the push-button. You can change the FMC altitude and stay in VNAV. There is no indication on the MCP to show you selected the altitude intervention. The only indication is on the FMC LEGS page on the CDU.

Vertical Speed Thumbwheel

To set the vertical speed, turn the vertical speed thumbwheel. Turn the thumbwheel UP to make a nose up change in the value. Turn the thumbwheel DN to make a nose down change in the value. The thumbwheel has increments of 50 feet per minute (fpm) from 0 to 1000 fpm and 100 fpm for more than 1000 fpm.

Vertical Speed Display

This display shows the flight crew selected vertical speed. The vertical speed range is from -7,900 fpm to +6,000 fpm.

Autopilot (A/P) Engage Switches

There are four A/P engage switches. Two switches are for FCC A and two are for FCC B. The switches engage an autopilot to command (CMD) or control wheel steering (CWS).

The switches are push-button/light type switches. If the pre-engage logic is correct, the A/P engages and the switch light comes on when you push the switch. If the pre-engage logic is not correct, the A/P will not engage and the switch light will not come on when you push the switch.

After you engage the A/P, some conditions must stay correct or the autopilot disengages. If the A/P disengages, the switch light goes off.

A/P Disengage Bar

You disengage the A/P when you push the A/P disengage bar down.

Mode Selector Switches

These are the mode selector switches:

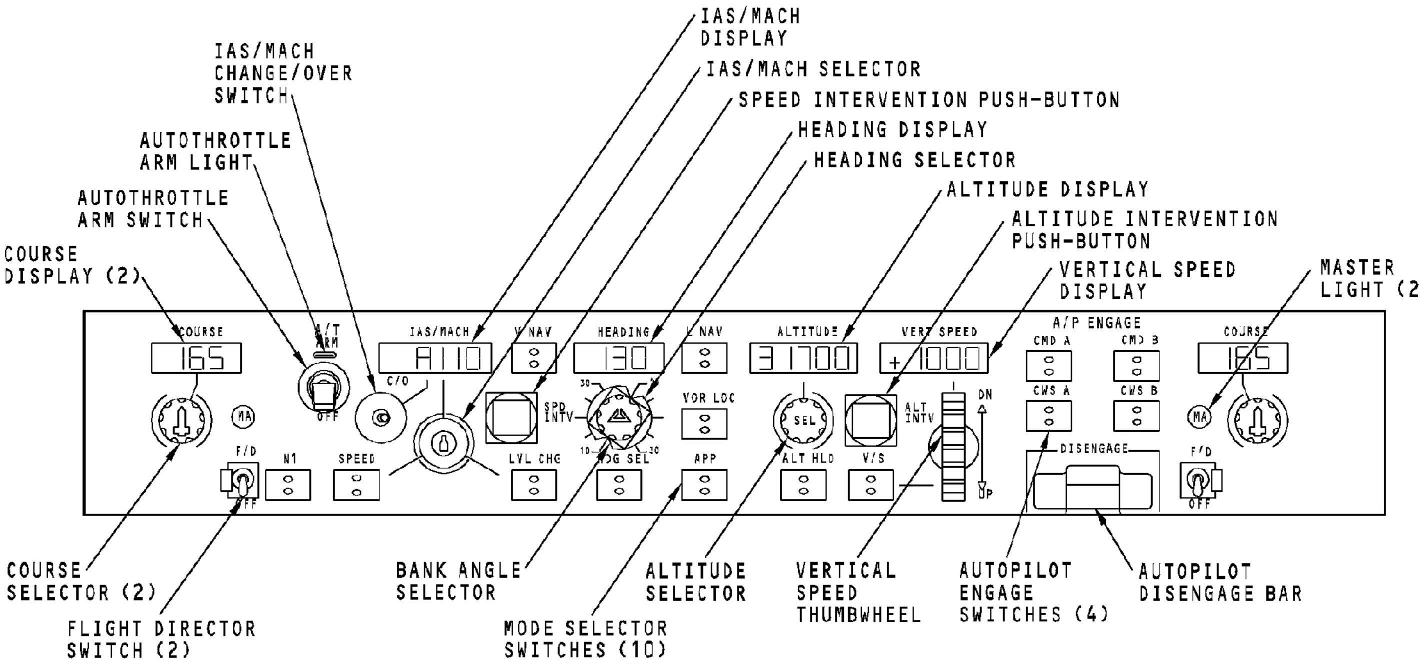
- Autothrottle N1
- Autothrottle speed
- Level change
- Heading select
- Approach
- VNAV

- LNAV
- VOR LOC
- Altitude hold
- Vertical speed.

If a mode selector switch light is on, you can turn off that mode when you push the switch again.

Light Sensors

Two photo diode light sensors on the MCP front panel monitor the light in the crew compartment area. The sensors control the brightness of the LCDs.



DFCS - MODE CONTROL PANEL - CONTROLS AND DISPLAYS

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DFCS - FLIGHT CONTROL COMPUTER - PHYSICAL DESCRIPTION

Purpose

The purpose of the flight control computer (FCC) is to get data inputs and calculate these functions:

HAP 031-054, 101-999
- Autothrottle function

HAP ALL
- Autopilot commands
- Flight director commands
- Altitude alerts
- Speed trim commands
- Mach trim commands.

The input data is from the pilot through the MCP and sensor inputs. The FCC also sends signals to control surface actuators and shows displays on the common display system (CDS).

Loadable Software

HAP 012, 013, 015-026, 028-054, 101-999; HAP 001-011 POST SB 737-31-1136

The software in the FCC is loadable. The software can be loaded using the data loader and the data loader control panel. The software can be loaded after these conditions are met:

- Successful long term power-up
- Valid data signals
- Airplane is on the ground
- Groundspeed is less than 60 knots
- No wheel spin
- No autopilot is engaged.

HAP 031-054, 101-999

The software can be cross-loaded from one FCC into the other FCC.

HAP 001-011 PRE SB 737-31-1136

The software in the FCC is loadable. The software can be loaded through the front test connectors. The software can be loaded after these conditions are met:

- Successful long term power-up
- Valid data signals
- Airplane is on the ground
- Groundspeed is less than 60 knots
- No wheel spin
- No autopilot is engaged.

HAP ALL

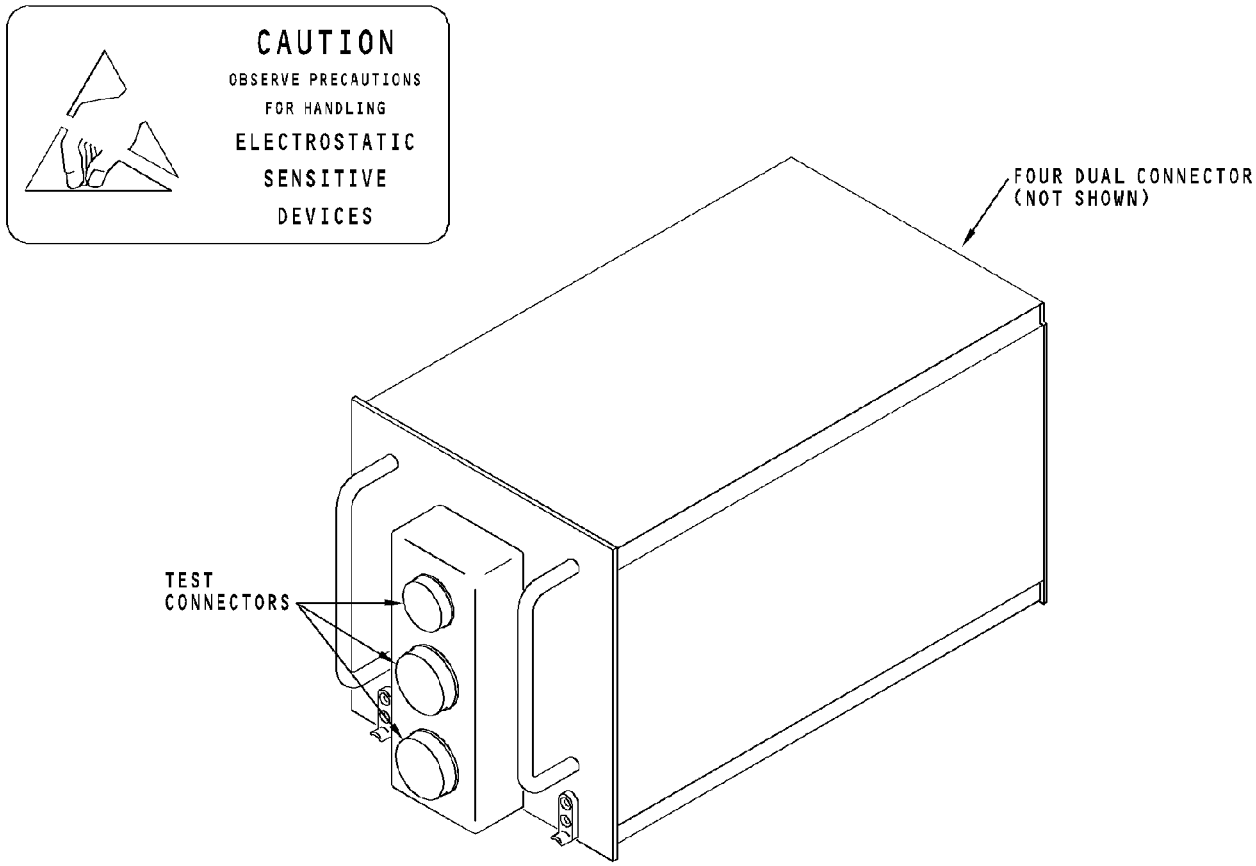
NOTE: Do not interrupt power to the system during software loading. If power is interrupted, you will need to do the software load procedure again.

Physical Description

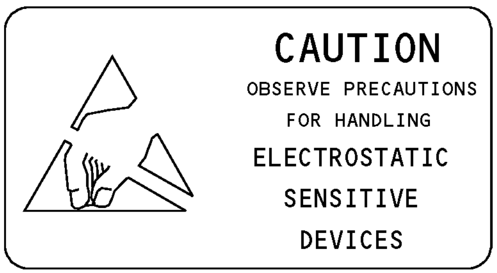
The FCC is 6 MCU in size. Any connector on the back is for interface signals and test connectors with covers are on the front. The two FCCs are the same and interchangeable line replaceable units (LRU).

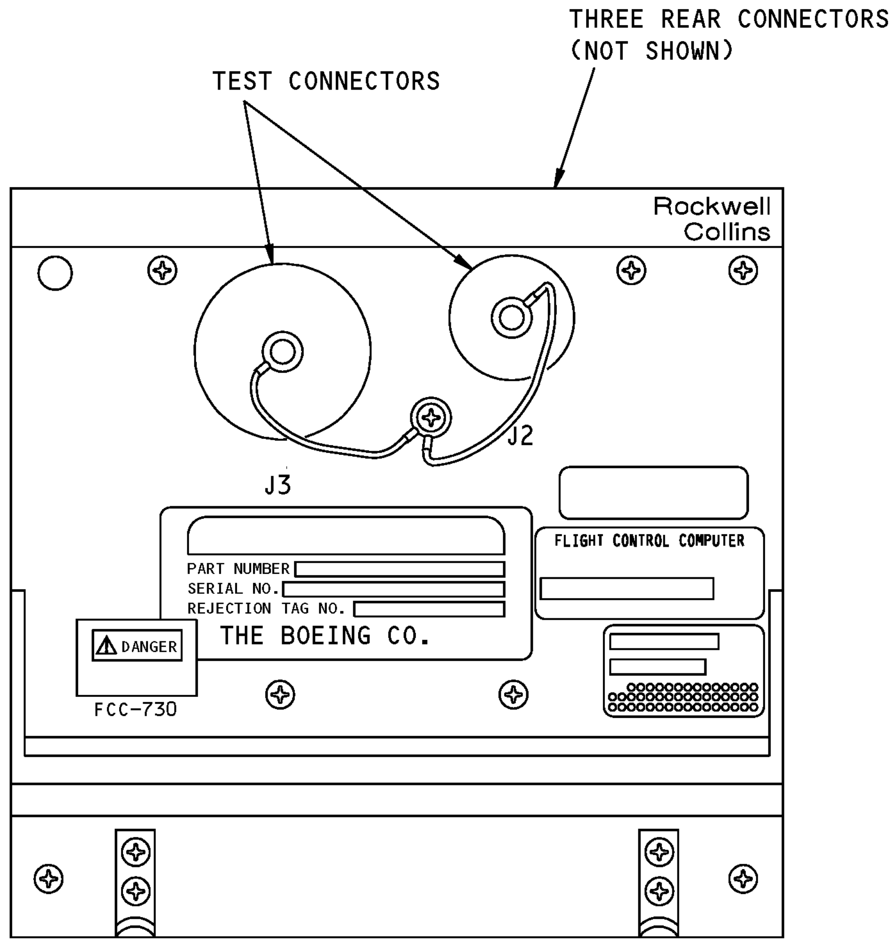
DFCS - FLIGHT CONTROL COMPUTER - PHYSICAL DESCRIPTION

CAUTION: DO NOT TOUCH THE FCC BEFORE YOU DO THE PROCEDURE FOR DEVICES THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE FCC.



DFCS - FLIGHT CONTROL COMPUTER - PHYSICAL DESCRIPTION





DFCS - FLIGHT CONTROL COMPUTER - PHYSICAL DESCRIPTION

DFCS - FLIGHT CONTROL COMPUTER - FUNCTIONAL DESCRIPTION

General

The flight control computer (FCC) is a digital computer. It takes inputs from many systems to calculate the flight control signals. The FCC contains these components:

- Direct memory access (DMA) system
- Computer processing units (CPUs) 1 and 2
- Program memory
- Power supply.

DMA System

The DMA system has these components:

- DMA I/O devices
- DMA controller
- DMA RAM.

The FCC can receive and send these types of data:

- Digital
- Analog
- Discrete.

The DMA I/O devices receive ARINC 429 data or convert analog and discrete signals to ARINC 429 data. This data then goes to the DMA controller. The DMA I/O devices also convert ARINC 429 data to analog and discrete signals before it goes to other systems.

The DMA controller controls all data to and from the FCC and all data between CPU 1 and CPU 2. It keeps the data in the DMA RAM.

CPUs

Each FCC has two 16-bit CPUs. The two processors have different part numbers to make sure that a design problem is not in both processors. The CPUs calculate different commands. This prevents a failure of both autopilot (A/P) pitch and roll commands at the same time.

The CPU 1 calculates these commands:

- Flight director (F/D) pitch and roll commands
- Mach trim commands
- Stabilizer and speed trim commands
- Altitude alert commands
- A/P roll commands in cruise and approach
- A/P pitch commands in cruise
- A/P alternate pitch commands in approach
- Autoland (approach, flare, go-around) monitor
- Aileron limiter signals
- Engage/interlock high signal
- Mode and annunciator warning logic.

The CPU 2 calculates these commands:

- A/P pitch commands in approach
- A/P alternate roll commands in approach
- Stabilizer and speed trim warnings

- Aileron limiter monitor
- Autoland monitor
- Engage/interlock low signal
- Software data loader.

When in the approach mode, the CPUs calculate the same roll and pitch commands. The CPUs compare these commands before they send them to the A/P actuators. When in autoland, the two processors look at sensor data to make sure the control surfaces move correctly. Also, both CPUs continue to look at engage and interlock signals.

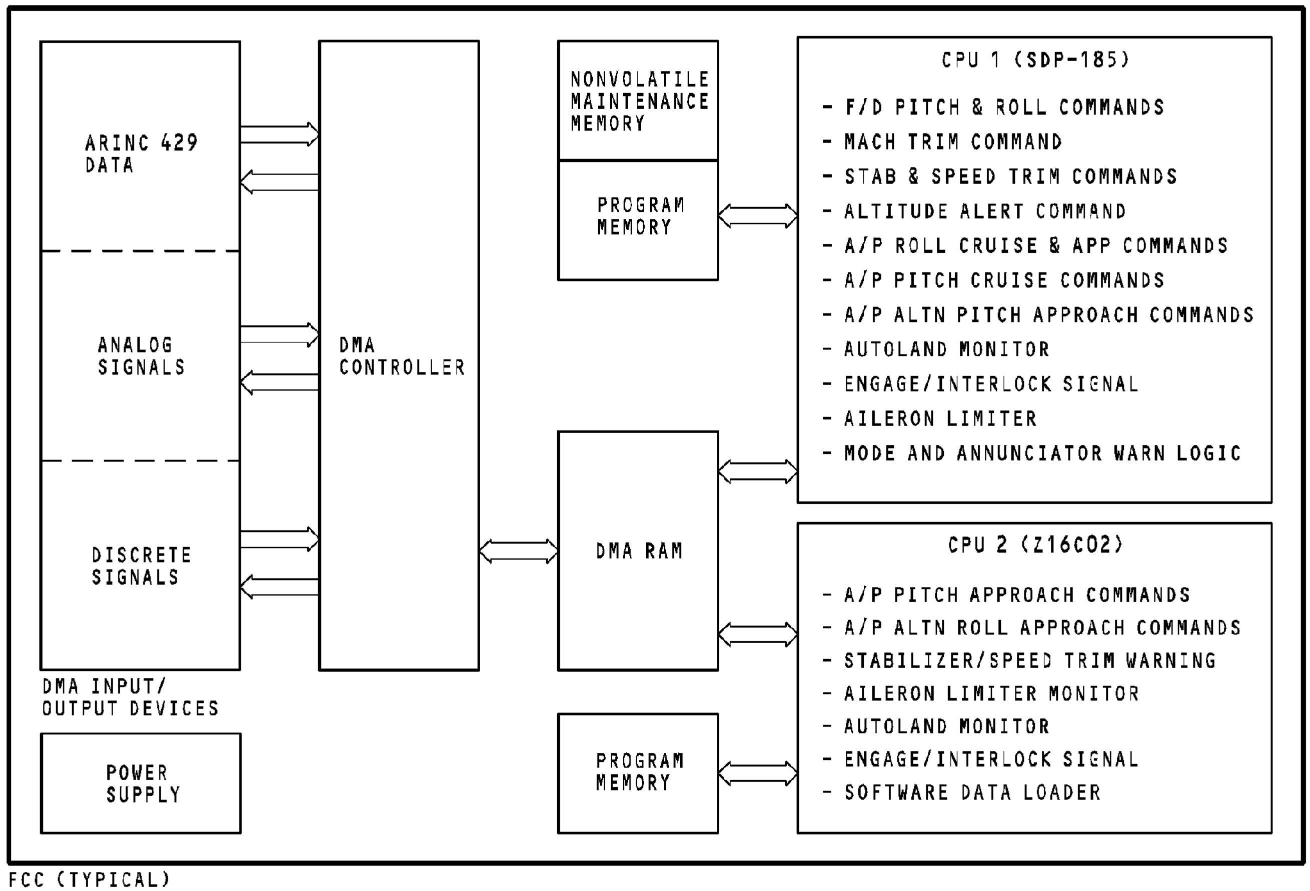
If the commands or signals do not agree, either CPU can disengage the autopilot. This occurs because the MCP needs the high and the low engage/interlock signal to engage the autopilot and keep it engaged. The CPU 1 can remove the high signal and the CPU 2 can remove the low signal.

Program Memory

Each CPU has its own memory to keep data and calculate commands. The CPU 1 also has access to the nonvolatile maintenance memory to keep BITE data as it occurs.

Power Supply

The power supply gets 28v dc and 115v ac. It changes the 28v dc to 14v ac, 1800 Hz for control surfaces position sensors. It changes the 28v dc to several other dc voltages for use within the FCC. It also changes the 115v ac to 26v ac for the mach trim actuator.



DFCS - FLIGHT CONTROL COMPUTER - FUNCTIONAL DESCRIPTION

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DFCS - CONTROL SURFACE POSITION SENSORS

Single Synchro Sensor

A single synchro sensor has one synchro and only one output. The stabilizer position sensor B is the only single synchro sensor. This sensor is not interchangeable with the dual sensors.

Dual Synchro Sensors

A dual synchro sensor has two synchros with two outputs. The dual synchro sensors measure the position of these control surfaces:

- Aileron
- Elevator
- Elevator neutral shift

HAP 038, 042-046, 048, 051-053, 104-999

- Rudder

HAP ALL

- Spoiler 4
- Spoiler 9
- Stabilizer (sensor A).

These sensors are the same and are interchangeable.

Aileron Position Sensor

The aileron position sensor measures the movement of the aileron input torque tube. One output of the sensor goes to the FCC A and the other goes to the FCC B.

Elevator Position Sensor

The elevator position sensor measures the movement of the elevator lower input torque tube. One output of the sensor goes to the FCC A and the other goes to the FCC B.

Elevator Neutral Shift Sensor

The horizontal stabilizer and the elevator operate together to supply pitch control of the airplane. For each position of the horizontal stabilizer, there is one position of the elevator that makes the two operate together as one control surface. This is the neutral shift position. The elevator neutral shift sensor supplies an electrical signal that is in proportion to the elevator neutral reference position. The elevator neutral shift sensor measures the movement of the elevator feel and centering unit. One output of the sensor goes to the FCC A and the other output goes to the FCC B.

HAP 038, 042-046, 048, 051-053, 104-999

Rudder Position Sensor

The rudder position sensor measures the movement of the rudder input torque tube. One output of the sensor goes to FCC A and the other output goes to FCC B.

HAP ALL

DFCS - CONTROL SURFACE POSITION SENSORS

Spoiler Position Sensors

The spoiler position sensors measure the movement of spoilers 4 and 9. One output of the sensor goes to the FCC A and the other goes to the FCC B.

Stabilizer Position Sensor A

The stabilizer position sensor A measures the position of the horizontal stabilizer. One output of the sensor goes to the FCC A and the other goes to the flight data acquisition unit (FDAU).

Stabilizer Position Sensor B

The stabilizer position sensor B measures the position of the horizontal stabilizer. The output of the sensor goes to the FCC B.

Physical Description

The dual synchro sensor is a cylindrical unit. It is 5.3 inches long and 1.6 inches in diameter. The sensor weighs 0.75 pounds.

The single synchro sensor is a cylindrical unit. It is 4.4 inches long and 1.3 inches in diameter. This sensor weighs 0.4 pounds.

The two sensors turn +/- 140 degrees. There are index marks on the case and the input shaft of the sensor. These marks help align the sensor.

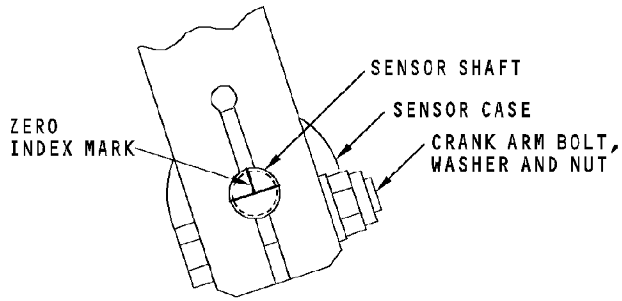
Functional Description

The two-wire input to the sychros comes from the FCCs. It is 14v ac at a frequency of 1800 Hz. The three-wire output can change from 0v ac to 6.36v ac as the input shaft turns from 0 degrees to +140 degrees. It can change from 0v ac to 6.36v ac with a phase change of 180 degrees as the input shaft turns from 0 degrees to -140 degrees.

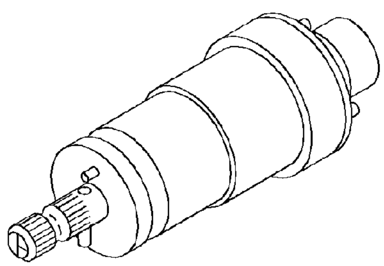
Training Information Point

Examine the alignment reference marks when you install a position sensor.

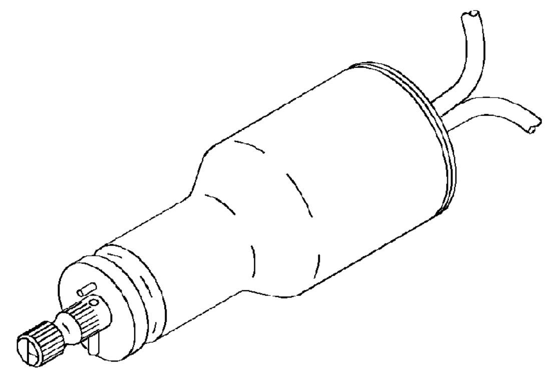
The DFCS BITE current status test finds a failure of the sensors. You use the DFCS BITE rigging tests to do a check of the sensor adjustment. You also use DFCS BITE analog sensors test to see the sensor output.



POSITION SENSORS INSTALLATION



SINGLE SYNCHRO POSITION SENSOR



DUAL SYNCHRO POSITION SENSOR

DFCS - CONTROL SURFACE POSITION SENSORS

DFCS - CONTROL WHEEL STEERING FORCE TRANSDUCER

General

The purpose of the control wheel steering (CWS) force transducer is to supply electrical signals which vary in proportion to the force on the transducer. These are the CWS force transducers on the airplane:

- Captain pitch CWS force transducer
- First officer pitch CWS force transducer
- Roll CWS force transducer.

The pitch transducers measure the force on the control column. The roll transducer measures the force on the control wheel.

Physical Description

The force transducer is a cylindrical unit. It is 5 inches long and 2.25 inches in diameter.

Functional Description

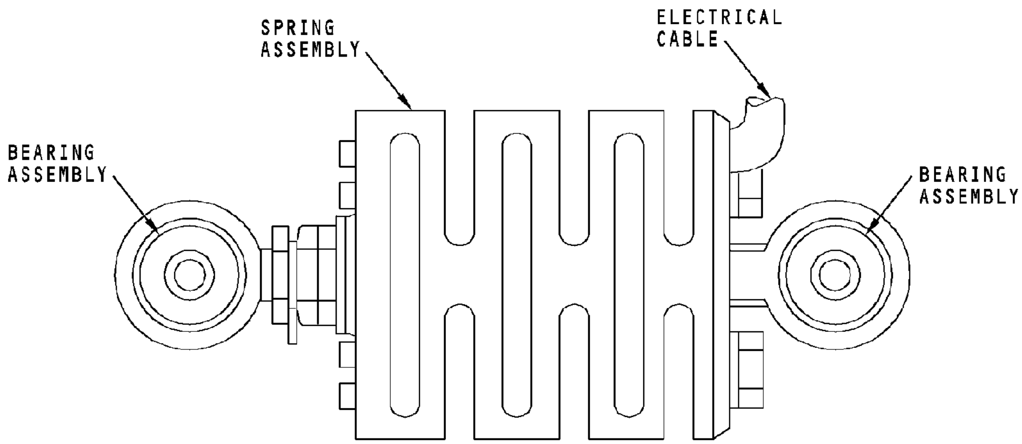
The force transducer has two sensors. Each sensor is a linear variable differential transformer (LVDT). One output goes to the FCC A and the other goes to the FCC B.

The transducer has a spring assembly with two coils and two armatures. A bearing assembly is at each end of the transducer. You use the bearing assembly to install the unit. The transducers are adjustable. There are stops to prevent the spring assembly from being extended too far.

The input to the force transducer is 26v ac at 400 Hz. The output changes from 0v ac to 6.2v ac as the force changes from 0 pounds to +119 pounds. It can change from 0v ac to 6.2v ac with a phase change of 180 degrees as the input force changes from 0 to -119 pounds.

Training Information Point

The DFCS BITE status test can find a failure of the force transducer. You use the DFCS BITE rigging test to do a check of the transducer adjustment. You also use the DFCS BITE analog sensors test to see the transducer output.



DFCS - CONTROL WHEEL STEERING FORCE TRANSDUCER

22-11-00-034

DFCS - ROLL CWS FORCE TRANSDUCER - LOCATION

Roll CWS Force Transducer Component Locations

You attach one end of the roll CWS force transducer to the bus drum assembly. You attach the other end to the control drum assembly.

Roll CWS Force Transducer Operation

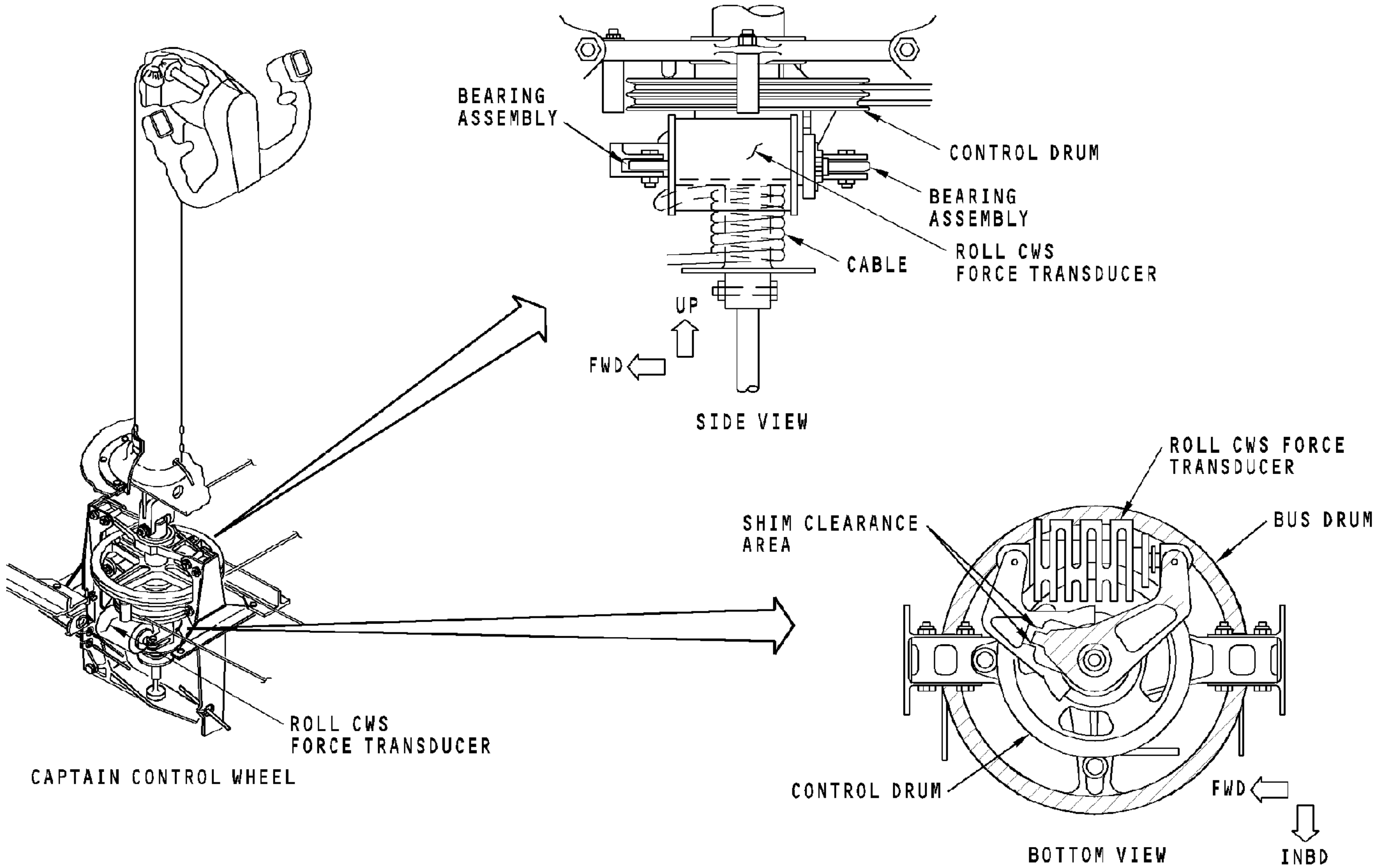
When the autopilot is disengaged and the pilot turns the control wheel, the bus drum turns. This causes the right arm that is attached to the force transducer to turn. The force transducer is very rigid so it turns the left arm which causes the control drum to turn. This moves the aileron cables to the aileron input torque tube and causes the ailerons to move.

When the autopilot is engaged, the aileron A/P actuator is pressurized and the actuator holds the aileron input torque tube so it cannot move. This does not let the control drum turn so the left arm that is attached to the force transducer cannot move. When the pilot turns the control wheel, the right arm attached to the force transducer compresses or expands the force transducer. The shim clearance area allows the movement of the right arm. This provides the electrical signal to the FCCs. The FCCs send a command to the aileron A/P actuator to move the input torque tube and then the ailerons.

If the force transducer breaks, the tab on the right arm contacts the gap edge of the left arm and the bus drum rotation turns the control drum.

Training Information Point

When you make an adjustment to the roll CWS force transducer, you put shims between the shaft and the drum in the shim clearance area. After the adjustment, make sure you remove the shims.



DFCS - ROLL CWS FORCE TRANSDUCER - LOCATION

DFCS - PITCH CWS FORCE TRANSDUCER - LOCATIONS

Pitch CWS Force Transducers Locations

There are two pitch CWS force transducers. One transducer is on the control quadrant at the lower end of the captain control column. The other one is on the control quadrant at the lower end of the first officer control column.

Pitch CWS Force Transducer Operation

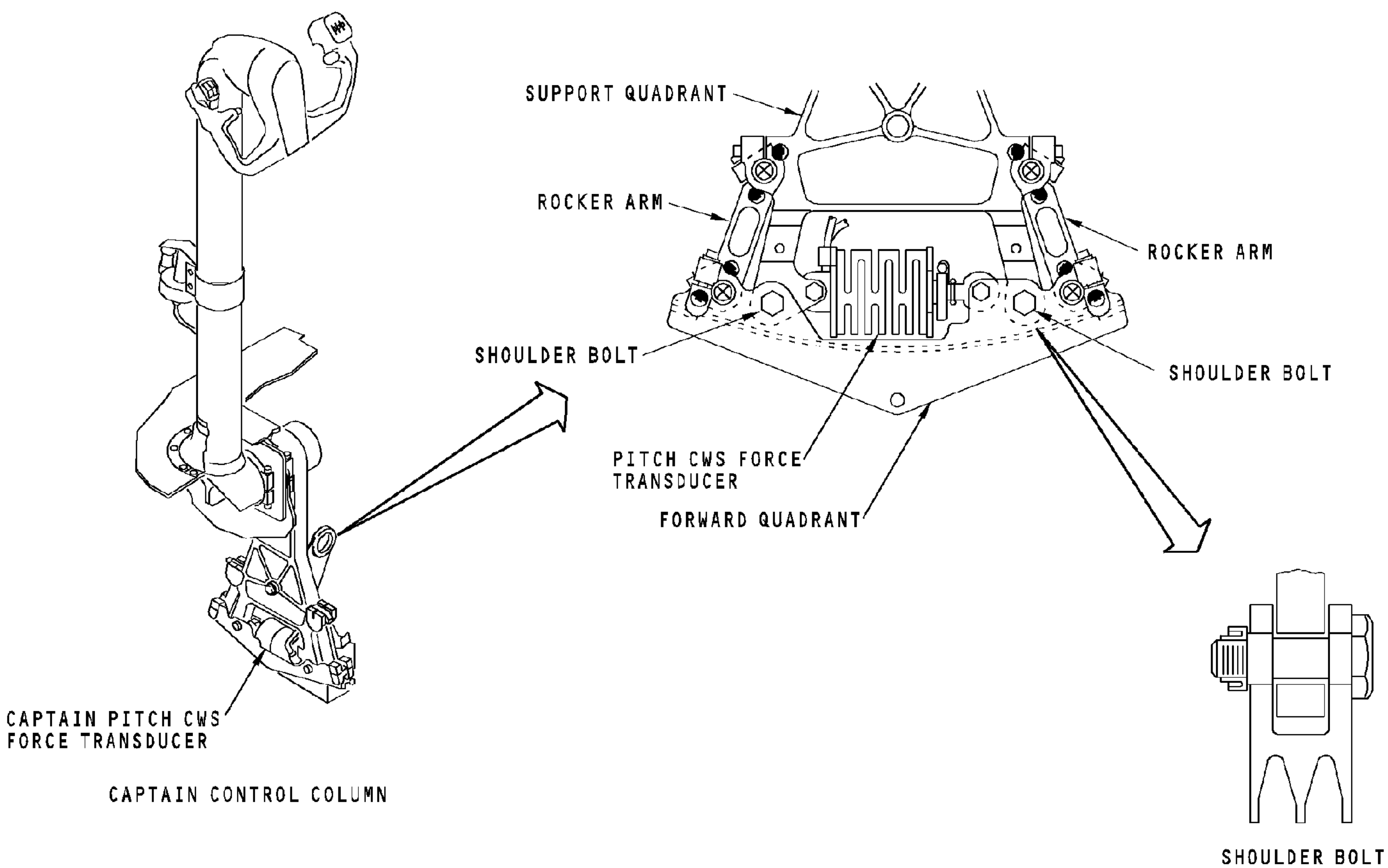
When the autopilot is disengaged and the pilot moves the control column, the support quadrant turns. This causes the left arm of the support quadrant that is attached to the force transducer to move. The force transducer is very rigid so it moves which causes the forward quadrant to turn. This moves the elevator cables to the elevator input torque tube and causes the elevator to move.

When the autopilot is engaged, the elevator A/P actuator is pressurized and the actuator holds the elevator input torque tube so it cannot move. This does not let the forward quadrant move so the right attachment to the force transducer cannot move. When the pilot moves the control column, the left support quadrant arm attached to the force transducer compresses or expands the force transducer. The shoulder bolt allows the movement of the left arm. This provides the electrical signal to the FCCs. The FCCs send a command to the elevator A/P actuator to move the input torque tube and then the elevator.

If the force transducer breaks, the support quadrant contacts the center of the shoulder bolts and the forward quadrant turns to move the elevator control cables.

Training Information Point

When you make an adjustment to the pitch CWS force transducer, you replace the shoulder bolts with regular bolts. After the adjustment, make sure you remove the regular bolts and put the shoulder bolts back.



DFCS - PITCH CWS FORCE TRANSDUCER - LOCATIONS

22-11-00-036

EFFECTIVITY
HAP ALL

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DFCS - AUTOPILOT ACTUATOR - INTRODUCTION

Purpose

The purpose of the autopilot actuator is to change electrical commands from the FCC into a hydraulically controlled mechanical output. The outputs of the actuators become inputs to the aileron and the elevator power control units (PCU). The PCUs move the control surfaces.

Operation

There are four autopilot actuators on the airplane. They operate independently. Two actuators control the ailerons and two actuators control the elevators. One aileron and one elevator actuator receive electrical signals from the FCC A. These actuators get hydraulic pressure from hydraulic system A. The other aileron and elevator actuator receives electrical signals from the FCC B. These actuators get hydraulic pressure from hydraulic system B.

You can control the ailerons with only aileron actuator A or aileron actuator B. In the dual mode, you use the two aileron actuators A and B together. This is also the way the elevator actuators operate.

Shear rivets on the actuator output cranks protect against jams inside the actuator. The pilot can override any jam with the application of approximately 100 pounds at the controls. This will break the shear rivets.

Physical Description

The actuator is approximately 17.5 inches long, 7.5 inches wide and about 6.0 inches high. The actuator weighs approximately 15.5 pounds with no hydraulic fluid in it.

These are the line replaceable units (LRU) on the actuator:

- Actuator solenoid valve
- Detent solenoid valve
- Transfer valve
- Hydraulic pressure switch.

The linear variable differential transformer (LVDT) measures the position of the actuator main piston. It is not an LRU.

Training Information Point

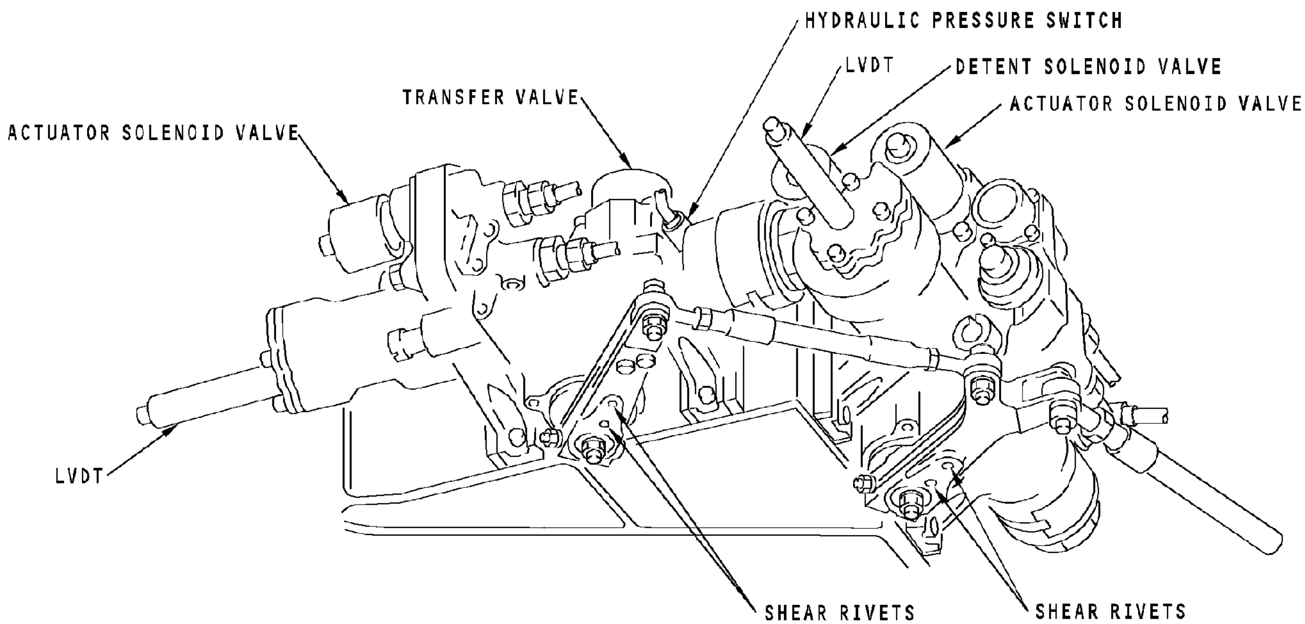
Before you remove an autopilot actuator, obey this warning.

WARNING: ISOLATE OR TAG THE AILERON, ELEVATOR, RUDDER, SPOILER AND SPEED BRAKE CONTROL SYSTEMS. THESE SYSTEMS MAY MOVE SUDDENLY WHEN YOU REMOVE THE HYDRAULIC POWER. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.

If you work on an aileron actuator, obey this warning.

DFCS - AUTOPILOT ACTUATOR - INTRODUCTION

WARNING: YOU MUST CAREFULLY INSTALL THE GROUND LOCKS IN ALL LANDING GEAR. AN ACCIDENTAL RETRACTION OF THE LANDING GEAR CAN CAUSE INJURY TO PERSONS AND DAMAGE TO EQUIPMENT.



DFCS - AUTOPILOT ACTUATOR - INTRODUCTION

22-11-00-037

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DFCS - AUTOPILOT ACTUATOR - FUNCTIONAL DESCRIPTION

General

The autopilot actuator changes an electrical signal from the FCC to a hydraulic pressure. This moves the main piston and the output crank. The actuator position sensor supplies a signal to the FCC.

Before Autopilot Engagement

The actuator solenoid is not energized before engagement of the autopilot. This prevents hydraulic pressure in the autopilot actuator. Without hydraulic pressure, the detent piston springs move the detent pistons away from the internal output crank. This lets the output crank move freely as the control surfaces move.

Autopilot Engagement

When you engage the autopilot, a signal from the mode control panel (MCP) energizes the actuator solenoid. This pressurizes the transfer valve and the detent solenoid. The detent control engage orifice that is between the actuator and detent solenoids does these two things:

- It keeps the maximum flow to the pressure regulator to a limit to protect from hydraulic overpressure
- Gives a time delay for synchronization.

Synchronization of the Autopilot Actuator

The control surface position sensor (aileron or elevator) sends a signal through the FCC to the transfer valve. This moves the main piston to a position that aligns with the position of the internal output crank. When this is synchronized, it prevents a sudden movement of the control surface when the FCC engages the detent solenoid.

After the main piston and the internal output crank are synchronized, the FCC sends a signal to energize the detent solenoid. This pressurizes the detent pistons and they touch the sides of the internal output crank. The pressure regulator keeps the hydraulic pressure at a safe limit. The hydraulic pressure also closes the hydraulic pressure switch. The switch sends a signal to the FCC to show that the autopilot actuator is ready to operate.

Normal Operation

A command signal from the FCC A/P to the transfer valve causes the main piston to move. A movement of the main piston now causes a movement of the output crank and the control surface. The rate limiting orifices control the rate of movement of the main piston.

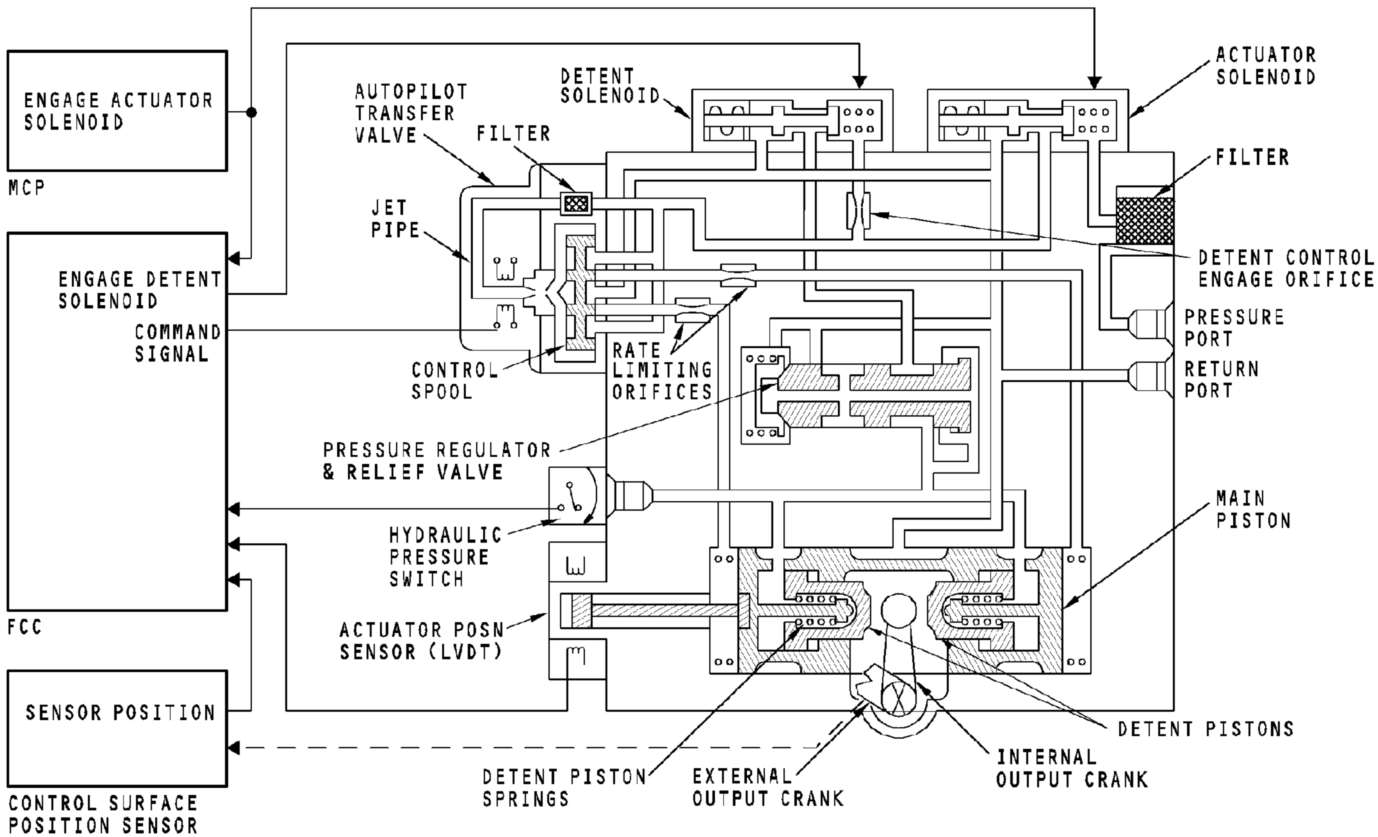
DFCS - AUTOPILOT ACTUATOR - FUNCTIONAL DESCRIPTION

Camout

A camout condition is when the main piston moves but the detent pistons cannot move with the main piston. Therefore, the output crank does not move with the main piston. Camout lets the pilot mechanically override the autopilot and also gives protection against hardover failures.

Mechanical Override

When CWS is not the active mode, the pilot can mechanically override the autopilot actuator. A force of approximately 25 pounds on the control column or wheel can override the actuator. If both channels A and B are active, approximately 50 pounds of force is necessary to override the two actuators. The relief valve opens when override pressure goes to the detent pistons.



AUTOPILOT ACTUATOR SCHEMATIC

DFCS - AUTOPILOT ACTUATOR - FUNCTIONAL DESCRIPTION

DFCS - AUTOPILOT ACTUATOR - TRANSFER VALVE

Purpose

The purpose of the transfer valve is to get an electrical signal from the FCC and control the hydraulic pressure to the main piston.

Physical Description

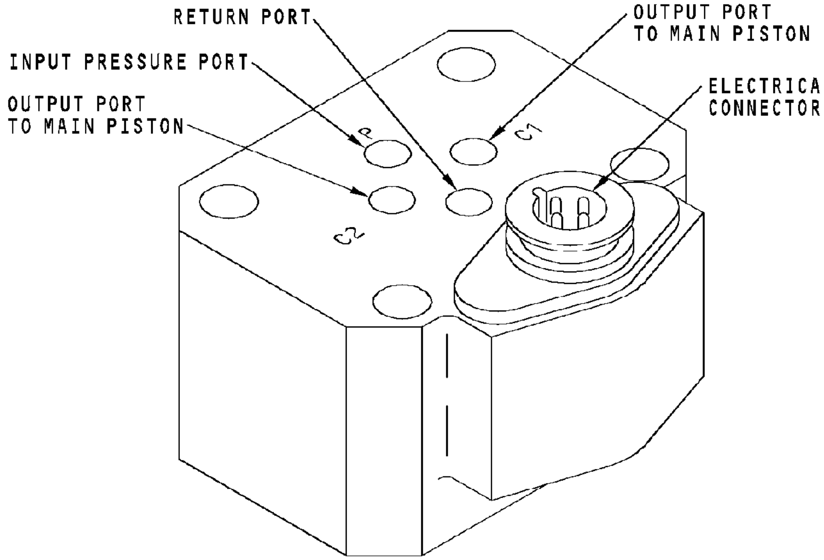
The transfer valve is approximately 1.5 inches high and about 1.6 inches in diameter. It weighs approximately 1 pound. These are the four hydraulic ports:

- Input pressure port for the jet pipe controller
- Return port
- Two output ports for the two sides of the main piston.

A four pin electrical connector attaches the wires from the FCC.

Functional Description

When an electrical signal comes from the FCC, it moves the jet pipe in the transfer valve. This causes the pressure at each end of the control spool to change. This causes the control spool to move which changes the output pressure in each of the two output ports. The autopilot actuator uses this change in the output lines to move the main piston.



DFCS - AUTOPILOT ACTUATOR - TRANSFER VALVE

22-11-00-039

DFCS - AUTOPILOT ACTUATOR - HYDRAULIC PRESSURE SWITCH

Purpose

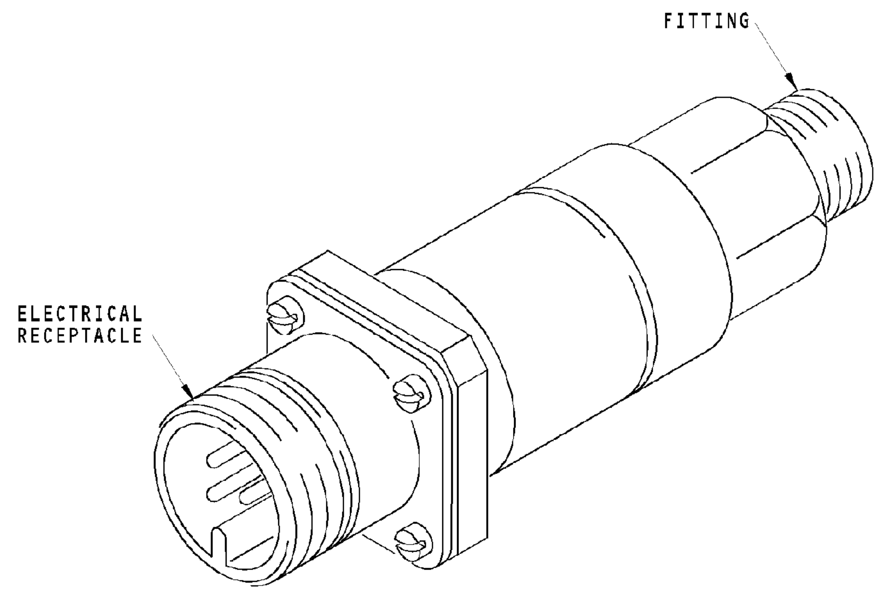
The purpose of the hydraulic pressure switch is to tell the FCC when the detent hydraulic pressure gets to the operational level. The autopilot actuator is then ready to get signals from the FCC to move the control surfaces.

Physical Description

The switch is approximately 3.6 inches long and has a maximum diameter of approximately 1.0 inches. The switch weighs approximately 3.1 ounces. One end of the switch has a fitting. It attaches to the autopilot actuator. The other end has a receptacle. It attaches to an electrical connector.

Functional Description

The switch energizes when the hydraulic pressure increases between 300 and 500 psi. The switch disconnects when the pressure decreases to between 500 and 300 psi.



DFCS - AUTOPILOT ACTUATOR - HYDRAULIC PRESSURE SWITCH

DFCS - AUTOPILOT ACTUATOR - SOLENOID VALVES

Purpose

The purpose of the solenoid valves (both actuator and detent solenoids) is to open its valve when it receives an electrical signal. When the valve opens, it lets hydraulic pressure go to the components within the autopilot actuator.

Physical Description

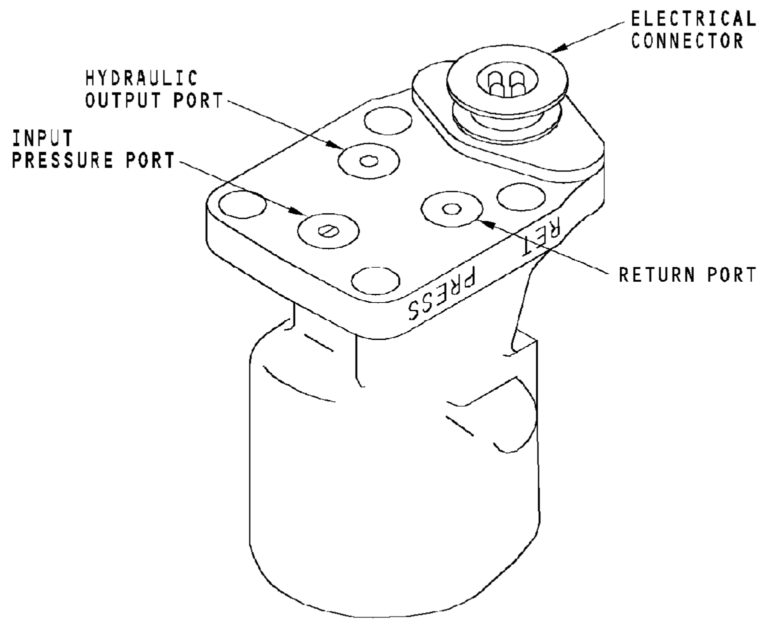
Each solenoid is approximately 2.8 inches high and 1.7 inches in diameter. the solenoid weighs approximately .7 pounds. These are the three hydraulic ports in the solenoid:

- Pressure for input hydraulic pressure
- Return for the hydraulic fluid to go to the reservoir
- Cylinder for the output of hydraulic pressure.

An electrical connector attaches the wires from the FCC.

Functional Description

When the solenoid receives an electrical signal, it energizes a hydraulic relay. This lets the hydraulic pressure go from the pressure port to the cylinder port. When the electrical signal stops, the pressure at the cylinder port goes to return.



22-11-00-041

DFCS - AUTOPILOT ACTUATOR - SOLENOID VALVES

DFCS - AUTOPILOT RUDDER ROLLOUT GUIDANCE ACTUATOR - INTRODUCTION

Purpose

The purpose of the rollout guidance actuator is to change electrical commands from the FCC into a mechanical output. The output of the actuator is input to the rudder input torque tube. The torque tube moves the rudder to give yaw control for category IIIb approaches and landings. It also gives inputs to control the path of the airplanes on the runway during the rollout phase of the landing. The actuator back-drives the rudder control system to provide nosewheel steering inputs.

Operation

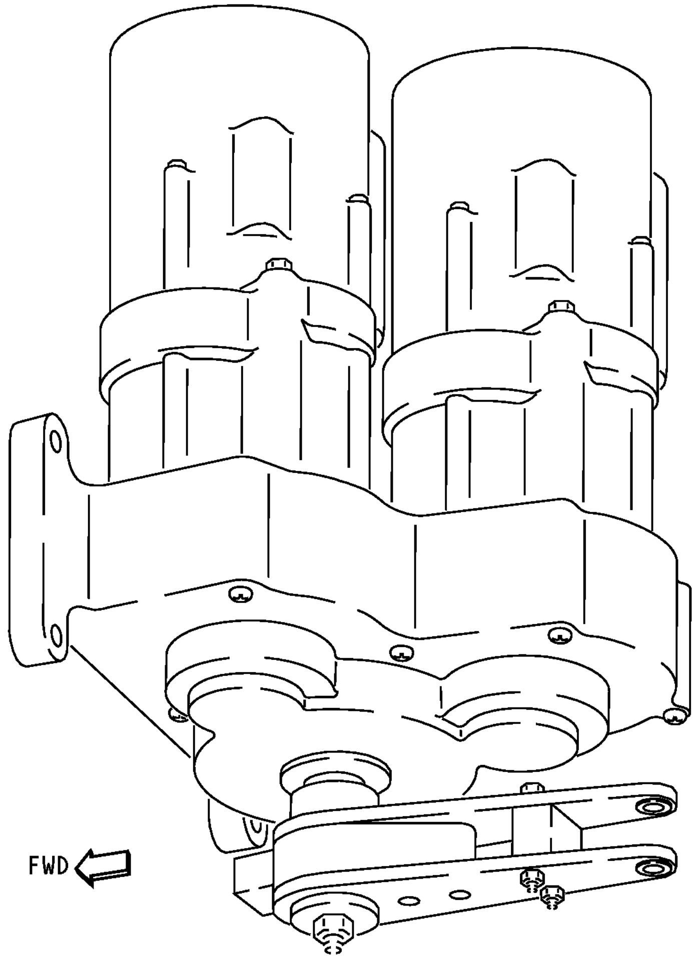
There is one actuator mounted in the vertical fin. It has two indepedent drive motors, each mechanically connected to a tachometer generator. The output of the drive motors goes through an electrically operated clutch and shear pin to the output crank.

Each tachometer generator has dual outputs that go to the separate lanes in the same FCC.

A shear pin on the actuator protects against any rudder system jams. The pilot can override any jam in the actuator.

Physical Description

The actuator is approximately 9.25 inches high, 7 inches wide and 6.5 inches deep. The actuator weighs approximately 17 pounds.



DFCS - AUTOPILOT RUDDER ROLLOUT GUIDANCE ACTUATOR - INTRODUCTION

22-11-00-150

EFFECTIVITY
HAP 038, 042-046, 048, 051-053, 104-999

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DFCS - AUTOFLIGHT STATUS ANNUNCIATOR

Purpose

The purpose of the autoflight status annunciator is to show these annunciations:

- Autopilot warning
- Autopilot disconnect
- Start BITE test
- Autothrottle (A/T) disengage
- Airspeed warning
- Alert messages on the FMC or an FMC fails.

Physical Description

The autoflight status annunciator is 3.25 inches wide, 1.5 inches high and approximately 5.2 inches deep. The annunciator weighs approximately 1.1 pounds.

Three warning light annunciators are on the front. The color of the A/P light can be red or amber. The color of the A/T light can be red or amber. The FMC light can only be amber. There is also a three position switch that you can use to do a test of the lights.

Operation

When you push the test switch to the number 1 position, all three annunciator lights come on amber. When you push the test switch to the number 2 position, the A/P and A/T annunciators come on red. The FMC annunciator comes on amber.

If the A/P annunciator flashes red, you can turn off that light if you push the annunciator. If the A/T annunciator flashes red, you can turn off that light if you push the annunciator. If the FMC annunciator is amber, you can turn off that light if you push the annunciator.

Warning Annunciations

The red A/P annunciator flashes when an A/P disconnects. The red A/P annunciator comes on steady when any of these conditions occurs:

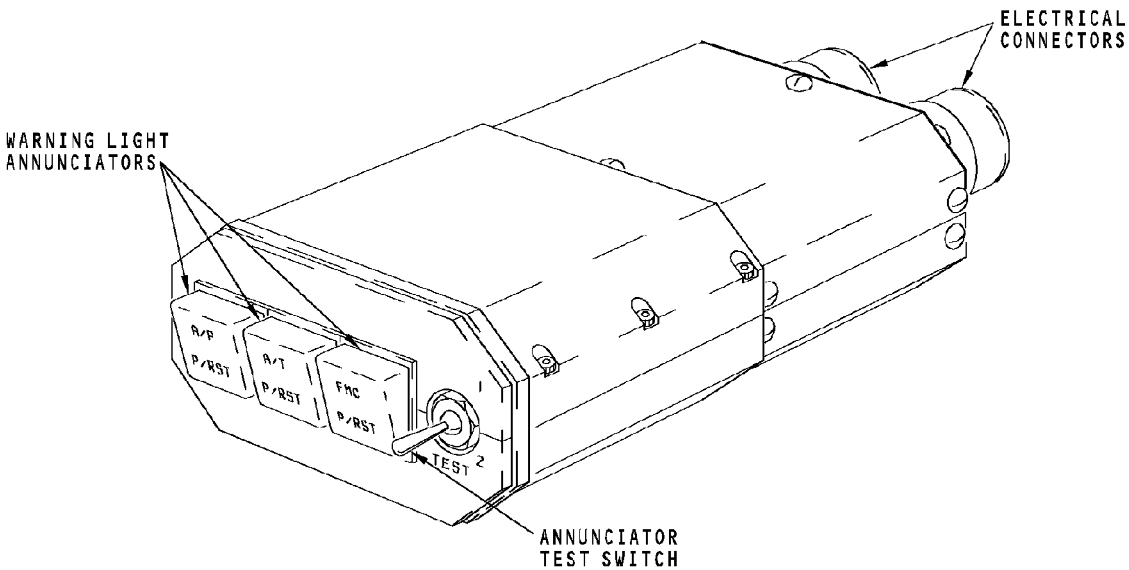
- DFCS is in BITE
- The foreign FCC part number is invalid
- The power up test fails on the ground
- The MCP bus fails when the airplane is in A/P pitch G/A
- The airplane is above 400 feet and cannot exit A/P G/A to altitude acquire because single channel pitch authority is not available
- The stab out of trim warning is set and the airplane is in dual pitch A/P below 800 feet.

The red A/T annunciator flashes when the A/T disengages. The red A/T annunciator comes on steady when the A/T is in BITE.

The amber A/T flashes when the A/T is in the MCP or FMC SPD mode and the FCC calculates an A/T speed warning. The speed warning occurs when the true airspeed is 10 knots above the target speed or 5 knots below the target speed and is not accelerating to the target speed. The flaps must be down for the warning to occur.

Training Information Point

Each warning light indicator has four filament lamps. You do not have to remove the ASA to replace the lamps. Pull the front cap out and hold it down to get access to the lamps.



DFCS - AUTOFLIGHT STATUS ANNUNCIATOR

DFCS - AUTOFLIGHT STATUS ANNUNCIATOR - FUNCTIONAL DESCRIPTION

General

The autoflight status annunciator has these functions:

- Autopilot (A/P) system annunciations
- Autothrottle (A/T) system annunciations
- Flight management computer system (FMCS) annunciations.

A/P System Annunciations

A ground signal can turn on the red or the amber A/P annunciator lights. When you push the A/P annunciator, a reset signal goes from the annunciator to the FCCs and the mode control panel (MCP). This also turns off the A/P annunciator if it flashes red or flashes amber.

A/T System Annunciations

A ground signal can turn on the red or the amber A/T annunciator lights. When you push the A/T annunciator, a reset signal goes from the annunciator to the FCCs and the A/T computer. This also turns off the A/T annunciator if it flashes red or flashes amber.

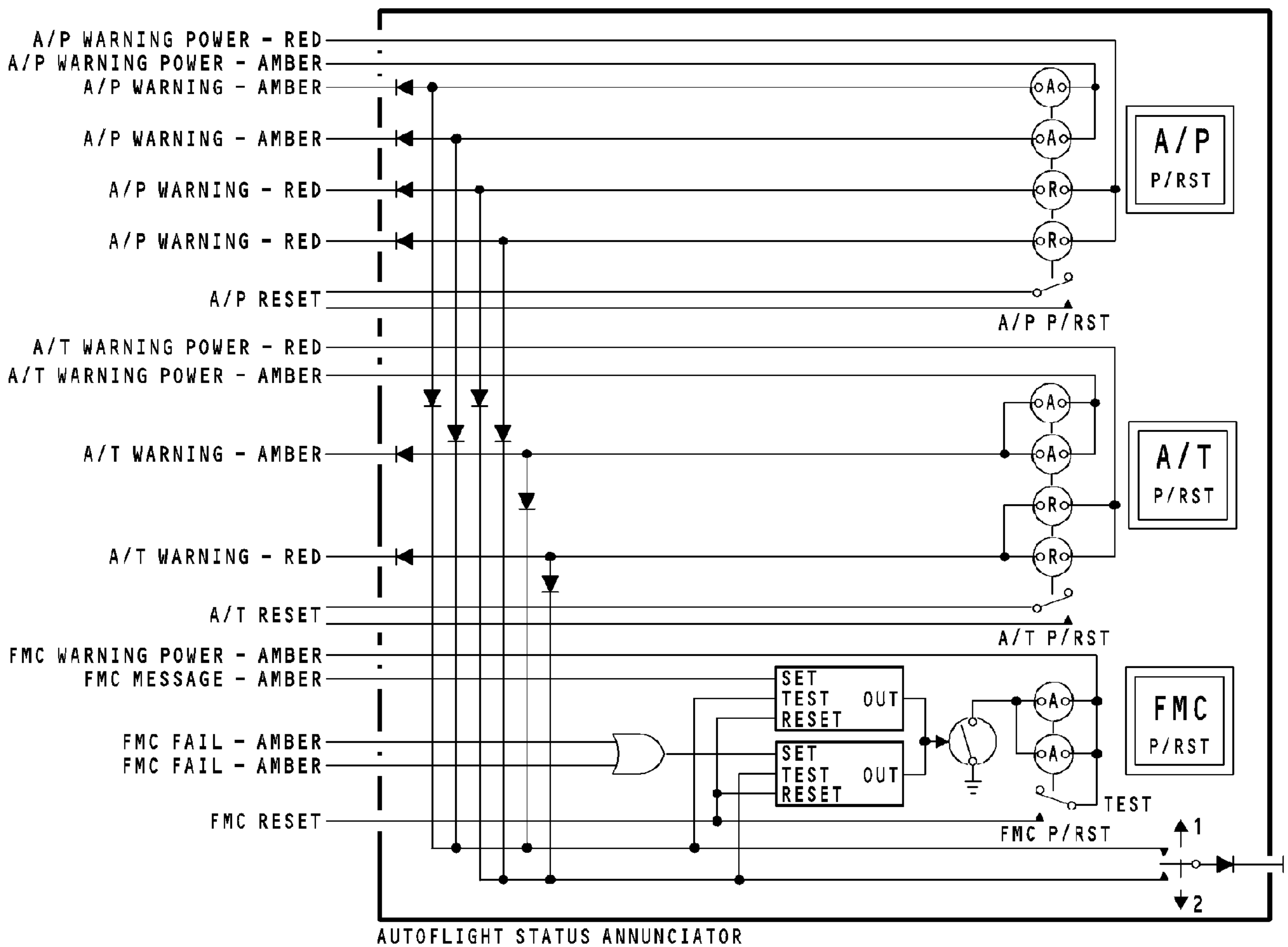
FMCS Annunciations

A ground signal can turn on the amber FMC annunciator light. Either an FMC failure or an FMC alert message sets one logic circuit in the annunciator. This turns on an electronic switch which sends a ground to the FMC amber light. This keeps the amber light on. When you push the FMC annunciator, a reset signal goes to the logic circuit and resets it so that the light goes off.

Test Switch

When the test switch is in the number 1 position, a ground goes to the A/P and A/T amber lights. A ground also goes to the FMC message logic circuit to turn on the electronic switch. This does a test of the amber lights.

When the test switch is in the number 2 position, a ground goes to the A/P and A/T red lights. A ground also goes to the FMC fail logic circuit to turn on the electronic switch. This does a test of the red A/P and A/T lights and the amber FMC lights.



DFCS - AUTOFLIGHT STATUS ANNUNCIATOR - FUNCTIONAL DESCRIPTION

22-11-00-043

DFCS - INTEGRATED FLIGHT SYSTEM ACCESSORY UNIT

Purpose

The purpose of the integrated flight system accessory unit (IFSAU) is to give an interface between the DFCS and the airplane systems.

Physical Description

The IFSAU is a 3 MCU box. It uses a single camloc-type hold down handle to carry the unit and to connect it in the E-1 rack. There are four electrical connectors on the back of the IFSAU.

Functional Description

The IFSAU contains two printed circuit cards. The A1 card is the autopilot card. The A2 card is the flight instrument card.

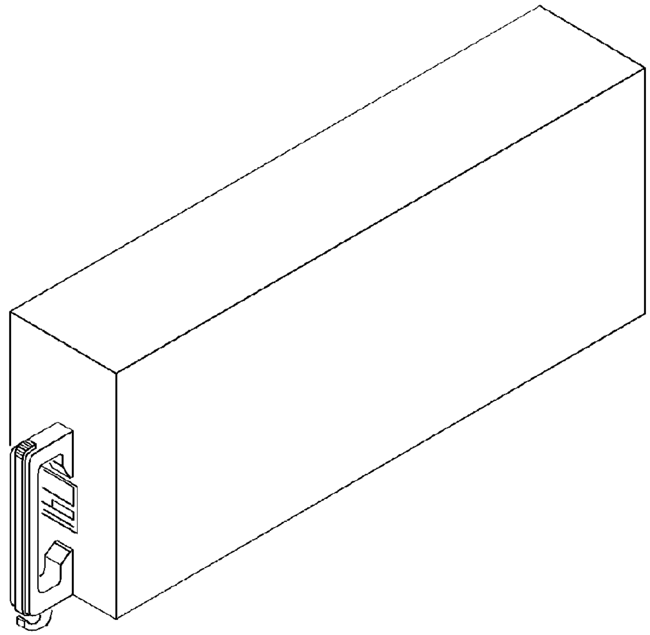
The A1 card contains electronic components to do these operations:

- Supply 26v ac sensor power
- FCC mach trim selection
- DC bus isolation
- Navigation transfer
- Autoland transfer
- Autoland warning logic.

The A2 card contains electronic components to do these operations:

- VOR/ILS test inhibit
- ADIRU warning/crew call horn
- Right ADIRU five minute power off delay after AC loss
- Isolation diodes.

See the ADIRS section for more information on the operation of the IFSAU. (SECTION 34-21)



DFCS - INTEGRATED FLIGHT SYSTEM ACCESSORY UNIT

DFCS - MACH TRIM ACTUATOR

Purpose

As the airplane speed gets very fast, the center of lift moves aft and the airplane starts to nose down. This is mach tuck. One purpose of the mach trim actuator is to trim the elevator at these high speeds to raise the nose to correct for mach tuck.

The other purpose of the mach trim actuator is to move the elevator when the airplane is in the FCC controlled neutral shift region (FCNSE). This region occurs when the flaps are not in the up position and either engine N1 is more than 20%. This increases the elevator movement during takeoff.

Physical Description

The mach trim actuator is 9.3 inches long, 4.8 inches wide and 4.0 inches high. The output shaft can move about .5 inches.

Location

The mach trim actuator is on the top of the elevator feel and centering unit. When the actuator moves, it causes the feel and centering unit to turn.

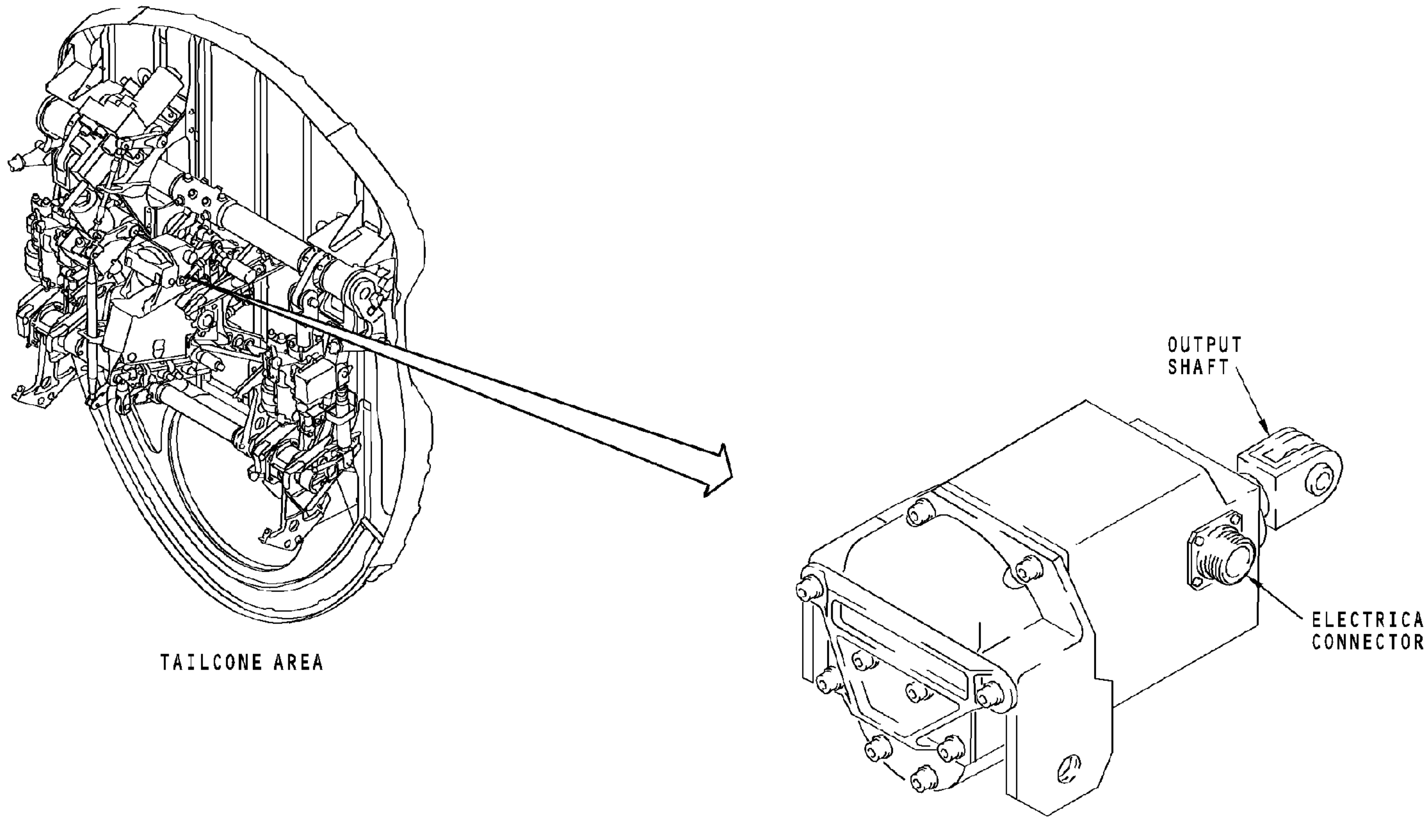
Functional Description

An electric motor turns a gear train that causes the output shaft to move in and out. There is an electric brake that holds the output shaft when the motor is not on. A synchro is on the gear train and an electrical signal tells the FCCs the position of the output shaft.

The motor operates with 115v ac 400 Hz power to the fixed phase motor windings. When the motor gets 36v ac 400 Hz power to the phase control winding, it will turn.

Before the motor turns, the brake windings must get 28v dc to release the brake. When you remove power from the control windings, you also remove power from the brake windings. This immediately stops the motor.

When the position synchro gets 26v ac 400 Hz power, an output voltage goes to the FCCs to show the position of the mach trim actuator.



22-11-00-045

DFCS - MACH TRIM ACTUATOR

DFCS - TAKEOFF/GO-AROUND SWITCH

General

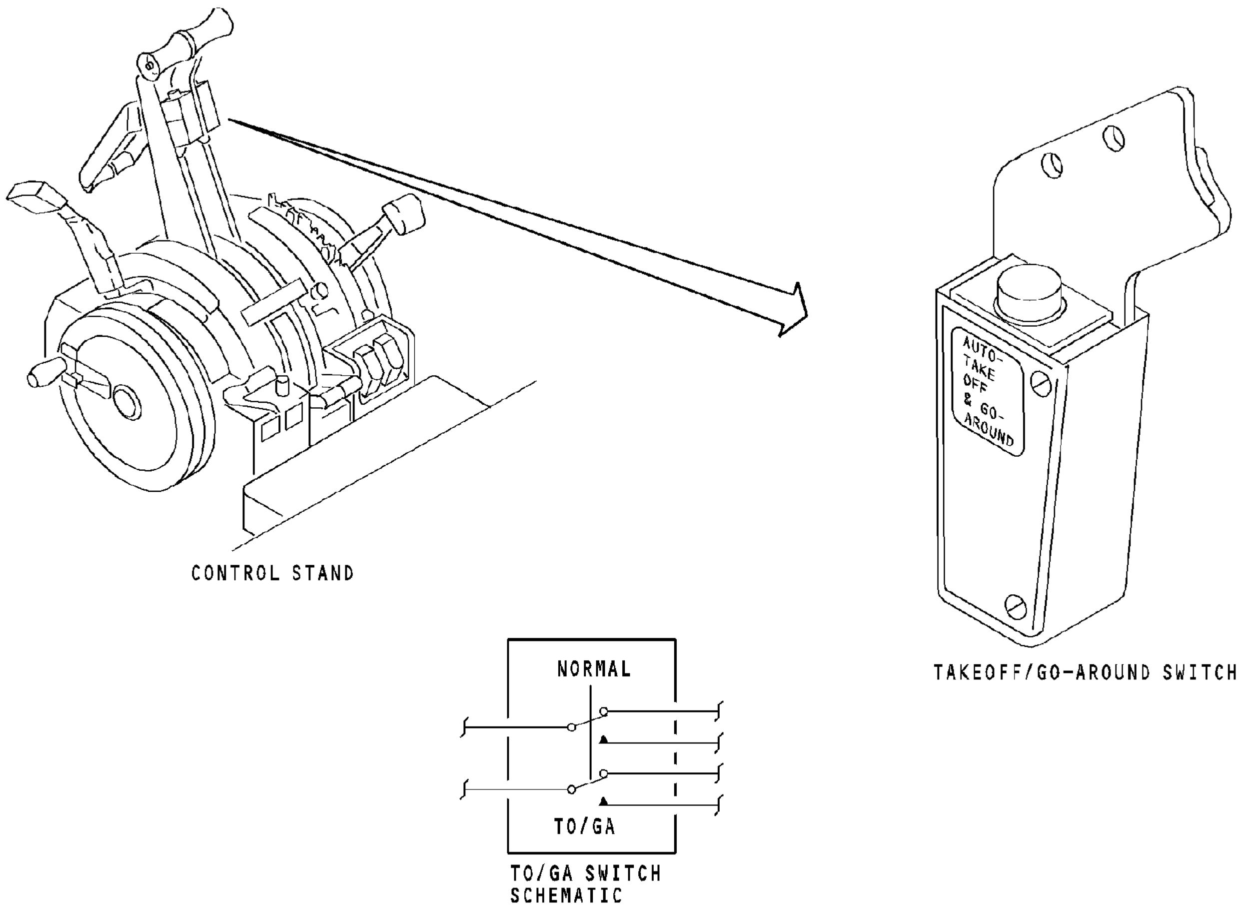
The purpose of the takeoff/go-around (TO/GA) switch is to set the takeoff or the go-around mode for these systems:

- Autothrottle (A/T) system
- Stall management yaw damper (SMYD) system
- Digital flight control system (DFCS).

There are two TO/GA switches on the control stand. One switch is on each thrust lever. Each switch is a momentary action pushbutton switch.

Physical Description

The TO/GA switch is approximately 2.5 inches long, 1.1 inches wide, and .9 inches deep.



DFCS - TAKEOFF/GO-AROUND SWITCH

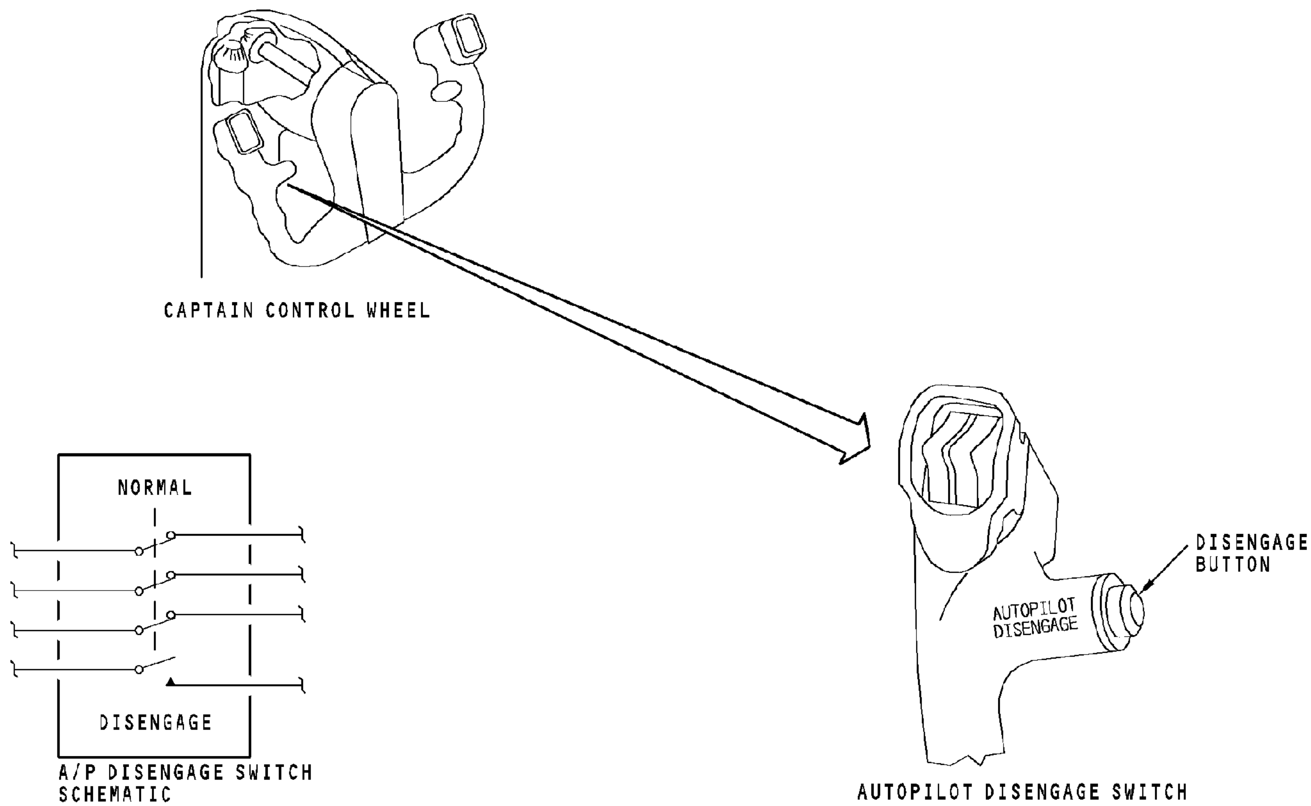
22-11-00-046

DFCS - AUTOPILOT DISENGAGE SWITCH

General

There are two A/P disengage switches. One is on the outboard side of the captain control wheel. The other is on the outboard side of the first officer control wheel. The two switches can disengage both FCCs and turn off both ASAs.

Each switch is a momentary pushbutton switch. Each switch has three normally-closed contacts and one normally-open contact.



DFCS - AUTOPILOT DISENGAGE SWITCH

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DFCS - FUNCTIONAL DESCRIPTION - AUTOPILOT CONTROLS

General

These are the autopilot (A/P) functions of the flight control computer (FCC):

- A/P roll control
- A/P pitch control
- Autoland
- Engage interlocks
- Warning and annunciations
- Stabilizer trim.

The autopilot can control the airplane two ways. In the command (CMD) mode, it controls the airplane automatically with no control column inputs from the pilots. In the control wheel steering (CWS) mode, it controls the airplane using control column inputs from the pilots.

Changes between A/P modes do not supply unwanted movement. Changes between the A/P and flight director (F/D) modes do not supply unwanted movement or F/D commands.

A/P Names

The A/P may be called one of these names:

- Channel A or channel B.
- Local (LCL) or foreign (FGN)
- Master or slave.

The A/P channel A is the A/P from FCC A and the A/P channel B is from FCC B.

For A/P channel A, the LCL A/P is FCC A and the FGN A/P is FCC B. For A/P channel B, the LCL A/P is FCC B and the FGN A/P is FCC A.

When the crew engages one A/P, that A/P is the master and the other A/P is the slave. When the crew engages both A/Ps (dual mode), the first A/P engaged is the master and the second engaged is the slave. The master A/P controls the mode displays on the flight mode annunciator (FMA) and the data that goes to the A/T and FMCS.

A/P Roll Control

The roll control function uses data from several airplane sensors and the roll CWS force transducer to calculate a roll command. The roll command goes to the aileron A/P actuators to move the control surfaces through the aileron PCUs. The FCCs use feedback signals from these sensors to calculate the roll commands:

- Aileron position sensor
- Spoiler position sensors
- Flap position transmitter
- Aileron A/P actuator position sensors.

DFCS - FUNCTIONAL DESCRIPTION - AUTOPILOT CONTROLS

A/P Pitch Control

The pitch control functions use data from several airplane sensors and the pitch CWS force transducers to calculate a pitch command. The pitch command goes to the elevator A/P actuators to move the control surfaces through the elevator power control units (PCU). The FCCs use feedback signals from these sensors to calculate the pitch commands:

- Elevator position sensor
- Elevator neutral shift sensor
- Stabilizer position sensors
- Flap position transmitter
- Elevator A/P actuator position sensors.

Autoland

The autoland function consists of these parts of the flight path:

- Approach
- Flare
- Go-around.

The autoland function will only operate if both FCC A and FCC B are engaged. The autoland function contains both pitch and roll commands.

Engage Interlocks

The autopilot engage interlock circuits monitor these functions:

- Power
- Operation
- Components.

With normal conditions, the circuits let the autopilot engage. If conditions are not normal, the autopilot disengages or the autopilot will not engage.

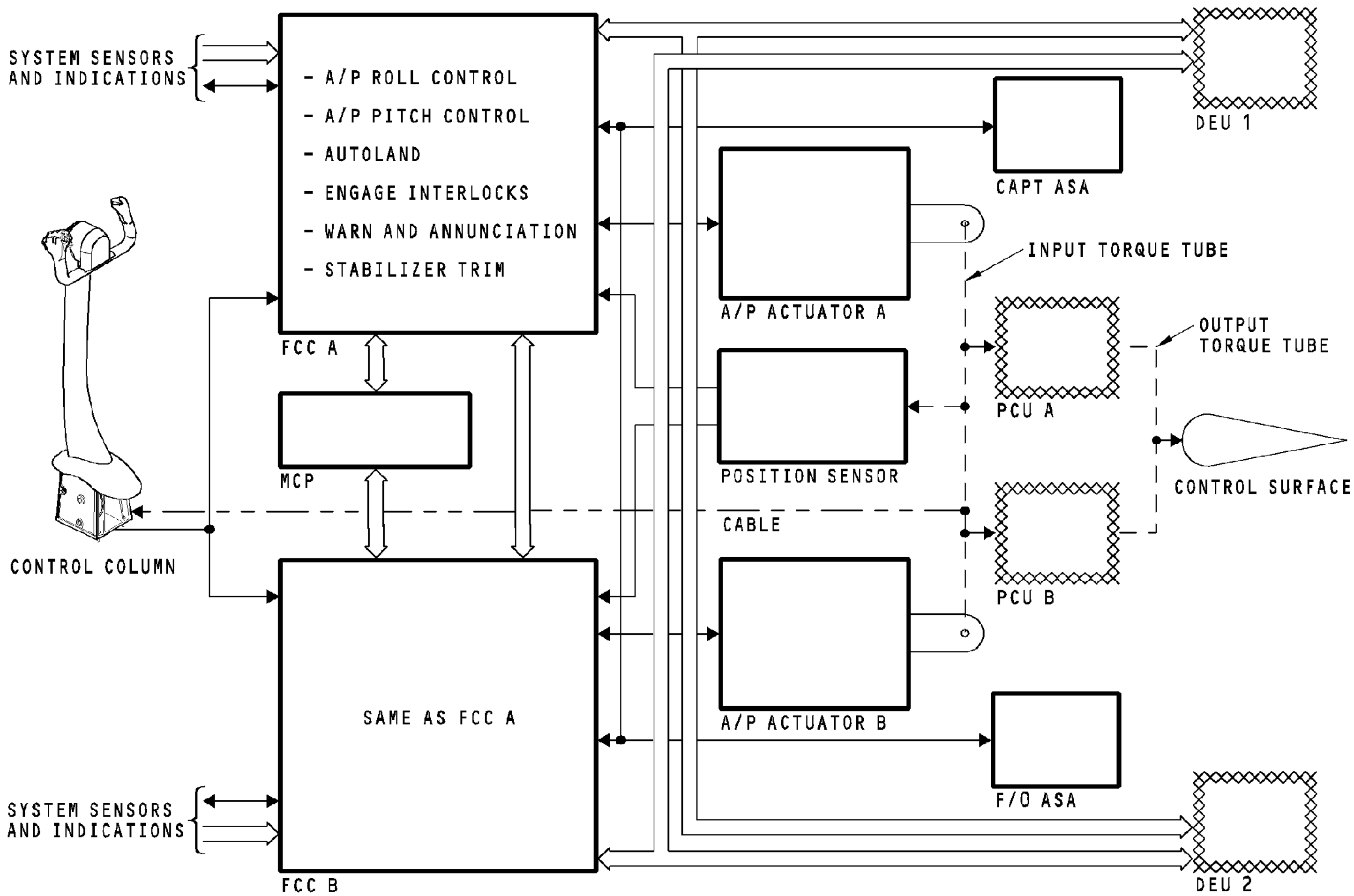
Warning and Annunciations

The warning and annunciation function sends normal and non-normal indications of the autopilot performance to these components:

- Captain autoflight status annunciator (ASA)
- First Officer ASA
- Display electronics unit (DEU)
- Flight control panel
- MCP IAS/MACH indicator
- Stab out of trim light.

Stabilizer Trim

When the autopilot is engaged, it sends trim commands to the stabilizer. The stabilizer trim system uses the same stab trim electric actuator that the speed trim system uses.



DFCS - FUNCTIONAL DESCRIPTION - AUTOPILOT CONTROLS

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DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL CONTROL

General

The FCC calculates the aileron commands for the roll modes that go to the aileron autopilot actuators. They also calculate the flight director (F/D) commands that go to the DEUs.

The FCCs calculate the roll commands for these roll modes:

- Lateral navigation (LNAV)
- Heading select (HDG SEL)
- Very high frequency omni range (VOR)
- Localizer (LOC)
- Go-around (G/A)
- Takeoff (T/O).

The crew can also engage the A/P in roll control wheel steering (CWS).

LNAV

In the LNAV mode, the roll command is the LNAV steering command that the FCC gets from the FMC.

HDG SEL

The FCC uses these inputs to calculate the heading select roll command:

- MCP HDG SEL mode selector pushed
- MCP selected heading
- Airplane magnetic heading
- True airspeed
- MCP bank angle limit.

VOR

These are the three submodes of the VOR mode:

- VOR capture
- VOR on-course
- VOR over-station.

The FCC uses these inputs to calculate the VOR roll commands for the three submodes:

- MCP VOR/LOC mode selector pushed
- MCP selected course
- Airplane magnetic track
- VOR omnibearing
- DME distance
- True airspeed
- MCP bank angle limit
- Airplane roll attitude
- Uncorrected altitude.

LOC

These are the three submodes of the LOC mode:

- LOC arm
- LOC capture
- LOC on-course.

DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL CONTROL

The FCC uses these inputs to calculate the LOC roll commands for the three submodes:

- MCP VOR/LOC mode selector pushed
- MCP selected runway heading
- Airplane magnetic track
- Lateral acceleration
- Airplane roll attitude
- Localizer deviation
- Radio altitude
- Glideslope (G/S) engaged.

Roll G/A

The FCC uses the airplane magnetic track to calculate the roll G/A command.

Roll T/O

The FCC uses these inputs to calculate the roll T/O command:

- MCP selected heading
- Airplane magnetic heading.

Roll CWS

The attitude hold and the heading hold are two submodes of the roll CWS mode. The FCC uses these inputs to calculate the CWS roll commands for the submodes:

- Roll CWS force transducer
- Airplane magnetic heading
- True airspeed
- Airplane roll attitude
- Airplane roll rate.

Autopilot Aileron Commands

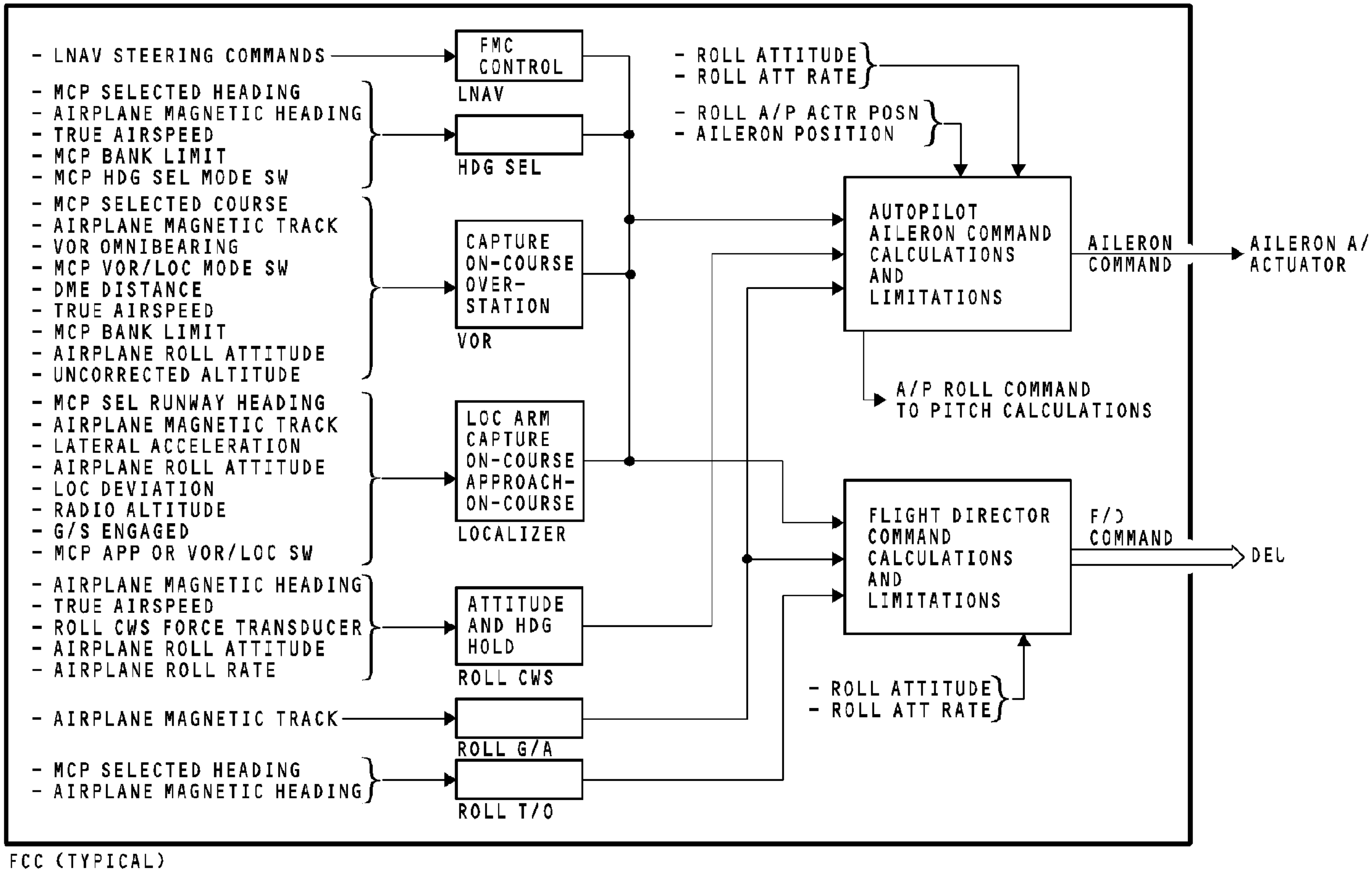
The FCC can use the roll commands from all the modes except the roll T/O mode to calculate the autopilot aileron command. The FCC also applies roll limits to the aileron commands. The FCC also uses these signals to calculate the aileron command:

- Airplane roll attitude
- Airplane roll rate
- Roll A/P aileron actuator position
- Aileron Position.

The FCC uses the roll command to calculate the pitch commands to increase the pitch as the airplane rolls.

Flight Director Roll Commands

The FCC can use the roll command from all the modes except the roll CWS mode to calculate the F/D commands. The FCC also applies roll limits to the F/D commands. The FCC also uses the airplane roll attitude and roll rate to calculate the F/D commands.



DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL CONTROL

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DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH CRUISE CONTROL

General

The FCC control laws calculate the elevator commands that go to the elevator autopilot actuators for the pitch modes. They also calculate the F/D commands that go to the DEUs. There are cruise pitch modes and takeoff/approach pitch modes

The FCCs calculate the pitch commands for these cruise pitch modes:

- Vertical navigation (VNAV)
- Altitude acquire (ALT ACQ)
- Altitude hold (ALT HOLD)
- Vertical speed (V/S)
- Level change (LVL CHG).

The crew can also engage the A/P in pitch CWS.

VNAV

The FCC uses these inputs to calculate the VNAV speed (VNAV SPD) and VNAV path (VNAV PTH) pitch commands:

- MCP VNAV mode selector pushed
- FMC target altitude
- FMC target V/S
- FMC target airspeed
- FMC target mach
- FMC discretes
- MCP selected altitude.

ALT ACQ

The FCC automatically selects the altitude acquire mode when the airplane approaches the MCP selected altitude. There are no mode selector switches to select this mode.

The FCC uses these inputs to calculate the altitude acquire pitch commands:

- MCP selected altitude
- Baro corrected altitude
- True airspeed
- Inertial vertical speed
- Inertial altitude
- Uncorrected altitude.

ALT HOLD

You can select the altitude hold mode with the ALT HLD pushbutton. The FCC selects the altitude hold mode automatically when the airplane reaches the MCP selected altitude.

The FCC uses these inputs to calculate the altitude hold pitch commands:

- MCP ALT HLD mode selector pushed
- Speed and altitude reference from the altitude acquire mode
- Uncorrected baro altitude
- True airspeed
- Inertial vertical speed

- Inertial altitude.

Vertical Speed

The FCC uses these inputs to calculate the vertical speed pitch commands:

- MCP V/S mode selector pushed
- Inertial vertical speed
- True airspeed
- MCP selected V/S.

LVL CHG

In the level change mode, the A/P uses the elevator to control the airplane speed. The FCC uses these inputs to calculate the level change pitch commands:

- MCP LVL CHG mode selector pushed
- MCP selected altitude
- MCP selected speed
- Longitudinal acceleration
- True airspeed
- Airplane pitch attitude
- Flap angle
- Angle of airflow
- Inertial V/S and acceleration
- calibrated airspeed.

Pitch CWS

The FCC uses these inputs to calculate the CWS pitch command.

- Captain pitch CWS force transducer
- First officer pitch CWS force transducer
- Computed airspeed
- Uncorrected baro altitude.

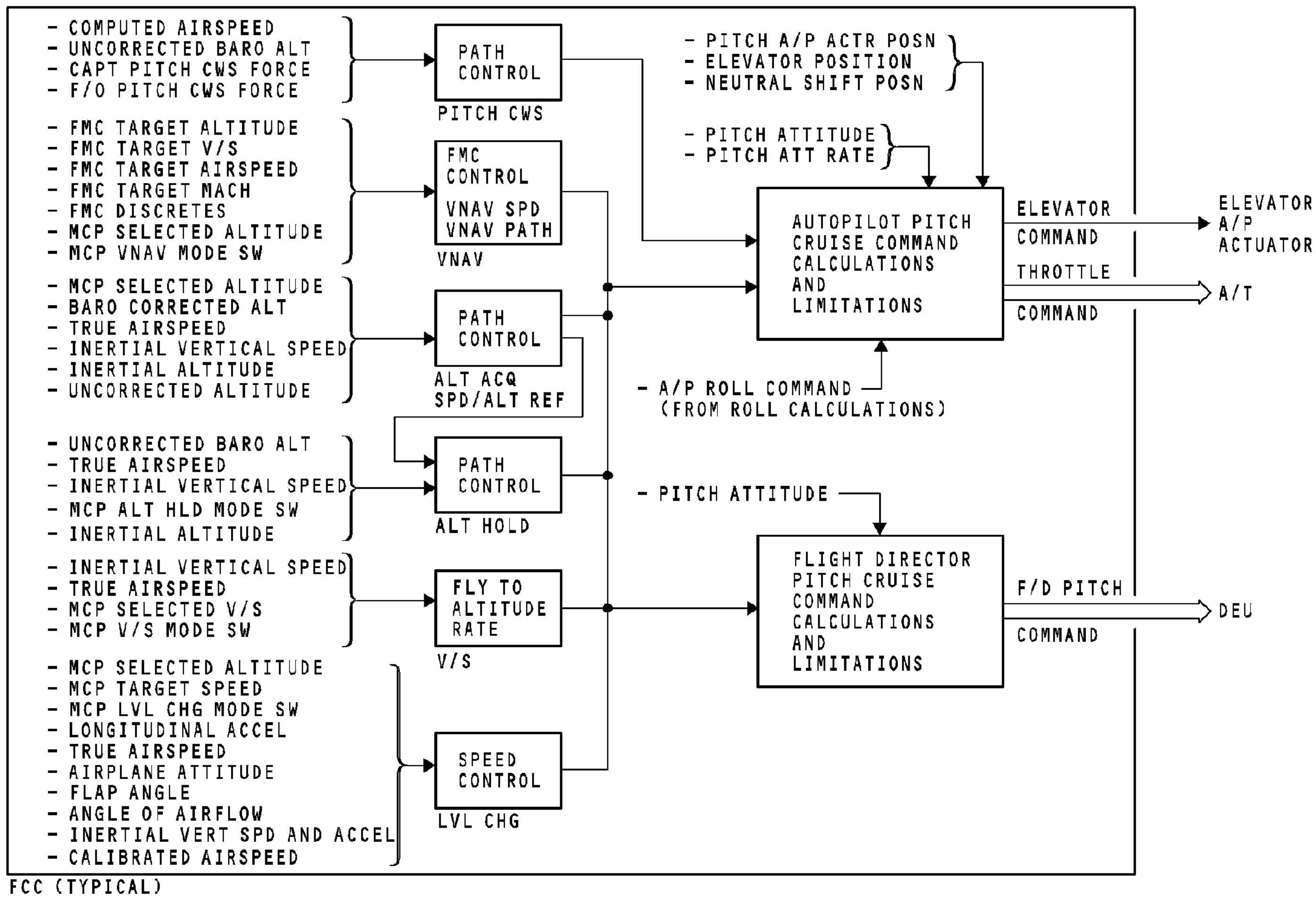
Autopilot Elevator Commands

The FCC can use the pitch commands from all the cruise modes to calculate the autopilot elevator command. The FCC also applies pitch limits to the aileron commands. The FCC also uses these signals to calculate the elevator command:

- Airplane pitch attitude
- Airplane pitch rate
- Pitch A/P elevator actuator position
- Elevator Position
- Neutral shift sensor position
- A/P roll command.

Flight Director Pitch Commands

The FCC can use the pitch command from all the cruise modes except the pitch CWS mode to calculate the F/D commands. The FCC also applies pitch limits to the F/D commands. The FCC also uses the airplane pitch attitude to calculate the F/D commands.



DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH CRUISE CONTROL

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DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH APPROACH CONTROL

General

The pitch takeoff/approach mode consists of the approach/go-around (G/A) mode and the takeoff (T/O) mode. The T/O mode is a flight director mode only.

Approach/Go-Around Mode

The pitch approach/go-around mode has these submodes:

- G/S capture
- G/S track
- Approach-on-course
- Flare
- Go-around.

The FCC uses these inputs to calculate the approach/go-around pitch command:

- MCP APP mode selector pushed
- Inertial vertical speed and acceleration
- Airplane pitch attitude and pitch rate
- Longitudinal acceleration
- Flight path acceleration
- G/S deviation
- Radio altitude
- True and computed airspeed

HAP 001-013, 015-026, 028-036, 038-054, 101-999

- Nav receiver tuned to LOC frequency

HAP 037

- Nav receiver tuned to LOC frequency or GLS channel

HAP ALL

- Stabilizer position and trim
- Flap angle
- A/P pitch actuator position
- Engine N1
- Angle of airflow
- Wheel speed
- TO/GA switch
- ground speed
- squat switch.

Takeoff Mode

The FCC calculates the takeoff mode commands with same inputs as the approach/go-around mode.

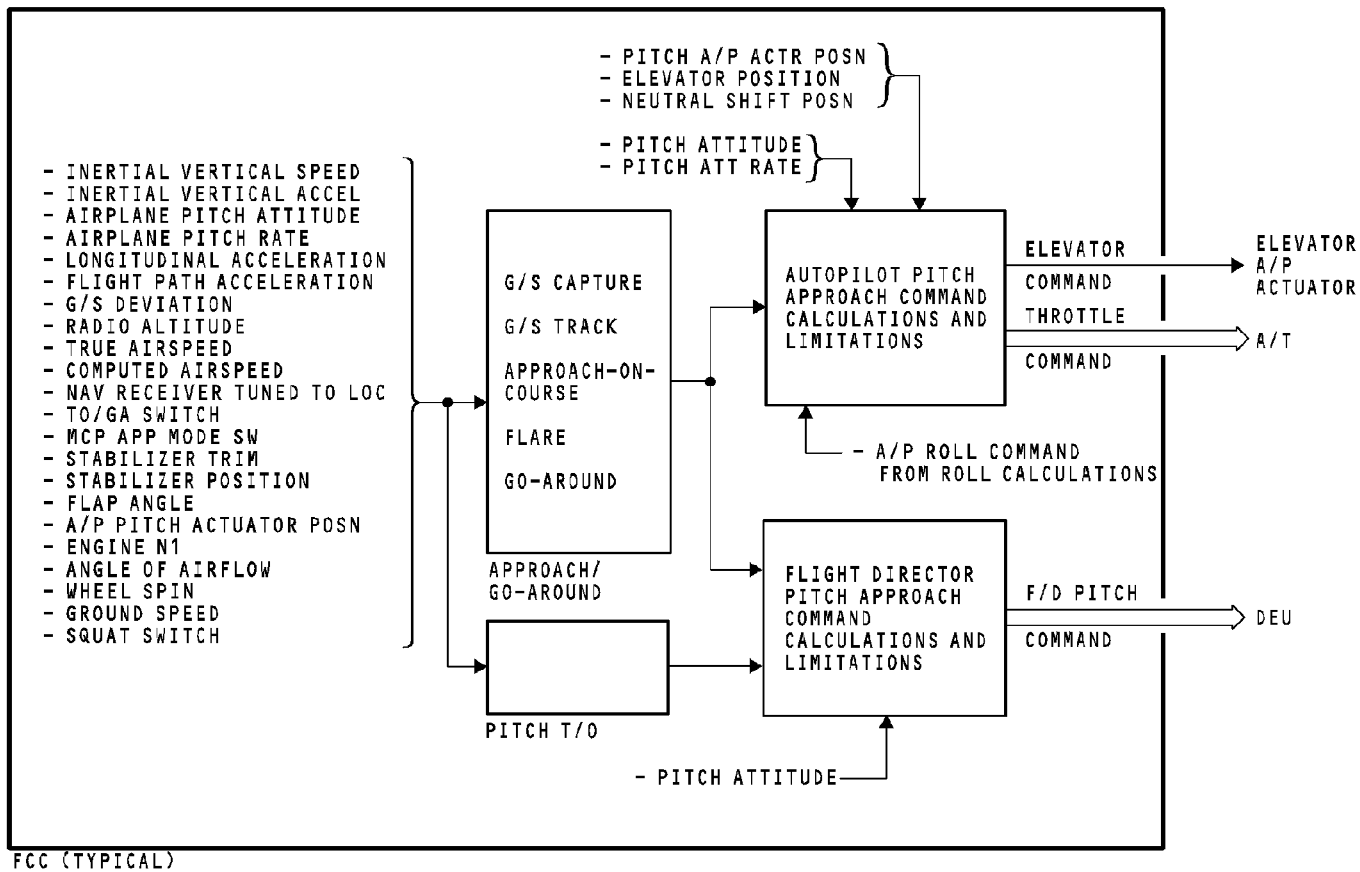
Autopilot Elevator Command

The FCC uses the pitch commands from the approach/go-around mode to calculate the autopilot elevator command. The FCC also applies pitch limits to the aileron command. The FCC also uses these signals to calculate the elevator command:

- Pitch A/P elevator actuator position
- Elevator Position
- Neutral shift sensor position
- Airplane pitch attitude
- Airplane pitch rate
- A/P roll command.

Flight Director Pitch Command

The FCC can use the pitch command from both modes to calculate the F/D command. The FCC also applies pitch limits to the F/D command. The FCC also uses the airplane pitch attitude to calculate the F/D command.



DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH APPROACH CONTROL

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DFCS - FUNCTIONAL DESCRIPTION - A/P YAW APPROACH

General

The FCC calculates the rudder command for the yaw control that goes to the rudder autopilot servo. The FCCs provide yaw control after these conditions occur:

- Approach-on-course (AOC)

- Dual channel engagement.

The FCCs calculate the yaw command for these modes:

- Runway alignment

- Rollout (ROLLOUT)

- Go-around (TO/GA).

Runway Alignment

If an engine fails after the rudder autopilot servo is engaged, the FCCs calculate a yaw command to compensate for the asymmetric thrust.

When there are crosswinds, the FCC calculates yaw commands to align the airplane with the runway centerline. These commands begin when the airplane is at 450 feet radio altitude. The FCC aligns the airplane to the runway using a maximum of 5 degress sideslip.

The FCC uses these inputs for runway alignment:

- Ground speed

- Localizer deviation

- Runway heading.

- Magnetic heading

- Sideslip angle

- Rudder surface position

- Radio altitude.

There is no annunciation for runway alignment.

Rollout

During rollout, the FCC calculates yaw commands to follow the runway centerline after touchdown. The yaw commands go to the rudder servo to move the rudder and to backdrive the rudder pedals. This allows the yaw command to drive the nose wheel steering.

The rollout mode engages when the gear altitude is less than 2 feet. The autopilot will disengage during rollout when ground speed decreases to 40 knots.

The FCC uses these inputs to calculate the yaw command for rollout:

- Localizer deviation

- Rudder surface position

- Yaw rate

- Cross-runway acceleration

- Radio altitude.

Roll G/A

The FCC uses the yaw control to provide engine-out compensation during go-around.

The FCC uses these inputs to calculate the yaw command for go-around:

- Rudder surface position

- Yaw rate

- Cross-track acceleration.

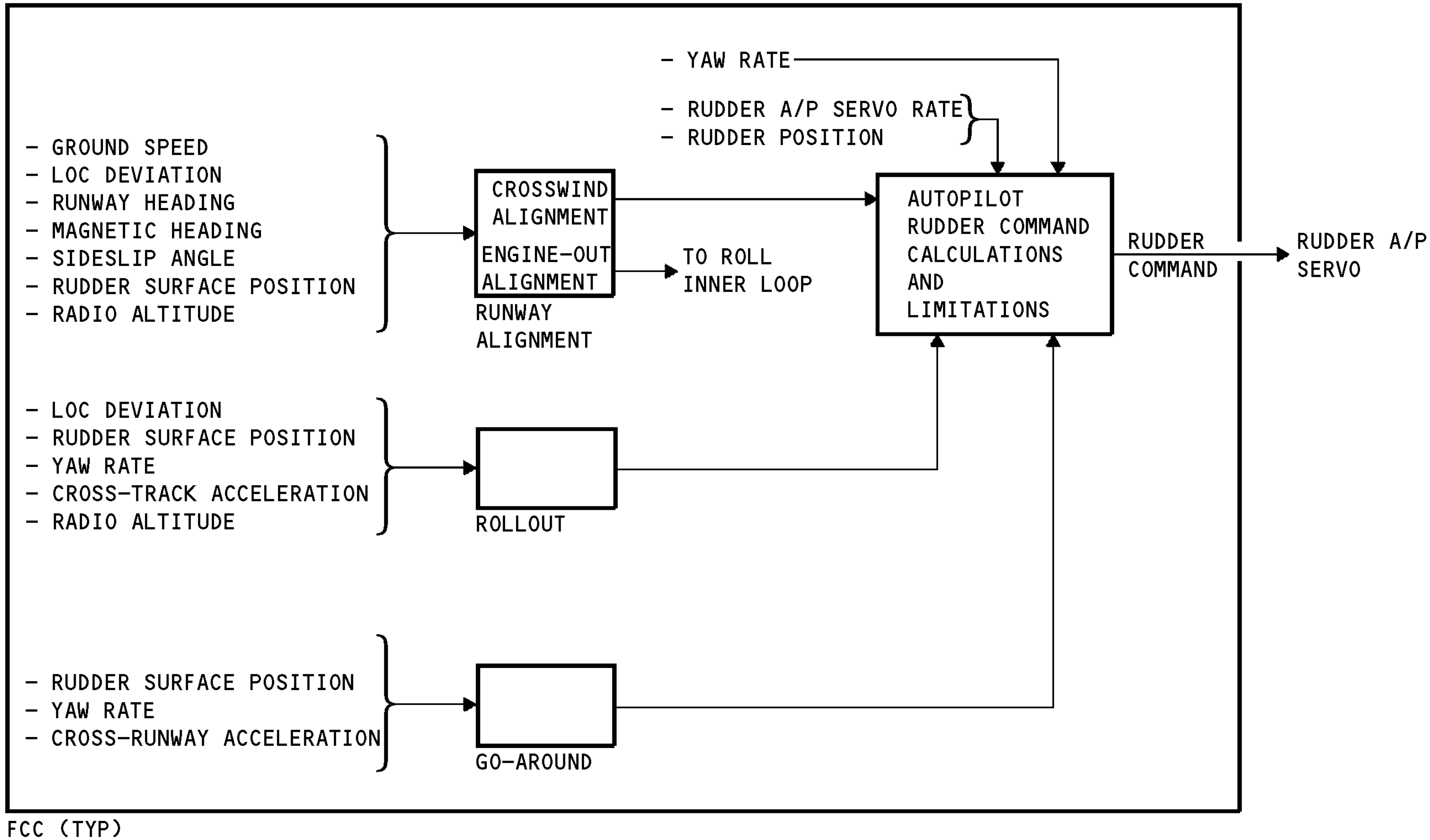
Autopilot Rudder Commands

The FCC uses these signals to calculate the rudder command:

- Airplane yaw rate

- Rudder autopilot servo rate

- Rudder position.



DFCS- FUNCTIONAL DESCRIPTION - A/P YAW APPROACH

22-11-00-149

EFFECTIVITY
HAP 038, 042-046, 048, 051-053, 104-999

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DFCS - FUNCTIONAL DESCRIPTION - A/P AUTOLAND

General

The autoland function is the dual channel (FCC A and FCC B) operation of the digital flight control system (DFCS). To make an autoland approach, you use the autoland function. The autoland function consists of these operations:

- Synchronization
- Initialization
- Equalization
- Monitors

HAP 038, 042-046, 048, 051-053, 104-999

- Rudder Servo Pre-Engagement Tests

HAP ALL

These functions are necessary to engage the autoland function.

Synchronization

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103

When each FCC is engaged in the autopilot command mode (CMD) or CWS, the A/P actuators for that FCC synchronize their outputs to the control surface position. This occurs before the FCC energizes the detent solenoids. This prevents a sudden movement of the control surfaces when the actuator detent piston clamps onto the output shaft.

HAP 038, 042-046, 048, 051-053, 104-999

When each FCC is engaged in the autopilot command mode (CMD) or CWS, the A/P aileron and elevator actuators for that FCC synchronize their outputs to the control surface position. This occurs before the FCC energizes the detent solenoids. This prevents a sudden movement of the control surfaces when the actuator detent piston clamps onto the output shaft.

HAP ALL

Initialization

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103

The CPU 1 and CPU 2 in the FCC that is engaged first calculate the control laws. At initialization, the first FCC transfers the control law data to the CPUs in the second FCC. The first FCC also transfers the data between its own CPUs. FCC A and FCC B have the same data so they should agree on the pitch and roll commands.

HAP 038, 042-046, 048, 051-053, 104-999

The CPU 1 and CPU 2 in the FCC that is engaged first calculate the control laws. At initialization, the first FCC transfers the control law data to the CPUs in the second FCC. The first FCC also transfers the data between its own CPUs. FCC A and FCC B have the same data so they should agree on the pitch, roll and yaw commands.

HAP ALL

Equalization

The FCCs compare the two elevator A/P actuator output positions and make them the same if there is a difference. This also occurs for the aileron A/P actuators. This makes sure that the actuators agree with each other.

HAP 038, 042-046, 048, 051-053, 104-999

Rudder Servo Pre-Engagement Tests

The rudder servo is a rate-controlled device for the aft rudder quadrant. The FCCs move the servomotors at a set rate. Tachometers sense the movement of the motor and give rate feedback to the FCC. The rudder servos connect to the current position of the rudder quadrant through a clutch mechanism. No mechanical synchronization is necessary.

Before the FCC connects the rudder servo, the FCC does tests to make sure the rudder servo and feedback circuits operate correctly. The FCC does these tests of the rudder servo:

- Rudder servo spin test
- Rudder torque fight test
- Rudder wiggle test.

The rudder servo spin test makes sure that the servo motors turn and that the tachometers give feedback.

The rudder torque fight test makes sure that each servo can supply torque.

The rudder wiggle test gives the rudder a small movement. This test makes sure that the rudder servos can move the rudder torque tube.

HAP ALL

Monitors

These are the three monitor circuits that monitor the performance of the two FCC autopilots:

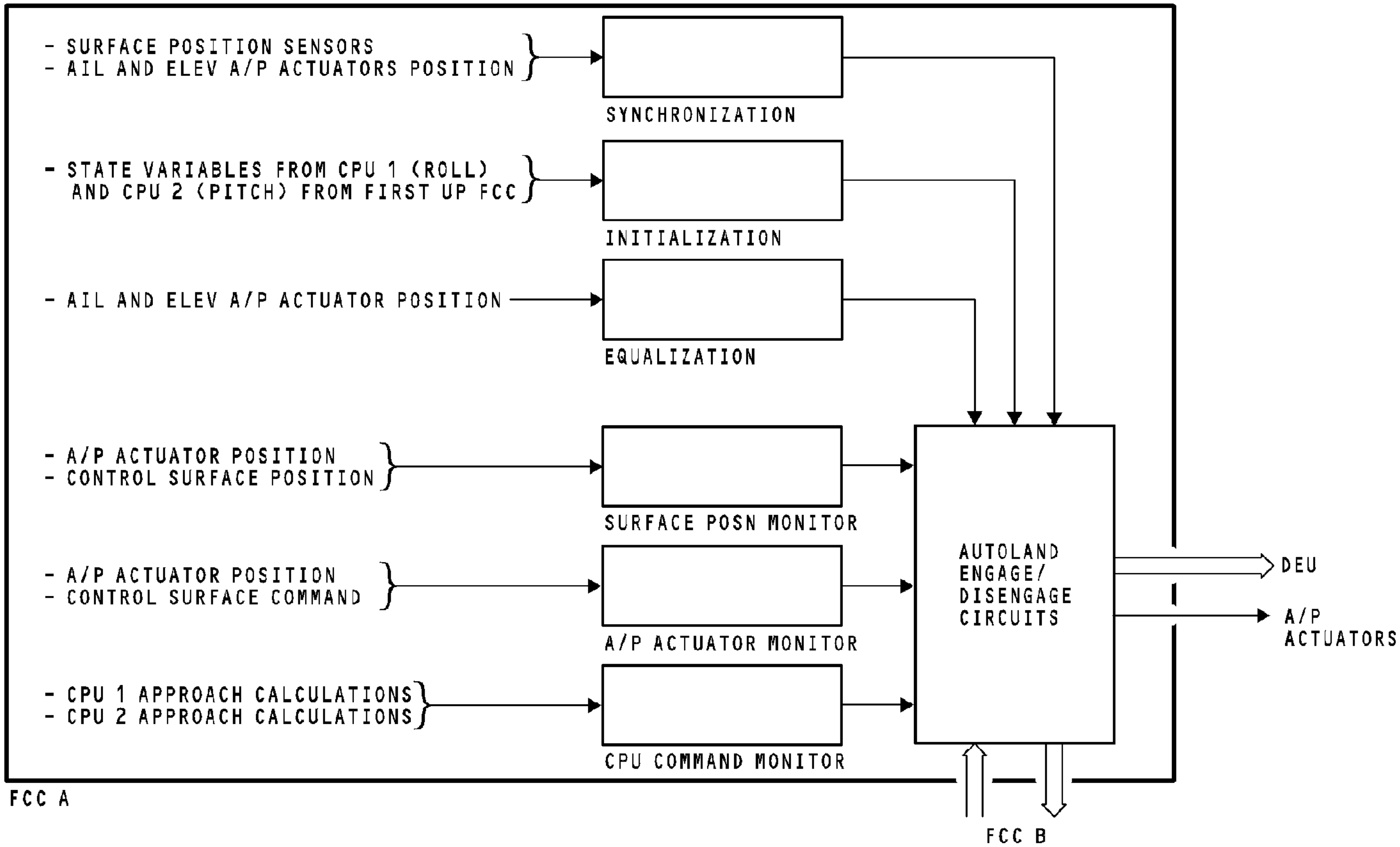
- Surface position monitor
- A/P actuator position monitor
- CPU command monitor.

The surface position monitor compares the position of the A/P actuator and the control surface.

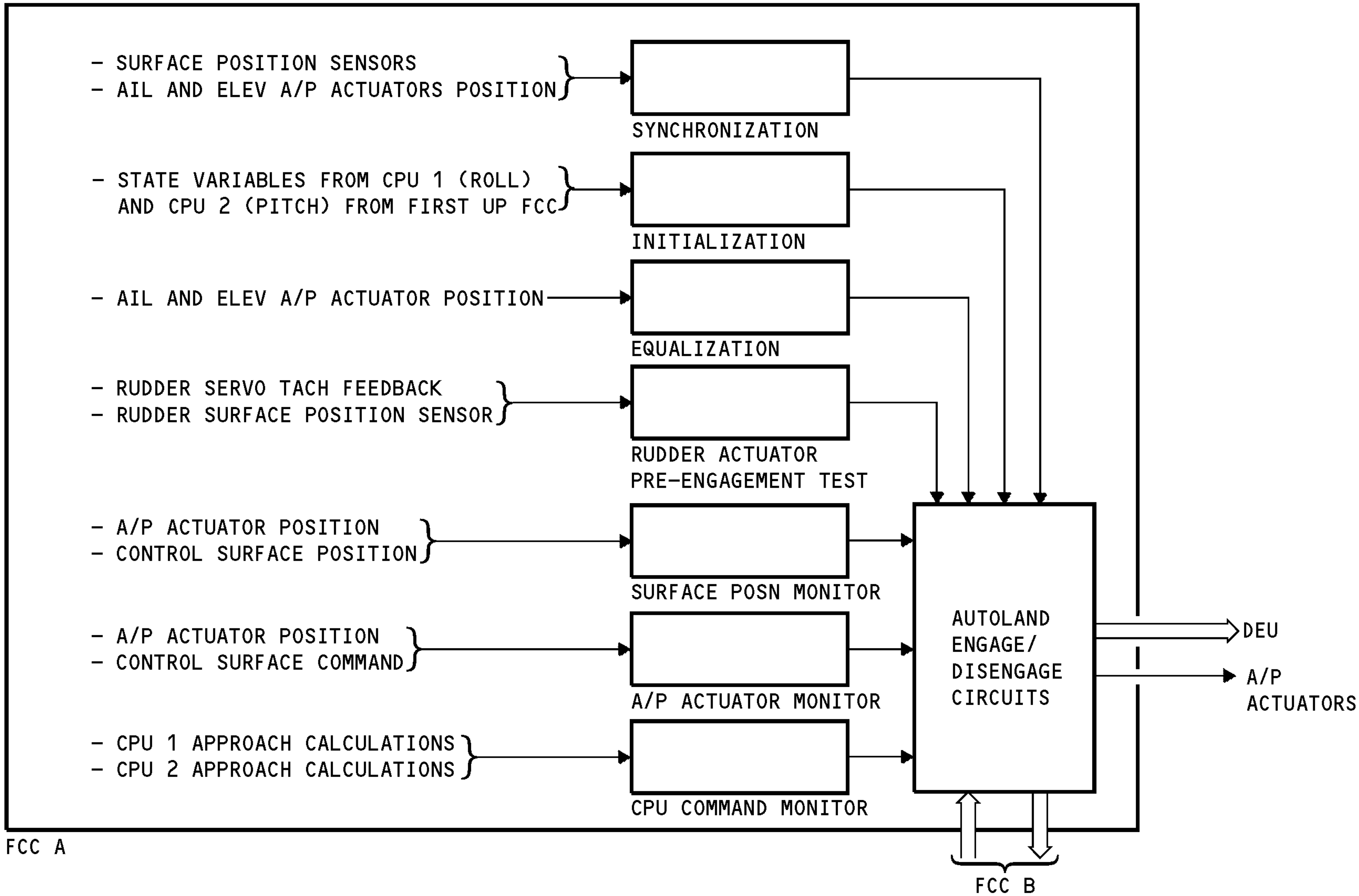
The A/P actuator position monitor compares the position of the actuator to the autopilot command.

The CPU command monitor compares the calculations made by the primary CPU and the alternate CPU.

Any differences will disengage the autoland function and the autopilots.



DFCS - FUNCTIONAL DESCRIPTION - A/P AUTOLAND



DFCS - FUNCTIONAL DESCRIPTION - A/P AUTOLAND

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE INTERLOCK SCHEMATIC

General

Engage and warning monitor circuits in the FCCs and MCP monitor important autopilot (A/P) functions.

MCP

There are two autopilot engage switches on the MCP for each autopilot system. These let the flight crew engage the autopilot. You can engage the autopilot in the command (CMD) or control wheel steering (CWS) mode. When you push one of the autopilot engage switches, an engage relay energizes and the autopilot engage switch light comes on if the engage enable signals from the FCC are valid.

When the autopilot engages, the MCP sends a signal to these components:

- Aileron A/P actuator
- Elevator A/P actuator
- FCC.

This signal energizes the actuator solenoid and tells the FCC that it has energized the A/P actuators. The MCP also tells the FCC which mode the crew selects.

The crew can disengage the autopilots with the captain's or first officer's disengage switches or the autopilot engage switches. There is also a disengage bar on the MCP that lets the flight crew quickly disengage the autopilots. If the autopilot disengages, the light on the autopilot engage switch goes out and the A/P disengage warning shows on the ASAs. The system aileron and elevator A/P actuators also de-energize.

FCC

The autopilot engage interlock circuits in the FCC monitor these items and send an engage enable signal to the MCP:

- Operation
- Power
- Components.

To engage the autopilot, the pre-engage logic must be valid. To keep the autopilot in the engage mode, the hold logic must be valid. The autopilot engage logic table shows these logic conditions.

CPU 1 sends a high engage enable signal to the MCP. CPU 2 sends a low engage enable signal to the MCP. The MCP needs both signals to engage the autopilot.

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE INTERLOCK SCHEMATIC

The FCC sends a signal to the A/P actuators to energize the detent solenoids. This occurs after the actuators synchronize to the control surface position. If the detent hydraulic pressure is not present 3.5 seconds after the detent solenoids are energized, the autopilot does not remain engaged.

During the cruise modes, you can only engage one autopilot, A or B. If autopilot A is engaged and the crew chooses to engage autopilot B, A will disengage after B has engaged.

When in the dual approach mode, you can engage both autopilots at the same time. After you push the APP mode selector switch on the MCP, you can push the second A/P CMD engage switch. The second system autopilot actuators synchronize to the control surfaces and engage the detent pistons after the airplane is in the approach-on-course mode.

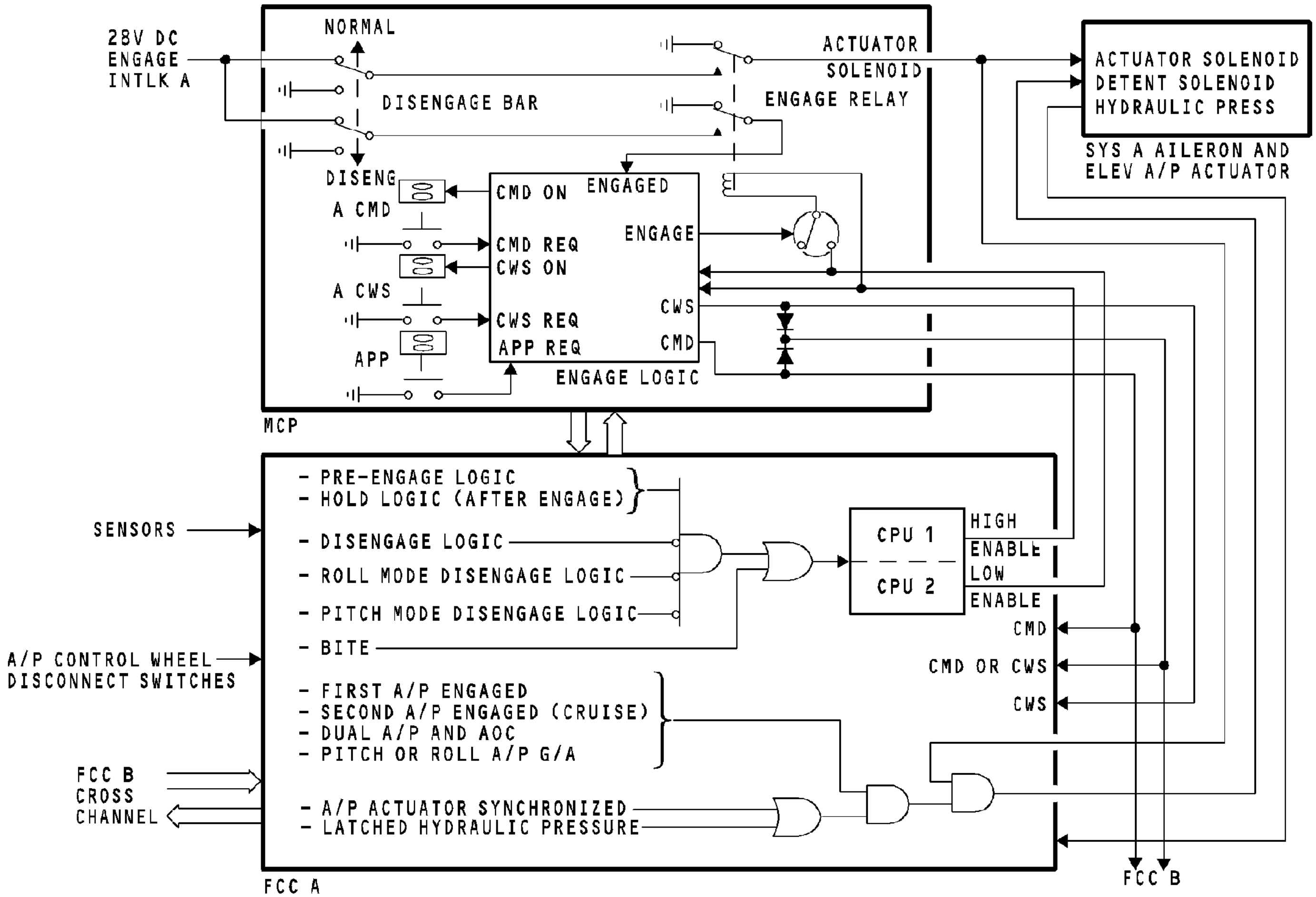
If the airplane is on a dual approach and the crew pushes a TO/GA switch, both A/Ps stay engaged in the go-around mode.

The autopilot disengages if any of the general disengage conditions shown on the autopilot engage logic table are present. The roll and pitch mode disengage tables show the roll and pitch conditions that will cause the autopilot to disengage.

A cross channel digital bus supplies engage and disengage data between the FCCs.

Training Information Point

When the FCC is in BITE, you can engage the autopilot in CMD or CWS.



DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE INTERLOCK SCHEMATIC

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DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-1

General

The table shows some of the functions that the autopilot engage interlock circuits monitor and the conditions that they cause. These are the three conditions:

- Pre-engage - shows the functions necessary to engage the autopilot
- Hold - shows the functions necessary to keep the autopilot engaged
- Disengage - shows functions that disengage the autopilot.

Engage and Disengage Functions

1. The stabilizer trim cutout switch must be in the normal position.

2. The crew must not push a main electric trim switch to manually trim the stabilizer.

3. The A/P stabilizer trim system must not try to trim nose up and nose down at the same time.

4. The stab trim motor is a two-speed motor and the speed depends on the position of the flaps. The motor speed and flap position must agree. A 10-second delay allows for flap movement.

5. The captain and first officer must not push A/P disengage switches.

6. Before the A/P engages, the A/P actuator hydraulic pressure switches must show no hydraulic pressure.

7. After the A/P actuators synchronize, the FCC energizes the detent solenoid. There must be hydraulic pressure in 3.5 seconds.

8. The FCC 115v ac must be valid. A delay allows an interrupt of 0.5 seconds.

9. The dc engage interlock is the power source for several interlocks and is necessary for pre-engage and hold logic.

10. The FCC 28v dc and the internal power supplies must be valid.

11. The power-up test monitors these components and functions and they must pass the test:

- CPU 1 and 2
- Autoland
- Go-around (G/A).

The FCC also does these continuous checks:

- Read only memory (ROM)
- Random access memory (RAM)
- Direct memory access (DMA) controller
- Digital to analog and analog to digital converters

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EFFECTIVITY
HAP ALL

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-1

- Program flow and master timer, also called heartbeat.

The FCC does these continuous autopilot checks:

- Actuator position transducers (LVDT) for an open circuit
- Neutral shift sensor for reasonable data
- Actuator commands to the actuator movement.

12. Any force on the control wheel must be less than 3 pounds. Any force on the control column must be less than 5 pounds.

13. This inertial reference data from the ADIRU must be valid:

- Roll angle
- Roll rate
- Pitch angle
- Pitch rate.

14. This air data from the ADIRU must be valid except when the autopilot is in the flare arm mode:

- Computed airspeed (CAS)
- Uncorrected baro altitude.

15. You can engage only one autopilot when in the cruise mode. When you try to engage the second autopilot, the first autopilot will disengage. The first autopilot will disengage after the second autopilot actuators are fully pressurized.

16. The captain or the first officer can disengage the autopilots if one pushes a disengage switch.

17. If the MCP bus is invalid, the autopilot will disengage in all the modes except the approach mode after approach on course.

18. A local AC bus transfer disengages the local autopilot in CMD. You may engage the autopilot again unless the foreign autopilot is in the approach and CMD modes.

CONDITIONS	PRE-ENGAGE	HOLD	DIS-ENGAGE
1. A/P STAB TRIM CUTOUT SWITCH NORMAL	X	X	
2. MAIN ELECTRIC TRIM SWITCHES NOT PUSHED	X	X	
3. BOTH TRIM UP AND TRIM DOWN NOT AT THE SAME TIME	X	X	
4. AUTO STAB TRIM MOTOR SPEED MATCH FLAP SETTING (10 SECOND DELAY)	X	X	
5. A/P DISENGAGE SWITCHES NOT PUSHED	X	X	
6. A/P ACTUATOR HYDRAULIC PRESSURE SWITCHES SHOW NO PRESSURE	X		
7. A/P ACTUATOR HYD PRESS SWITCHES SHOW PRESSURE WITHIN 3.5 SEC AFTER DETENT		X	
8. FCC 115V AC IS VALID (.5 SEC DELAY FOR INTERRUPTS)	X	X	
9. DC ENGAGE INTLK POWER IS VALID	X	X	
10. FCC 28V DC POWER AND INTERNAL POWER SUPPLIES ARE VALID	X	X	
11. POWER UP AND CONTINUOUS MONITOR CHECKS ARE VALID	X	X	
12. LESS THAN 3 LBS FORCE ON CONTROL WHEEL AND 5 LBS FORCE ON CONTROL COLUMN	X		
13. SELECTED ADIRU INERTIAL DATA IS VALID	X	X	
14. CAS AND UNCORRECTED BARO ALTITUDE ARE VALID, EXCEPT WITH FLARE ARMED	X	X	
15. AUTOPILOTS CHANGE ENGAGEMENT WHEN IN CRUISE MODE			X
16. CAPT OR F/O PUSHES THE A/P DISENGAGE SWITCH			X
17. MCP BUS INVALID IN ALL MODES EXCEPT APPROACH MODE AFTER AOC			X
18. LCL AC BUS TRANSFER			1

1 CAN BE RE-ENGAGED IN ANY MODE EXCEPT APP MODE WITH FGN IN CMD

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-1

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DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-2

General

The table shows more of the functions that the autopilot engage interlock circuits monitor and the conditions that they cause. These are the three conditions:

- Pre-engage - shows the functions necessary to engage the autopilot
- Hold - shows the functions necessary to keep the autopilot engaged
- Disengage - shows functions that disengage the autopilot.

Engage and Disengage Functions

19. If the crew wants to make a dual approach in CMD, they must put the other A/P in CMD at a radio altitude more than 800 feet.

20. The IRS transfer switch must be in the NORMAL position to engage the autopilot.

21. If the IRS transfer switch is in the BOTH ON 1 or BOTH ON 2 position, the autopilot will disengage and cannot be reengaged.

22. The VHF NAV transfer switch must be in a position so that the data that the autopilot uses also shows on the CDS.

23. The flap position data from the flap transmitters must agree with the flap position data from the SMYD.

24. The signal from the SMYD that shows a stall condition and activates the stick shaker must not be active.

25. The selected baro corrected altitude from the ADIRU must be valid.

26. The option pin that shows the FCC can do the dual approach, CAT IIIA (50 ft DH), must be selected in the second up channel FCC.

HAP 001-013, 015-026, 028-036, 038-054, 101-999

27. The VHF nav control panel for the second up channel must be tuned to the ILS frequency.

HAP 037

27. The VHF nav control panel for the second up channel must be tuned to the ILS frequency or GLS channel.

HAP ALL

28. The FCC that is the second up channel for a dual approach must be on a different power bus then the first up FCC.

29. The autopilot that is the second up for the dual approach must be in the CMD and not the CWS mode.

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-2

30. During a dual approach if one autopilot disengages, the other autopilot also disengages.

31. The trim sensors monitor compares the neutral shift expected value from stabilizer position and Mach trim feedback with the actual NSS input. If the difference is more than 0.5 elevator degrees and in dual autoland, the autopilot will disengage.

CONDITIONS	PRE-ENGAGE	HOLD	DIS-ENGAGE
19. FOR DUAL APP WITH FGN IN CMD AND AND RA > 800 FT	X	X	
20. IRU TRANSFER SWITCH IN NORMAL POSITION	X	X	
21. IRU TRANSFER SWITCH OUT OF THE NORMAL POSITION			X
22. VHF NAV TRANSFER SWITCH IN THE CORRECT CONFIGURATION	X	X	
23. REDUNDANT SOURCE OF FLAP POSITION DATA MUST AGREE	X	X	
24. STICK SHAKER SIGNAL FROM THE SMYD MUST NOT BE ACTIVE	X	X	
25. SELECTED BARO CORRECTED ALTITUDE MUST BE VALID	X	X	
26. CAT IIIA (50 FT DH) OPTION SELECTED IN SECOND UP CHANNEL DURING APPROACH	X	X	
27. THE SECOND UP CHANNEL IN DUAL MUST BE TUNED TO THE ILS FREQUENCY	X	X	
28. THE SECOND UP CHANNEL MUST BE ON ITS OWN POWER BUS	X	X	
29. SELECT CWS FOR THE SECOND UP CHANNEL IN DUAL			X
30. THE OTHER CHANNEL DURING A DUAL APPROACH DISENGAGES			X
31. DIFF BETWEEN NEUTRAL SHIFT EXPECTED VALUE AND NSS > 0.5 ELEV DEGS AND DUAL			X

DFCS - FUNCTIONAL DESCRIPTION - A/P ENGAGE LOGIC TABLE-2

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DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL MODE DISENGAGE LOGIC TABLE

General

The table shows the roll mode conditions that cause the autopilot to disengage.

Disengage Conditions

1. The magnetic heading must be valid when in the CWS heading hold or the autopilot will disengage. If the magnetic heading fails while in the heading mode, the A/P will go to the CWS mode first and then disengage.

2. If the radio altitude is less than 2000 feet and the A/P is not in flare arm, it will disengage if the crew pushes a TO/GA switch.

3. If the crew pushes a TO/GA switch after touchdown (wheel spin greater than 60 knots), both autopilots will disengage.

4. The LOC antenna must switch to the forward antenna when in the approach mode and the crew tunes to a LOC frequency. If it does not switch within 4.5 seconds, the autopilots will disengage.

5. When in the dual (autoland) mode for at least 5 seconds, the FCC monitors these:

- Autopilot actuator monitor (AAM)
- Surface position monitor (SPM)
- CPU monitor.

If a monitor shows a failure, the autopilots will disengage.

6. If the NAV transfer switch is in the BOTH ON 1 position, the B A/P disengages. If the NAV transfer switch is in the BOTH ON 2 position, the A A/P disengages.

7. After LOC engage, if the LOC receiver is not valid or a beam anomaly occurs, the autopilot disengages. There is a 10 second delay to allow for interrupts.

A beam anomaly occurs if the localizer beam rate is greater than 0.13 degrees/second and the beam deviation is greater than 0.3 degrees.

8. The autopilots will disengage below 350 feet if in dual mode and not in flare arm mode.

9. The true airspeed (TAS) must be valid in the CWS heading hold mode.

10. The lateral acceleration from the ADIRU must be valid or the autopilot will disengage in certain modes.

11. The magnetic track angle from the ADIRU must be valid or the autopilot will disengage in certain modes.

DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL MODE DISENGAGE LOGIC TABLE

12. If the autopilots are in the dual mode and one disengages, the other will disengage. This does not occur when one autopilot disengages because the other goes out of the G/A pitch mode.

13. If these conditions occur, the autopilot will disengage:

- Radio altimeter is not valid
- GS and LOC are engaged
- A/Ps are not in the flare arm mode.

A 2 second delay allows for short interruptions.

14. If both autopilots are in the flare arm mode, both radio altimeters must fail before the autopilots disengage.

15. If these conditions occur, the autopilot disengages:

- Autopilots are in the approach mode
- Local AC bus transfers
- Foreign autopilot is in the CMD mode.

16. If the aileron command is more than the allowable limits, the autopilot disengages.

	SELECTED MODES								
CONDITIONS	CWS	HDG	L NAV	VOR ENG	LOC ENG	APP PB	APP LOC ENG	APP OC	G/A
1. MAGNETIC HEADING INVALID AND HDG HOLD	X	1>							
2. TO/GA SWITCH PUSHED WHEN RA < 2000 FT AND NOT IN FLARE ARM	X	X	X	X	X	X	X	X	
3. TO/GA SWITCH PUSHED AFTER TOUCHDOWN (WHEEL SPIN)								X	
4. AFT LOC ANTENNA (4.5 SEC DELAY)						X	X	X	
5. DUAL ROLL CHANNEL MONITOR TRIP								X	X
6. NAV TRANSFER SWITCH OUT OF NORMAL				X	X	X	X	X	
7. LOC RECEIVER INVALID OR BEAM ANOMALY (10 SEC DELAY)							X	X	
8. DUAL IN CMD AND RA < 350 FT AND NOT IN FLARE ARM							X	X	
9. TAS INVALID AND HDG HOLD	X								
10. LATERAL ACCELERATION INVALID					X		X	X	
11. MAGNETIC TRACK ANGLE INVALID				X	X		X		X
12. DUAL IN CMD AND ONE DISENGAGE, EXCEPT INTENTIONAL G/A EXIT						X	X	X	X
13. RA INVALID, G/S AND LOC ENGAGED AND NOT FLARE ARM (2 SEC)							X	X	
14. BOTH RADIO ALTIMETERS INVALID AND FLARE ARM								X	
15. LCL OR FGN BUS TRANSFER AND FGN IN CMD						X	X	X	
16. AILERON COMMAND LIMITS EXCEEDED	X	X	X	X	X	X	X	X	X

1> A LOSS OF MAGNETIC HEADING CAUSES A REVERSION TO ROLL CWS AND THEN DISENGAGES THE A/P

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DFCS - FUNCTIONAL DESCRIPTION - A/P ROLL MODE DISENGAGE LOGIC TABLE

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DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH MODE DISENGAGE LOGIC TABLE

General

The table shows the pitch mode conditions that cause the autopilot to disengage.

Disengage Conditions

1. This is an unsafe flight condition. When the autopilot is in a speed mode, the airplane should be climbing but it is not, and it approaches a stall, the A/P disengages.

2. This is another unsafe flight condition. When the autopilot is in a speed mode, the airplane should be descending but it is not, and it approaches the VMO/MMO limit, the A/P disengages.

3. When the autopilot is in the G/S engage mode, it will disengage if the G/S receiver is not valid and the radio altitude is above 60 feet. There is a 4.5 second delay to allow for interrupts.

4. When in the dual (autoland) mode for at least 5 seconds, the FCC monitors these:

- Autopilot actuator monitor (AAM)
- Surface position monitor (SPM)
- CPU monitor.

5. The autopilots will disengage below 350 feet if in the dual mode and not in the flare arm mode.

6. If the autopilots are in the dual mode and one disengages, the other will disengage. This does not occur when one autopilot disengages because the other goes out of the G/A pitch mode.

7. An autopilot goes out of the G/A pitch mode when the crew sets a cruise pitch mode. The other autopilot will disengage when this occurs.

8. If the radio altitude is less than 2000 feet and the A/P is not in flare arm, it will disengage if the crew pushes a TO/GA switch.

9. An invalid longitudinal acceleration from the ADIRU causes the autopilot to disengage.

10. An invalid vertical acceleration from the ADIRU causes the autopilot to disengage.

11. An invalid vertical speed from the ADIRU causes the autopilot to disengage.

12. An invalid flight path acceleration from the ADIRU when in the dual mode causes the autopilot to disengage.

13. If these conditions occur, the autopilot will disengage:

- Radio altimeter is not valid
- G/S and LOC are engaged
- A/Ps are not in the flare arm mode.

DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH MODE DISENGAGE LOGIC TABLE

A two-second delay allows for short interruptions.

14. If both autopilots are in the flare arm mode, both radio altimeters must fail before the autopilots disengage.

15. After G/S engage, if the G/S receiver is invalid or a beam anomaly occurs the autopilot disengages. There is a 10 second delay to allow for interrupts.

16. If the minimum operating speed from the stall management yaw damper is invalid, the autopilot disengages.

17. If the elevator command is more than the allowable limits, the autopilot disengages.

CONDITIONS	SELECTED MODES						
	CWS	V/S ALT ACQ ALT HOLD	V NAV	LVL CHG	GS ENG	APP OC	G/A
1. CLB CMD AND ALPHA WARNING AND NOT CLIMBING AT MIN V/S AND NOT ON GRD (5 SEC)			X	X			
2. DES CMD AND VMO/MMO WARNING AND NOT DESCENDING AT MIN V/S AND NOT ON GRD (10 SEC)			X	X			
3. GLIDESCOPE INVALID AND RA > 60 FT (4.5 SEC DELAY)					X		
4. DUAL CHANNEL MONITOR TRIP AND DUAL ENGAGED						X	X
5. DUAL IN CMD AND RA < 350 FT AND NOT FLARE ARM					X	X	
6. BOTH A/P CMD, FGN A/P DISENGAGE (EXCEPT INTENTIONAL G/A EXIT)						X	X
7. INTENTIONAL G/A EXIT AND RA > 400 FT (DISENGAGE 2ND IN CMD)							X
8. TO/GA SWITCH PUSHED WHEN RA < 2000 FT AND NOT IN FLARE ARM	X	X	X	X	X	X	
9. LONGITUDINAL ACCELERATION INVALID					X	X	X
10. VERTICAL ACCELERATION INVALID					X	X	X
11. VERTICAL SPEED INVALID					X	X	X
12. FLIGHT PATH ACCELERATION INVALID, DUAL ENGAGE					X	X	X
13. RA ALT INVALID, LOC AND G/S ENGAGED AND NOT FLARE ARM (2 SEC)					X	X	
14. BOTH RADIO ALTIMETERS INVALID AND FLARE ARM						X	X
15. G/S RECEIVER INVALID OR BEAM ANOMALY (10 SEC DELAY)					X	X	
16. MIN OPERATING SPEED FROM STALL MANAGEMENT YAW DAMPER INVALID				X			
17. ELEVATOR COMMAND LIMITS EXCEEDED	X	X	X	X	X	X	X

DFCS - FUNCTIONAL DESCRIPTION - A/P PITCH MODE DISENGAGE LOGIC TABLE

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DFCS - FUNCTIONAL DESCRIPTION - A/P WARNING LIGHTS

General

The red A/P warning light on the autoflight status annunciator (ASA) can flash red or stay on steady red. The captain and the first officer red A/P warning lights are in parallel so they go on at the same time.

Steady Red A/P Warning Light

Circuits that can cause the steady red A/P warning light are in these components:

- FCC A and FCC B
- Mode control panel (MCP).

FCC A and FCC B

The steady red light will come on if the stab out of trim warning is set and all of these conditions are present:

- Airplane is in dual pitch mode
- The radio altitude is between 50 and 800 feet
- A/P G/S is engaged.

If the light is on when the airplane goes below 50 feet, it will stay on.

The light will also come on if the DFCS is in BITE or if the FCCs can not operate together.

The FCC will supply an A/P warning signal to the MCP if any of these conditions are present:

- The airplane is on the ground and the FCC fails the power up test
- The airplane is above 400 feet and cannot exit A/P G/A to altitude acquire because single channel pitch authority is not available
- The airplane is in A/P pitch G/A and the MCP bus fails.

MCP

If the MCP receives an A/P warning signal from either FCC and the flashing red A/P circuit is not on, the red A/P warning lights will come on steady. The steady red A/P warning lights will only go off if the condition that causes the warning goes away.

Flashing Red A/P Warning Light

The circuits that cause the flashing red A/P warning lights are in the MCP. If autopilot A or autopilot B disengage, the warning detector will turn on a flasher. This flasher will cause the red A/P warning lights in the ASAs to flash. The detector will also send a signal to the aural warning module which turns on the horn.

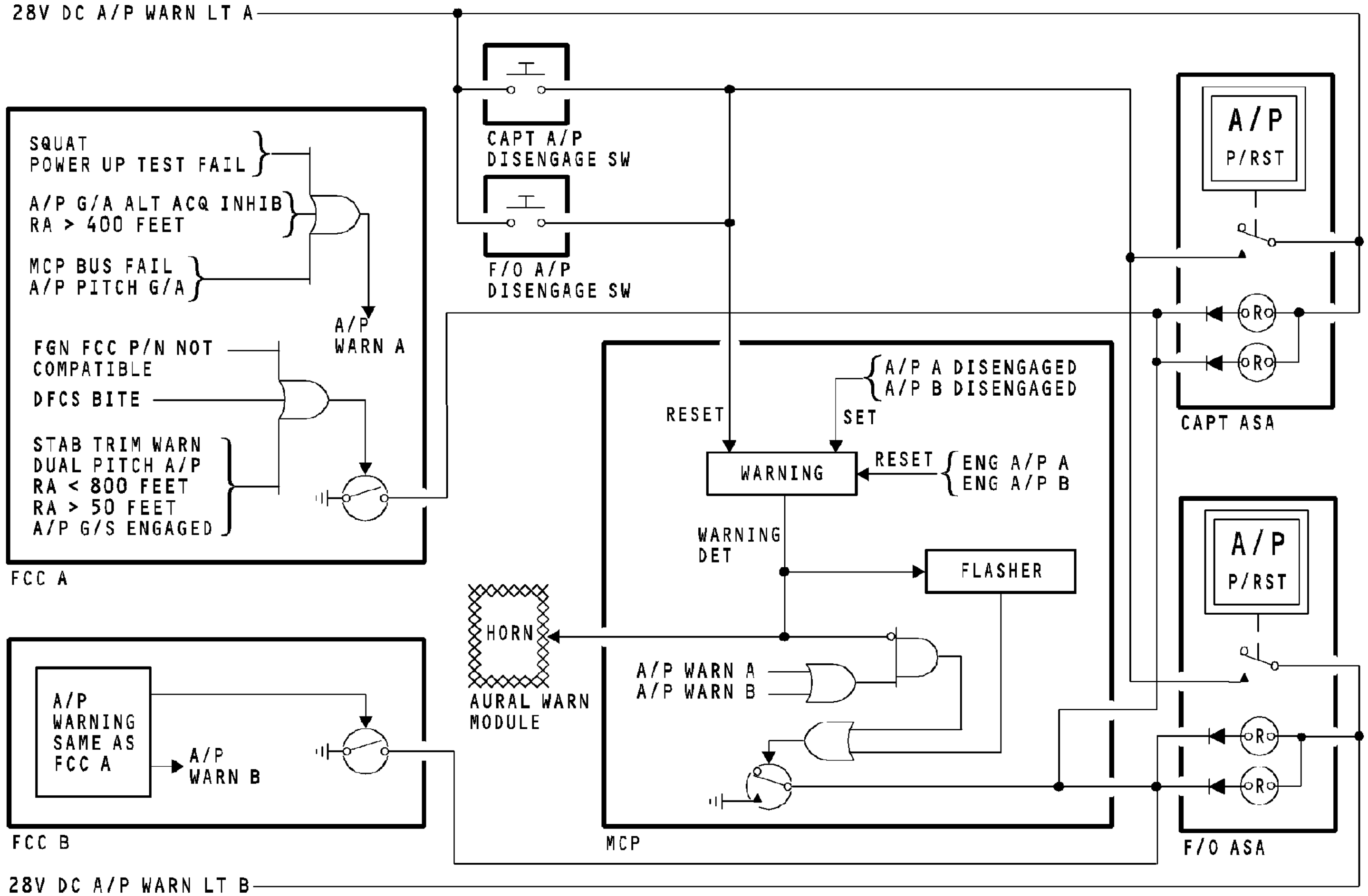
To reset the horn and flashing lights, push any one of these switches:

- Captain A/P disengage switch
- First officer A/P disengage switch

DFCS - FUNCTIONAL DESCRIPTION - A/P WARNING LIGHTS

- A/P light on the captain ASA
- A/P light on the first officer ASA.

If either autopilot engages, the warning resets.



DFCS - FUNCTIONAL DESCRIPTION - A/P WARNING LIGHTS

DFCS - FUNCTIONAL DESCRIPTION - A/P AMBER LIGHTS

General

The A/T speed warning causes the amber A/T lights on the autoflight status annunciators (ASA) to flash.

A/T Speed Warning

The A/P activates this warning if the true airspeed is not within limits when compared to the FMC or MCP selected airspeed.

The A/T speed warning occurs if all of these conditions occur:

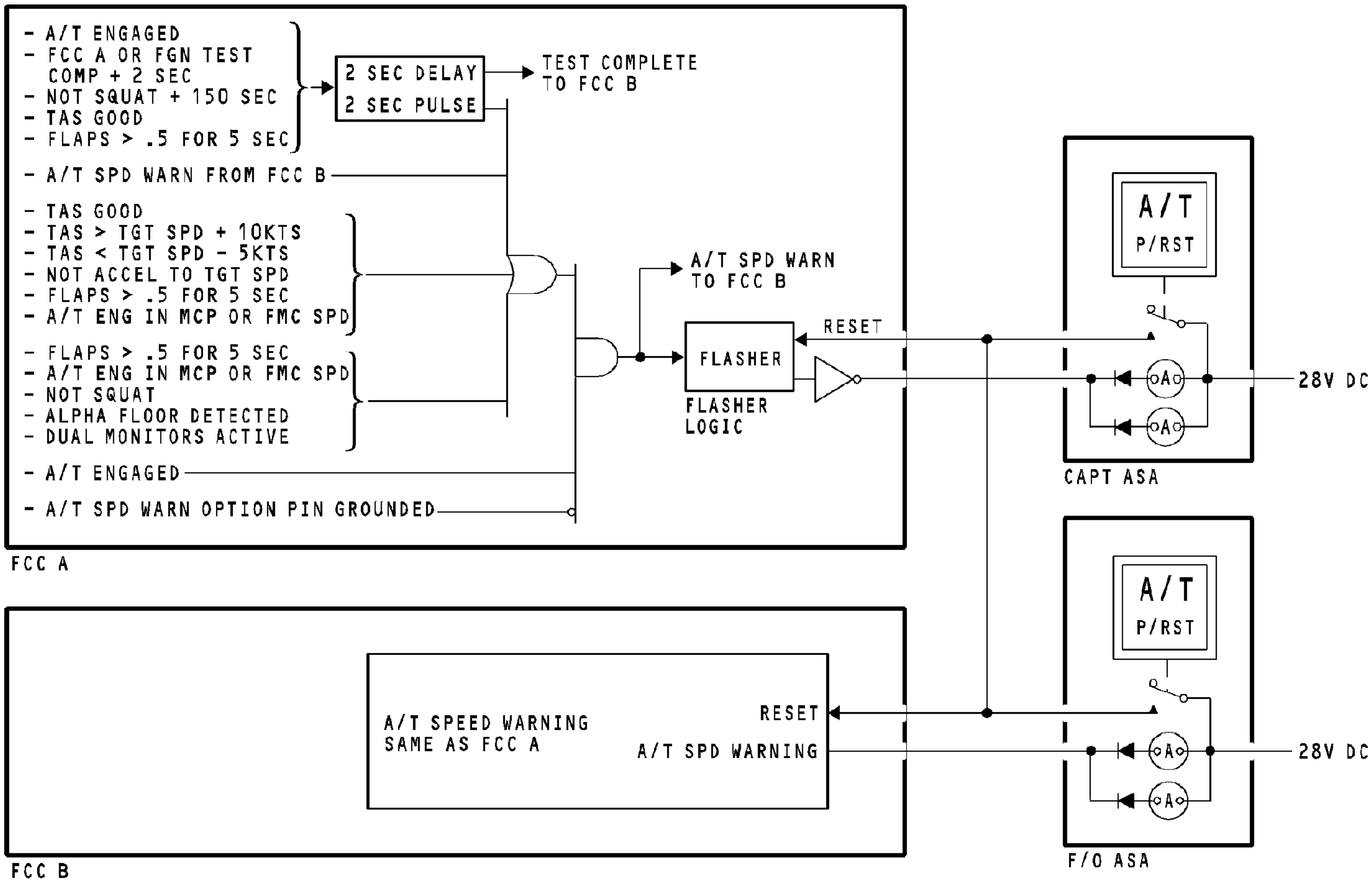
- Flaps are more than 0.5 degrees
- A/T MCP speed or A/T FMC speed is engaged
- Airplane is unsquat for more than 5 seconds
- Alpha floor is detected
- Dual monitors are active.

The A/T speed warning also occurs if all of these conditions occur:

- True airspeed is valid
- True airspeed is 10 kts faster than target speed or true airspeed is less than target airspeed minus 5 kts
- Airplane is not accelerating to the target speed
- Flaps are greater than 0.5 degrees
- A/T MCP speed or A/T FMC speed is engaged for more than 5 seconds.

The A/T speed warning also shows during the self test of the warning circuits. During the self test, the FCC does a 2-second test. It then sends a signal to the other FCC which waits 2 seconds and then does its test. If FCC B does not get the test signal, but it should, it waits 10 seconds and then does its own test.

The FCC A sends a warning to the captain ASA. The FCC B sends a warning to the first officer ASA. If one FCC detects the warning, it sends the warning to the other FCC. Therefore, both FCCs send the warning to their ASAs even if only one FCC detects the warning.



DFCS - FUNCTIONAL DESCRIPTION - A/P AMBER LIGHTS

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DFCS - FUNCTIONAL DESCRIPTION - A/P ILS DEVIATION WARNING

General

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The FCC supplies a warning to the DEUs when the airplane is on an ILS approach and it moves too far away from the ILS path. The localizer and glideslope scales change color from white to amber. The pointers flash at a 4 Hz rate.

HAP 037

The FCC supplies a warning to the DEUs when the airplane is on an ILS or GLS approach and it moves too far away from the glide path. The localizer and glideslope scales change color from white to amber. The pointers flash at a 4 Hz rate.

HAP ALL

FCC A supplies the deviation warning when it is in the command mode. FCC B supplies the warning if it is the only FCC in the command mode.

Localizer Deviation Warning

The localizer warning occurs if these conditions are present:

- Autopilot is in the approach-on-course mode
- A/P A or A/P B is in command mode
- Localizer mode is active
- APP mode selector switch is set
- Radio altitude is less than 1500 feet for 3 seconds
- Local FCC should supply the warning
- Localizer deviation exceeds 0.293 degree limit.

If the other FCC finds that the warning should be set and it is not, it sets the warning after 7 seconds.

Glideslope Deviation Warning

The glideslope warning occurs if these conditions are present:

- Autopilot is in the approach-on-course mode
- A/P A or A/P B is in command mode
- Glideslope mode is active
- APP mode selector switch is set
- Radio altitude is less than 1500 feet for 3 seconds
- Local FCC should supply the warning
- Glideslope deviation exceeds 0.35 degree limit below glideslope.

The warning will not occur if the airplane is below 100 feet. If the warning occurs and the airplane passes below 100 feet, it will stay on below 100 feet.

If the other FCC finds that the warning should be set and it is not, it sets the warning after 7 seconds.

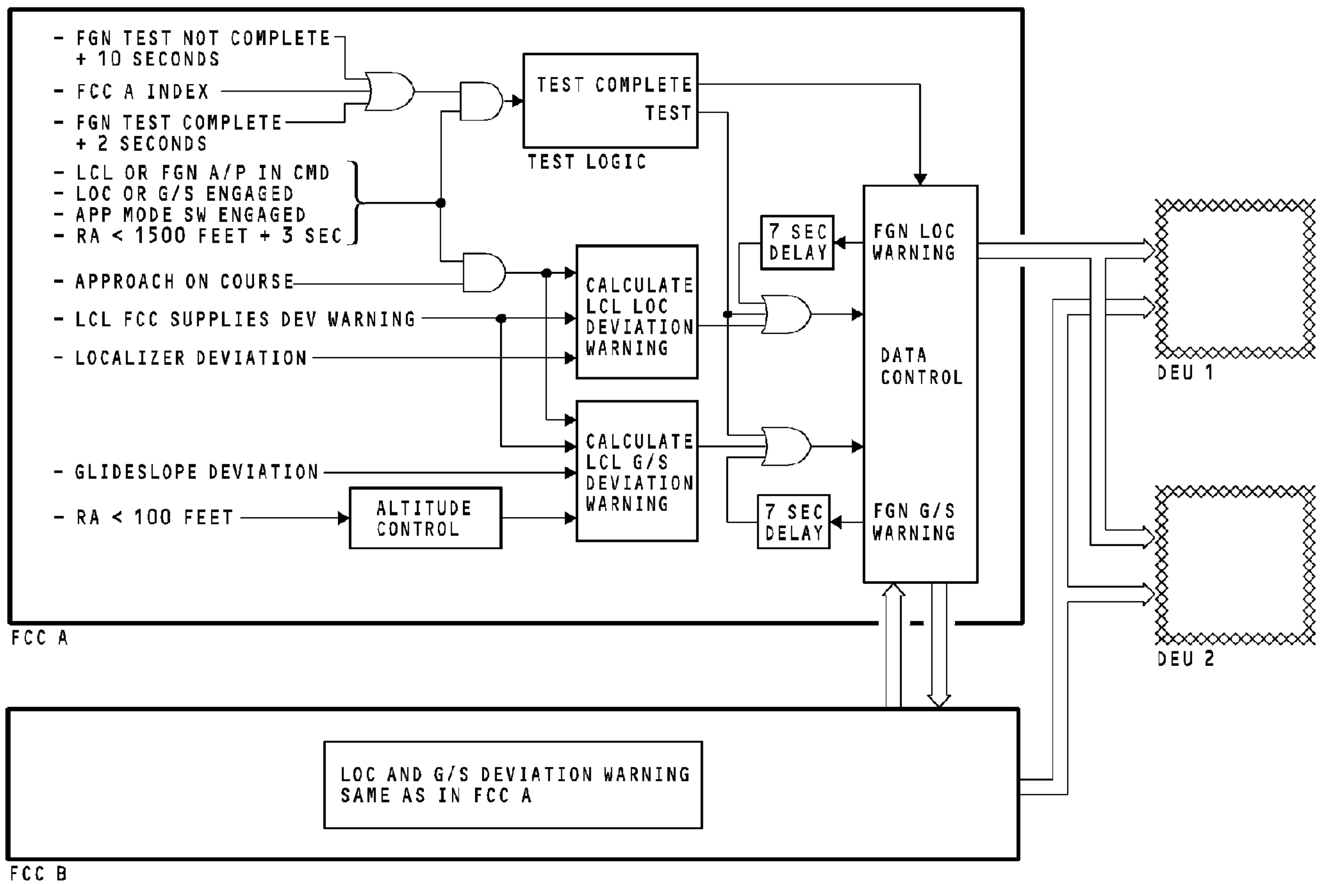
ILS Deviation Warning Test

The FCC does a test to show the crew that if a warning occurs, it shows on the CDS. The display for the test is the same as the warning display. FCC A starts the test. It will occur if these conditions are present:

DFCS - FUNCTIONAL DESCRIPTION - A/P ILS DEVIATION WARNING

- A/P A or A/P B is in command mode
- Localizer or glideslope is engaged
- APP mode selector switch is set
- Radio altitude is less than 1500 feet for 3 seconds.

The test lasts for two seconds. A test complete signal goes to FCC B. After a two-second delay, FCC B starts the test. If FCC B does not get the test complete signal from FCC A, it starts it own test 10 seconds after it finds the above conditions.



DFCS - FUNCTIONAL DESCRIPTION - A/P ILS DEVIATION WARNING

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EFFECTIVITY
HAP ALL

DFCS - FUNCTIONAL DESCRIPTION - MCP AIRSPEED FLAGS

General

The DFCS supplies envelope command limits and annunciation for these limits:

- Alpha floor
- Gear placard
- Flap placards
- Performance limit
- VMO/MMO.

Alpha Floor

The autopilot (A/P), flight director (F/D), and autothrottle (A/T) alpha floor limit is the minimum speed available for airspeed control that will override manual speed selection or FMC commands. The limit is approximately 1.3 times the stall speed.

Gear Placard

The gear placard reversion limits the maximum speed command to the gear placard speed and controls to that speed when the gear is extended.

Flap Placards

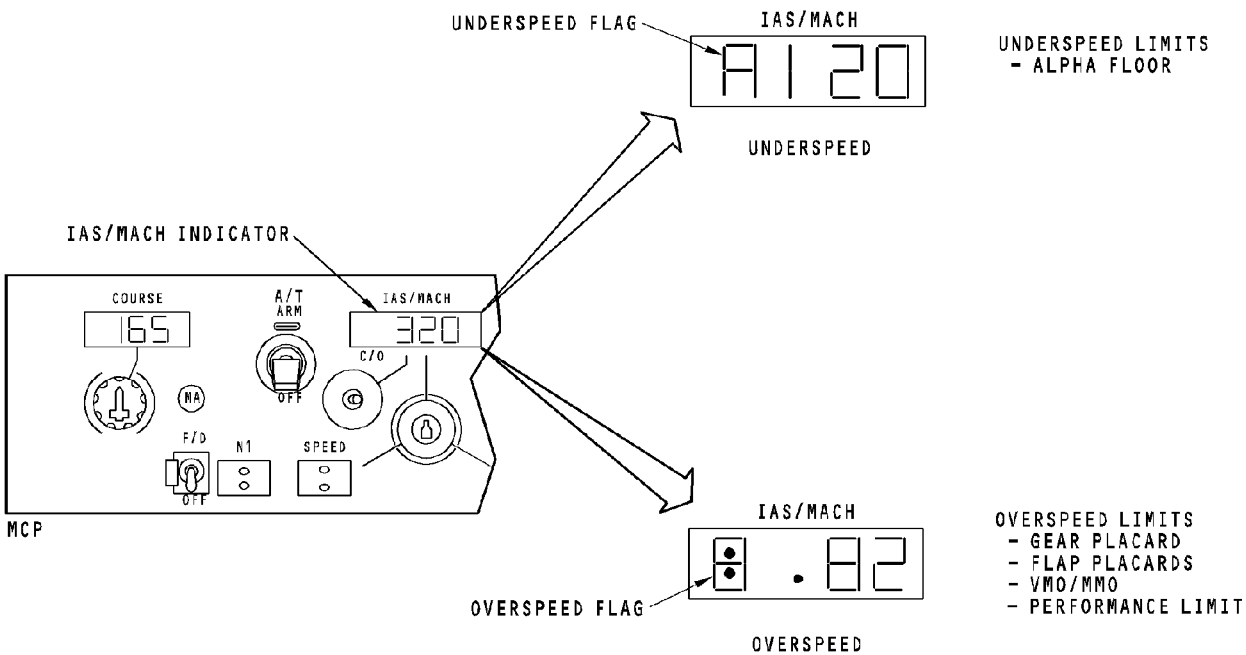
The flap placards reversion limits the maximum speed command to the flap placards speed and controls to that speed when the flaps are extended.

VMO/MMO

The VMO/MMO reversion supplies a limit to the maximum speed that the crew can select or the FMCS can control. The DFCS commands the A/T to a speed mode or engages to a speed on elevator mode when the airplane reaches the VMO/ MMO speed.

Performance Limit

The DFCS only enables the performance limit reversion when in VNAV PATH operation. For VNAV PATH descent, the performance limit reversion causes the mode to change to level change as a result of an FMC reversion request discrete. This request is to prevent the airplane from exceeding any speed constraints.



DFCS - FUNCTIONAL DESCRIPTION - MCP AIRSPEED FLAGS

22-11-00-077

DFCS - FUNCTIONAL DESCRIPTION - MCP ALTITUDE WINDOW WARNING

General

The DFCS supplies an altitude window warning when one of these conditions occurs:

- The altitude in the FCC memory changes without any change of the altitude selector
- The altitude in the FCC memory does not agree with the value in the MCP altitude display for five seconds.

Warning

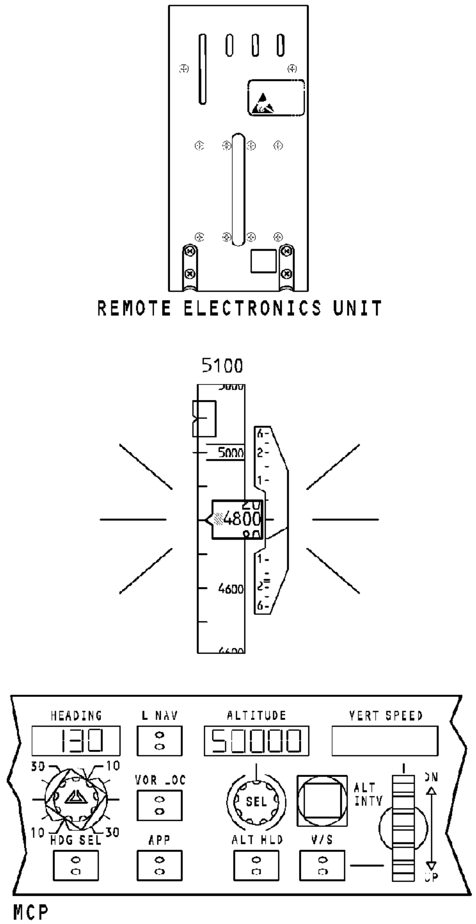
The warning that the DFCS supplies contains these items:

- The aural warning comes on for 2 seconds and then is off for 8 seconds and continues this sequence
- An amber border appears around the altitude display
- The altitude that shows in the MCP altitude display is 50,000 feet.

This warning continues until it is reset. Reset occurs if the crew turns the altitude selector or the airplane lands.

The warning does not occur if the glideslope mode is engaged or the radio altitude is less than 400 feet. However, if the warning occurs before either of these conditions occur, the warning stays until it is reset. The warning occurs on the ground if a continuous altitude selector knob motion signal is received by the FCC.

When the warning is reset, the altitude display goes to the last altitude shown plus any changes to the altitude selector that the FCC detected.



1. AURAL WARNING REPEATS
   - ON FOR 2 SECONDS
   - OFF FOR 8 SECONDS

2. AMBER BORDER AROUND THE AIRPLANE ALTITUDE DISPLAY FLASHES

3. ALTITUDE DISPLAY GOES TO 50,000 FEET

DFCS - FUNCTIONAL DESCRIPTION - MCP ALTITUDE WINDOW WARNING

22-11-00-078

DFCS - FUNCTIONAL DESCRIPTION - FLIGHT DIRECTOR COMMANDS

General

These are the flight director (F/D) functions that the FCC does:

- F/D roll control
- F/D pitch control
- F/D commands bias out of view (BOV)
- Fault detection.

Changes between F/D modes do not cause unwanted F/D commands. Changes between the A/P and F/D modes do not cause unwanted A/P or F/D commands.

F/D Names

Like the A/P, the F/D may be called one of these names:

- Channel A or channel B.
- Local (LCL) or foreign (FGN)
- Master or slave.

It is the same for the F/D as it is for the A/P, except for the master/slave relation when at least one A/P is engaged. If an A/P is engaged in CMD, it is the master.

F/D Pitch and Roll Controls

The FCC uses almost the same control laws to calculate the F/D pitch and roll commands as it uses to calculate the A/P pitch and roll commands.

The FCC does not use surface position sensor data to calculate the F/D commands because the F/D does not move the control surfaces. The F/D commands go to the DEUs to show on the common display system (CDS) instead of to the A/P actuators.

F/D Commands BOV

The autopilot disengages if a non-normal condition occurs. For flight director, the flight director commands on the CDS are biased out of view so the pilot cannot see them.

F/D Comparator

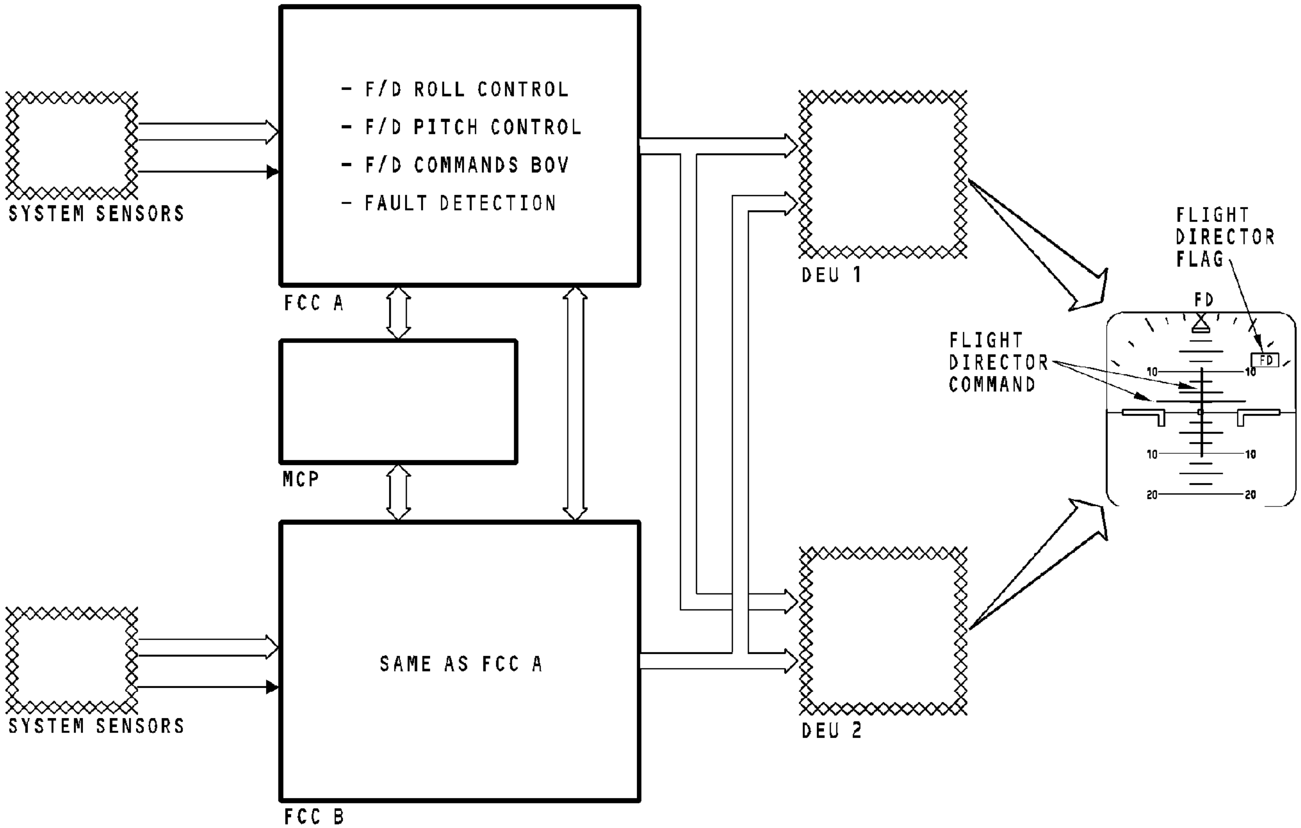
The flight director comparator operates during these conditions:

- Takeoff mode and below 400 feet
- Go around mode and below 400 feet
- Approach mode and below 800 feet.

During this time, the F/D comparator detects the F/D failures which are not detected by continuous monitoring or annunciated by a sensor valid and which could provide erroneous information to the pilot-in-command. In each FCC, this monitor compares local pitch and roll F/D commands with the corresponding cross-channel F/D commands. The local F/D only is BOV if the difference exceeds a given value.

Fault Detection

The fault detection circuit continually monitors the operation of the FCC. If it finds a failure, it sends a signal to the CDS to show the F/D flag on the attitude indicator.



DFCS - FUNCTIONAL DESCRIPTION - FLIGHT DIRECTOR COMMANDS

22-11-00-062

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DFCS - FUNCTIONAL DESCRIPTION - F/D FLAG AND BOV

General

The bias out of view (BOV) and failure warning circuits in the FCCs monitor important flight director (F/D) and FCC functions. Under certain conditions, the F/D command display on the common display system (CDS) does not show and the F/D flag shows. The FCC also selects which FCC is the master.

MCP

The MCP has two switches that turn on or off F/D A or F/D B. There is a master flight director indicator light above each F/D switch. This light shows which FCC is the master FCC.

FCC

The flight director (F/D) bias out of view (BOV) circuits monitor these items:

- Operation
- Power
- Components.

During normal conditions, the F/D commands show on the CDS when the crew turns on a F/D switch. If conditions are not normal, the F/D commands to the display electronic units (DEUs) is no computed data (NCD). The F/D roll and pitch mode BOV tables show when the F/D commands are BOV.

The FCC calculates a failure warning signal if any of these conditions exist:

- No FCC power
- Failure of internal power supply
- Loss of FCC heartbeat monitors
- Loss of F/D monitors
- Failure of servo amplifiers.

A cross channel digital bus supplies F/D commands and BOV data between the FCCs. Normally the flight directors operate independently. However, if the local power bus transfers under these condition, the switched FCC will get F/D commands from the other FCC:

- When in TO/GA at any altitude
- When in F/D approach with G/S and LOC engaged and under 800 feet.

Master FCC

With one or both autopilots in CMD, the master FCC is the autopilot first in CMD. If no autopilot is in CMD, the first F/D on is the master FCC. These are three conditions when only the F/Ds are on and both FCCs are the master:

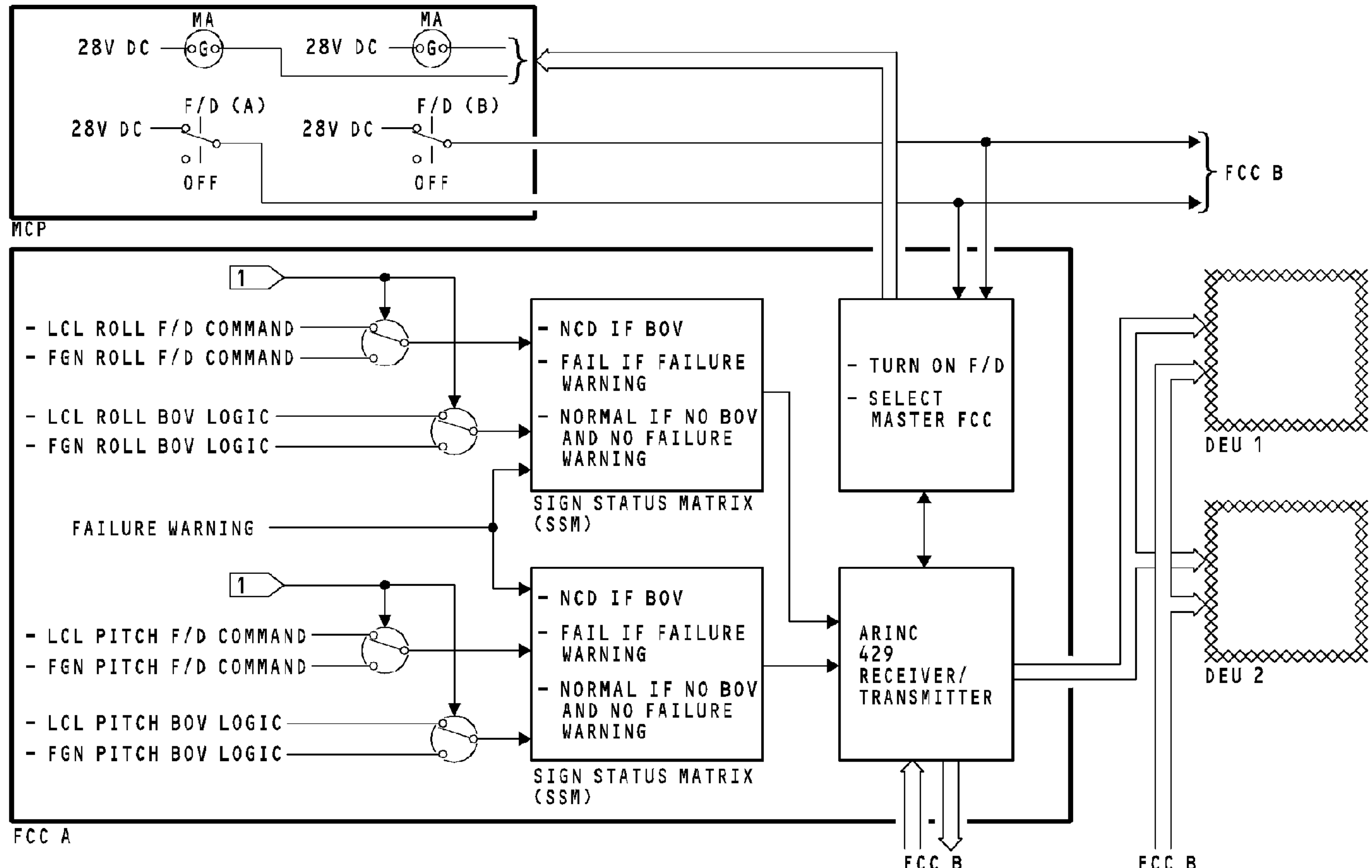
- In approach with G/S engaged and LOC capture
- In G/A with radio altitude less than 400 feet
- In T/O with radio altitude less than 400 feet.

DFCS - FUNCTIONAL DESCRIPTION - F/D FLAG AND BOV

CDS

The FCC biases the roll bar out of view if the F/D roll command is NCD. The FCC biases the pitch bar out of view if the F/D pitch command is NCD.

The failure warning signal causes the F/D flag to appear on the CDS and the F/D command to BOV.



1 LOCAL BUS TRANSFER DURING TO/GA AT ANY ALTITUDE OR DURING F/D ONLY APPROACH WITH GS AND LOC ENGAGED < 800 FT.

DFCS - FUNCTIONAL DESCRIPTION - F/D FLAG AND BOV

DFCS - FUNCTIONAL DESCRIPTION - F/D ROLL MODE BOV LOGIC TABLE

General

The table shows the conditions that cause the flight director (F/D) to bias out of view (BOV) the roll command bar.

BOV Conditions

These conditions cause the flight director to BOV:

- The roll command is BOV when the F/D is off except when the F/D is in the pop-up mode
- The roll command is BOV when the F/D is on and the crew did not set a roll mode

HAP 001-013, 015-026, 028-036, 038-054, 101-999

- The selected VOR or LOC receiver is invalid. There is an 8-second delay for the VOR signal and a 2-second delay for the LOC signal

HAP 037

- The selected VOR, LOC, or GLS receiver is invalid. There is an 8-second delay for the VOR signal and a 2-second delay for the LOC or GLS signal

HAP ALL

- The LVAV signal from the flight management computer (FMC) is invalid
- The crew tunes to a VOR frequency after localizer capture. Also the other A/P is in CMD and LOC capture, however, the local VHF navigation control panel is tuned to a VOR frequency
- The radio altimeter is invalid for more than 2 seconds and the F/D is in the LOC capture mode

HAP 001-013, 015-026, 028-036, 038-054, 101-999

- The other A/P is in CMD and VOR capture, however, the local VHF navigation control panel is tuned to a LOC frequency

HAP 037

- The other A/P is in CMD and VOR capture, however, the local VHF navigation control panel is tuned to a LOC frequency or GLS channel

HAP ALL

- The flare mode is active
- The true airspeed (TAS) is invalid
- The lateral acceleration from the ADIRU is invalid
- The magnetic track angle from the ADIRU is invalid
- The roll angle from the ADIRU is invalid
- The magnetic heading from the ADIRU is invalid
- A transfer of the IRS transfer switch to the BOTH ON R or the BOTH ON L position will BOV the F/D roll display
- An AC bus transfer with no A/P in CMD, both F/Ds are on, and above 800 feet will BOV the F/D roll display. If the transfer occurs below 800 feet, the F/D commands come from the other FCC
- The F/D comparator compares the roll commands from both F/Ds. If the difference is more than the set limit, the F/D roll display is BOV
- If the NAV transfer switch is in the BOTH ON 1 position, neither A/P is in CMD, and both F/Ds are on, F/D B will BOV. If the NAV transfer switch is in the BOTH ON 2 position, neither A/P is in CMD, and both F/Ds are on, F/D A will BOV
- An MCP bus invalid signal causes the roll F/D display to BOV. For the takeoff (T/O) and go-around (G/A) modes this occurs when below 400 feet
- The roll rate from the ADIRU is invalid.

CONDITIONS	TO	HDG	L NAV	VOR ENG	LOC ENG	APP LOC ENG	APP OC	G/A
	SELECTED MODES							
1. F/D OFF, EXCEPT IN POP UP MODE	X	X	X	X	X	X	X	X
2. F/D ON AND NO ROLL MODE SELECTED	-	-	-	-	-	-	-	-
3. SELECTED VOR OR LOC RECEIVER INVALID (VOR 8 SEC/LOC 2 SEC)				X	X	X	X	
4. LNAV INVALID			X					
5. LOC CAPTURED AND A VOR FREQUENCY IS TUNED					X	X	X	
6. RA INVALID (2 SEC DELAY) AND LOC CAPTURE					X	X	X	
7. VOR CAPTURED AND A LOC FREQUENCY IS TUNED				X				
8. FLARE							X	
9. TAS INVALID	X	X						
10. LATERAL ACCELERATION INVALID					X	X	X	
11. MAGNETIC TRACK ANGLE INVALID				X	X	X		
12. ROLL ANGLE INVALID	X	X	X	X	X	X	X	X
13. MAGNETIC HEADING INVALID	X	X						
14. IRS TRANSFER AND NEITHER A/P IN CMD AND BOTH F/D ARE ON	X				X	X	X	X
15. AC BUS TRANSFER AND NEITHER A/P IN CMD AND BOTH F/D ARE ON						[2]	[2]	
16. F/D COMPARATOR	X						[1]	X
17. VHF NAV TRANSFER AND NEITHER A/P IN CMD AND BOTH F/D ARE ON				X	X	X	X	
18. MCP BUS INVALID (5 SEC DELAY)	[3]	X	X	X				[3]
19. ROLL RATE INVALID		X	X	X	X			

[1] NEITHER A/P IN CMD AND RA < 800 FEET

[2] AC BUS TRANSFER WITH RA > 800 FEET

[3] MCP BUS INVALID WHEN RA < 400 FEET

DFCS - FUNCTIONAL DESCRIPTION - F/D ROLL MODE BOV LOGIC TABLE

DFCS - FUNCTIONAL DESCRIPTION - F/D PITCH MODE BOV LOGIC TABLE 1

General

The table shows the conditions that cause the flight director (F/D) to bias out of view (BOV) the pitch command bar.

BOV Conditions

These conditions cause the flight director to BOV:

- The pitch command is BOV when the F/D is off except when the F/D is in the pop-up mode
- The pitch command is BOV when the F/D is on and the crew did not set a pitch mode
- The foreign A/P is in CMD and G/S engaged, however, the local VHF navigation control panel is tuned to a VOR frequency
- The radio altimeter is invalid for more than 2 seconds
- The selected G/S receiver is invalid. There is a 2 second delay for the G/S signal
- This is an unsafe flight condition. The F/D is in a speed mode, the airplane should be climbing but it is not, and it approaches a stall
- This is another unsafe flight condition. The F/D is in a speed mode, the airplane should be descending but it is not, and it approaches the VMO/MMO limit
- The MCP is set for a higher altitude, however, the FMC command is V/S descent. There is a 0.5 second delay
- The MCP is set for a lower altitude, however, the FMC command is V/S climb. There is a 0.5 second delay
- The FMC target V/S is invalid.
- The autopilot is in the G/A mode, but the F/D does not go into G/A because of a failure. This causes the pitch F/D command to BOV
- The flare mode is active
- An AC bus transfer with no A/P in CMD, both F/Ds are on, and above 800 feet will BOV the F/D pitch display. If the transfer occurs below 800 feet, the F/D commands come from the other FCC
- If the NAV transfer switch is in the BOTH ON 1 position, neither A/P is in CMD, and both F/Ds are on, F/D B will BOV. If the NAV transfer switch is in the BOTH ON 2 position, neither A/P is in CMD, and both F/Ds are on, F/D A will BOV
- The pitch angle and vertical speed from the ADIRU are invalid.
- The roll angle from the ADIRU is invalid.

CONDITIONS	TO	V/S	MCP ALT ACQ	MCP ALT HLD	LVL CHG IAS	LVL CHG MAC	VNV SPD	VNV V/S	VNV ALT ACQ	VNV ALT HLD	G/S ENG	G/A
	SELECTED MODES											
1. F/D OFF, EXCEPT IN POP UP MODE	X	X	X	X	X	X	X	X	X	X	X	X
2. F/D ON AND NO PITCH MODE SELECTED	-	-	-	-	-	-	-	-	-	-	-	-
3. SELECTED LCL VOR TUNED AND FGN CMD AND G/S ENGAGED											X	
4. RA INVALID (2 SEC DELAY FOR G/S ONLY)											X	
5. G/S RECEIVER INVALID (2 SEC DELAY)											X	
6. CLB CMD, ALPHA WARN, NOT CLB MIN V/S, IN AIR (5S)					X	X	X					
7. DES CMD, VMO/MMO, NOT DES MIN V/S, IN AIR (10 SEC)					X	X	X					
8. MCP ALT CLB AND FMC V/S DESCENT (0.5 SEC DELAY)								X				
9. MCP ALT DES AND FMC V/S CLIMB (0.5 SEC DELAY)								X				
10. FMC TARGET V/S INVALID								X				
11. PITCH A/P G/A AND NOT F/D G/A												X
12. FLARE											X	
13. LCL AC BUS XFER AND NO A/P IN CMD AND BOTH F/D ON											1	
14. VHF NAV XFER AND NO A/P IN CMD AND BOTH F/D ON											X	
15. PITCH ANGLE AND VERTICAL SPEED INVALID	X	X	X	X	X	X	X	X	X	X	X	X
16. ROLL ANGLE INVALID		X	X	X				X	X	X	X	

1 AC BUS TRANSFER WHEN RA > 800 FEET

22-11-00-065

DFCS - FUNCTIONAL DESCRIPTION - F/D PITCH MODE BOV LOGIC TABLE 1

DFCS - FUNCTIONAL DESCRIPTION - F/D PITCH MODE BOV LOGIC TABLE 2

General

This table also shows the conditions that cause the flight director (F/D) to bias out of view (BOV) the pitch command bar.

BOV Conditions

These conditions also cause the flight director to BOV:

- The pitch attitude rate data from the ADIRU is invalid
- The vertical acceleration from the ADIRU is invalid
- The longitudinal acceleration from the ADIRU is invalid
- The static pressure from the ADIRU is invalid
- The true airspeed from the ADIRU is invalid
- The baro uncorrected altitude from the ADIRU is invalid
- The baro corrected altitude from the ADIRU is invalid
- The computed airspeed from the ADIRU is invalid
- The mach data from the ADIRU is invalid
- The F/D comparator compares the pitch commands from both F/Ds. If the difference is more than the set limit, the F/D pitch display is BOV
- The FMC target altitude is invalid
- The FMC target airspeed/mach is invalid
- An MCP bus invalid signal causes the pitch F/D display to BOV. For the takeoff (T/O) and go-around (G/A) modes this occurs when below 400 feet
- The flight path acceleration from the ADIRU is invalid
- If the foreign F/D pitch display is BOV and there is an AC bus transfer, the local F/D pitch display will BOV.

	SELECTED MODES											
CONDITIONS	TO	V/S	MCP ALT ACQ	MCP ALT HLD	LVL CHG IAS	LVL CHG MAC	VNV SPD	VNV V/S	VNV ALT ACQ	VNV ALT HLD	G/S ENG	G/A
17. PITCH ATTITUDE RATE INVALID	X										X	X
18. VERTICAL ACCELERATION INVALID	X				X		X				X	X
19. LONGITUDINAL ACCELERATION INVALID	X				X	X	X					X
20. STATIC PRESSURE INVALID					X	X	X					
21. TRUE AIRSPEED INVALID	X	X	X	X	X	X	X	X	X	X		X
22. BARO UNCORRECTED ALTITUDE INVALID		X	X	X	X	X	X		X	X		
23. BARO CORRECTED ALTITUDE INVALID		X	X	X								
24. COMPUTED AIRSPEED INVALID	X				X		X					X
25. MACH INVALID						X	X					
26. F/D COMPARATOR	X										X	X
27. FMC TARGET ALTITUDE INVALID									X	X		
28. FMC TARGET AIRSPEED/MACH INVALID							X					
29. MCP BUS INVALID (5 SEC DELAY)	[1]	X	X	X	X	X	X	X	X	X		[1]
30. FLIGHT PATH ACCELERATION INVALID	X											X
31. FGN F/D IS BOV AND AC BUS TRANSFERS		X	X	X	X	X	X	X	X	X		

[1] MCP BUS INVALID WHEN RA < 400 FEET

22-11-00-066

DFCS - FUNCTIONAL DESCRIPTION - F/D PITCH MODE BOV LOGIC TABLE 2

DFCS - FUNCTIONAL DESCRIPTION - ALTITUDE ALERT

General

The FCCs compare baro-corrected altitude with the selected reference altitude on the mode control panel (MCP). If the difference is within certain limits, the FCC causes an altitude alert warning.

FCC A uses the captain baro-corrected altitude from the left ADIRU and FCC B uses the First Officer baro-corrected altitude from the right ADIRU.

Altitude Alert Function

When you approach the selected altitude from above or below and are 900 feet from the selected altitude, the altitude alert starts. The alert consists of a one second aural warning and a bright white box around the airplane altitude display and the selected altitude display on the common display system (CDS). The visual warning continues until the airplane is less than 200 feet from the selected altitude.

If the airplane now climbs or descends more than 200 feet from the selected altitude, a one second aural warning occurs and a flashing amber box shows around the airplane altitude display. The visual warning stops for these conditions:

- Airplane returns to within 200 feet of the selected altitude
- You change the altitude on the MCP
- The airplanes is more than 900 feet from the selected altitude.

Altitude Alert Conditions

One FCC supplies the warning. FCC A normally gives the altitude alert warning. FCC B only gives the warning for these conditions:

- FCC A baro-corrected altitude is invalid
- Only FCC B autopilot is engaged in CMD and FCC B baro-corrected altitude is valid
- Only FCC B flight director is on and FCC B baro-corrected altitude is valid.

If the FCC captures the glideslope or the crew lowers the flaps more than 20 degrees, the FCC does not give the altitude alert warning.

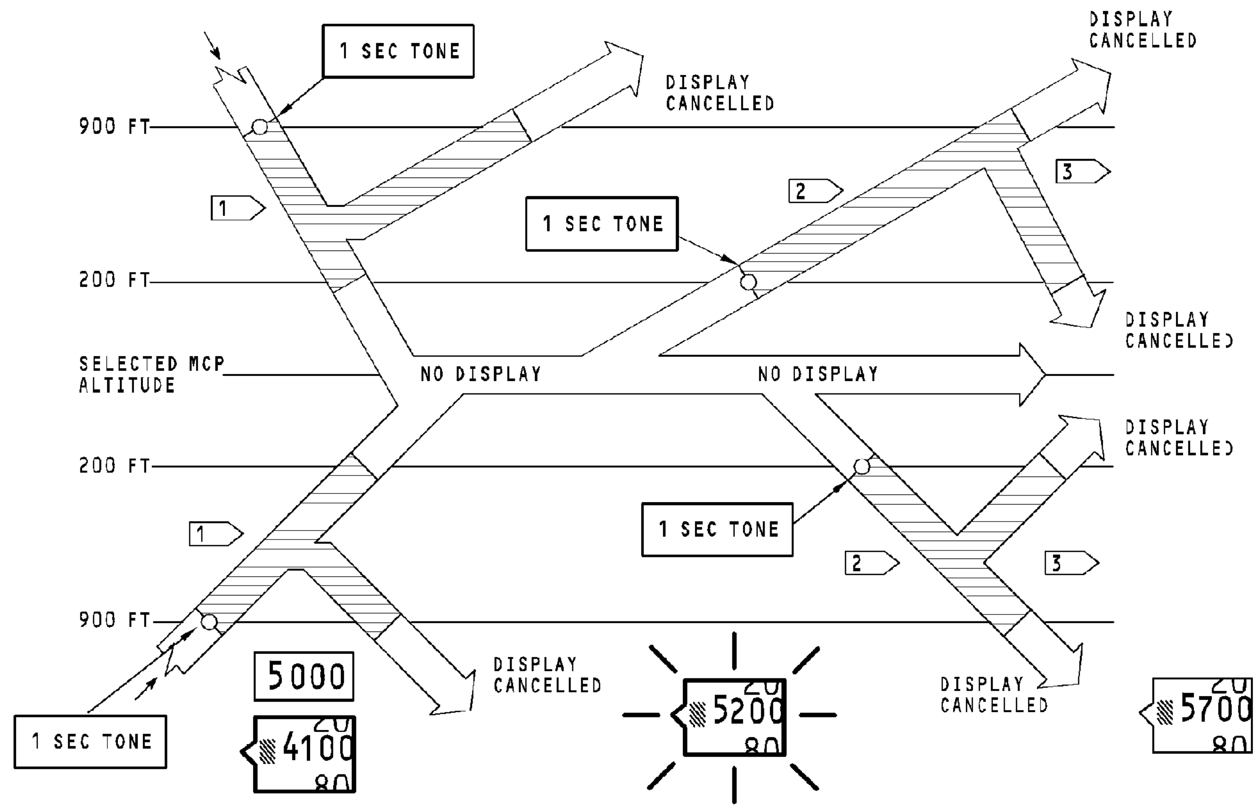
Loss of Baro-Corrected Altitude

If the baro-corrected altitude in both FCCs is invalid and the airplane is in the air, these events occur:

- The referenced altitude and its display on the MCP goes to 50,000 feet
- The visual warning display on the CDS flashes
- A single aural warning occurs.

The crew cannot change the selected altitude display, but if they turn the altitude select knob, the visual warning stops.

If one of the FCC baro-corrected altitudes becomes valid, the altitude alert warning stops and the crew can change the selected altitude on the MCP.



1 THE WHITE BOX SHOWS AROUND THE AIRPLANE ALTITUDE DISPLAY AND THE SELECTED ALTITUDE

2 THE AMBER BOX SHOWS AROUND THE AIRPLANE ALTITUDE DISPLAY AND FLASHES

3 THE AMBER ALTITUDE ALERT DISPLAY IS REMOVED WHEN A NEW ALTITUDE IS SELECTED

DFCS - FUNCTIONAL DESCRIPTION - ALTITUDE ALERT

DFCS - FUNCTIONAL DESCRIPTION - SPEED/AUTOPILOT TRIM BLOCK DIAGRAM

General

The speed trim system gives automatic stabilizer trim for positive speed stability during low-speed high-thrust conditions. The speed trim is only operational when the autopilot is not engaged.

The air data inertial reference unit (ADIRU) sends these signals to the FCC for speed trim calculations:

- Computed airspeed (CAS)
- Mach
- Inertial vertical speed
- Roll angle
- Angle of attack.

The display electronic units (DEU) send the engine N1 inputs to the FCC. The flap position sensors send the flap position data to the FCC. The radio altimeters send altitude data to the FCC. The FCC calculates speed trim command signals. It sends the signals through these switches to the stabilizer trim electric actuator:

- Column switching module
- A/P stabilizer trim cutout switch
- Stabilizer limit switches.

Speed Trim Stability

The speed trim controls the stabilizer to oppose any change of airspeed. An increase in CAS causes a nose up trim command to the stabilizer. A decrease in CAS causes a nose down trim command to the stabilizer. The signals from the stabilizer position sensors stop the commands when the stabilizer moves the correct amount.

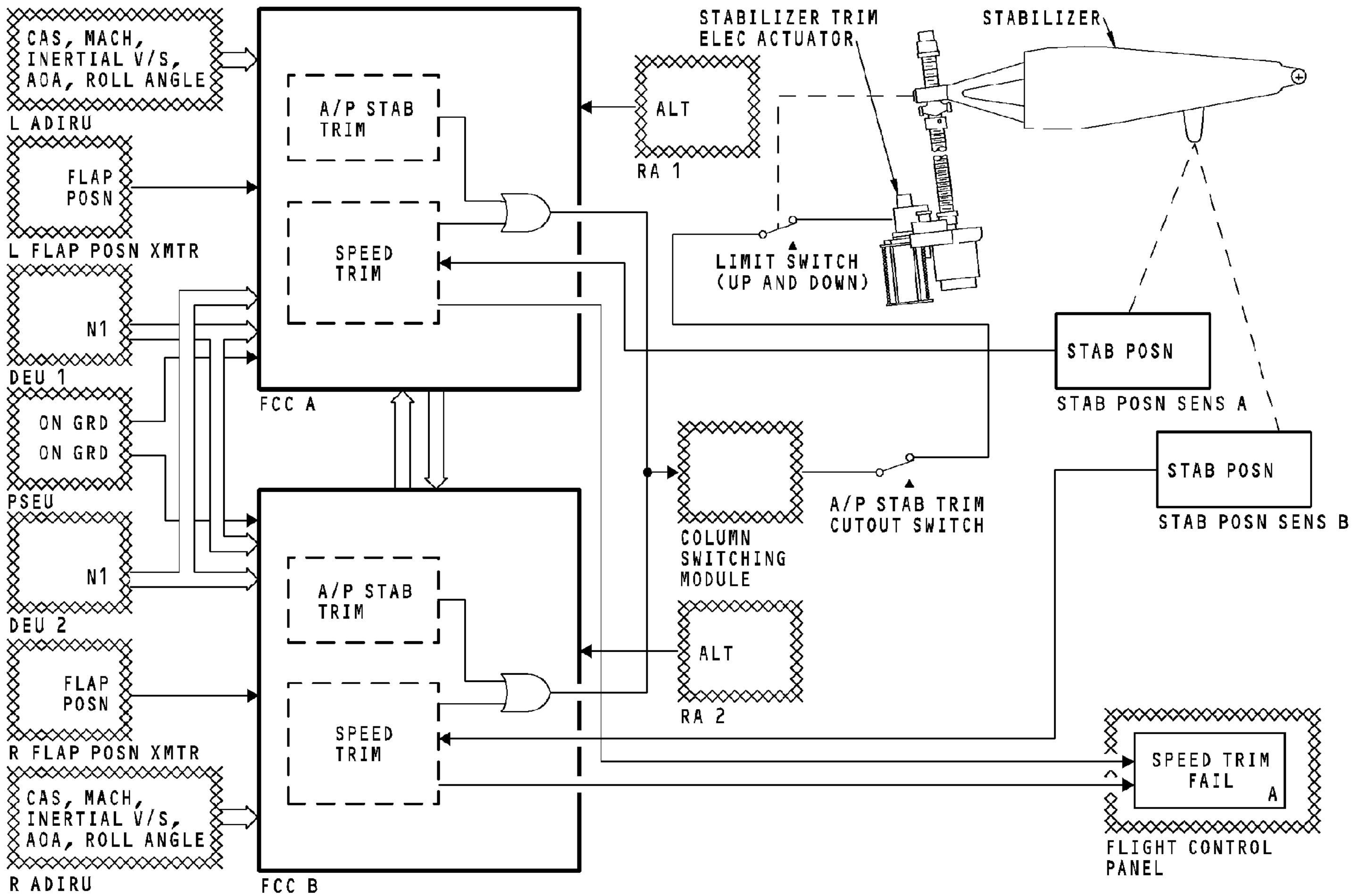
The FCC trims the stabilizer nose down as speed decreases and to allow for speed trim above the stickshaker AOA and idle thrust. When the stabilizer position reaches its limit, the trim stops. When the trim starts to exceed the aft column cutout position, the trim stops. The FCC stops the speed trim function if the roll angle is more than 40 degrees.

FCC Selection For Speed Trim

Only one FCC at a time supplies the speed trim signal to the stabilizer trim electric actuator. When the FCCs get electrical power, FCC A supplies the speed trim signals. If power remains on the FCCs, the on ground signal from the proximity switch electronics unit (PSEU) switches the FCC which supplies the speed trim signals. If one FCC fails, the other FCC automatically supplies the speed trim signal.

Speed Trim Failure Display

The speed trim fail annunciator on the flight control module will show when the speed trim function in the FCC meets certain failure conditions.



DFCS - FUNCTIONAL DESCRIPTION - SPEED/AUTOPILOT TRIM BLOCK DIAGRAM

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DFCS - FUNCTIONAL DESCRIPTION - SPEED TRIM FUNCTIONS

General

The FCC supplies these signals to do the speed trim functions:

- Speed trim nose up
- Speed trim nose down
- Speed trim reference hold
- Speed trim warning.

Speed Trim Commands

These input data and an adjustable gain control make the speed trim nose up and nose down commands:

- Stabilizer command
- Stabilizer position
- Inertial vertical speed (not used during F/D TO/GA).

The FCC uses computed airspeed (CAS) to calculate the stabilizer command signal.

This data goes through synchronizers before they are combined. The combined signals go through these components:

- Electronic switch
- Adjustable gain amplifier
- Speed trim detector.

Synchronizers

The synchronizer makes a reference signal from the input so that when speed trim starts, it compares the current value to the reference value. The synchronizers operate until conditions are met to calculate the speed trim commands and send them to the stabilizer actuator. This occurs when all of these conditions are true:

- Airplane is in the air for more than 10 seconds
- No manual electric trim for at least five seconds
- Autopilot in both FCCs is not engaged

HAP 101-999
- Flaps are down, gear is up, or CAS is less than 202 knots

HAP 001-013, 015-026, 028-054
- Flaps are down, gear is up, or CAS is less than 226 knots

HAP ALL
- Speed trim function is valid.

The airplane is in the air if the squat switch shows it is in the air or if the radio altimeter shows an altitude more than 10 feet.

The output signal from the synchronizer is the difference between the reference signal and the input signals.

DFCS - FUNCTIONAL DESCRIPTION - SPEED TRIM FUNCTIONS

Speed Trim Cutout Electronic Switch

The stall detection circuit monitors the flap position and the angle of airflow. Near stall, the speed trim function trims the stabilizer to a nose down condition to allow for trim above the stickshaker AOA and idle thrust. The trim continues until the stabilizer gets to its limits or the aft column cutout position is exceeded.

If the roll angle from the ADIRU is more than 40 degrees, it opens an electronic switch and stops the speed trim signals.

Gain Control For Adjustable Amplifier

The FCC uses these inputs to calculate the fade out gain of the output amplifier:

- Reference stabilizer position
- Average of the N1 signals from the DEUs
- Flap position
- Mach.

The gain is 100 percent for a 1.5 degree stabilizer position with flaps down or -0.75 degree stabilizer position with flaps up. The gain is zero for a -3.0 degree stab position with flaps down or a -2.5 degree stab position with flaps up. The gain is 100 percent for an average N1 more than 80 percent or zero for an average N1 less than 60 percent. The gain is 100 percent for a Mach less than 0.5 or zero for a Mach more than 0.68.

Speed Trim Detector

The detector calculates if the trim signal should be a nose up or a nose down command. It also makes sure that the signal is there for at least 0.5 seconds before it calculates the command.

Nose Up and Nose Down Commands

The speed trim nose up and nose down commands use these signals:

- Nose up or nose down signal from the speed trim detector
- Airplane is in the air for more than 10 seconds
- No manual electric trim for at least five seconds
- Autopilot in both FCCs is not engaged

HAP 101-999

- Flaps are down, gear is up, or CAS is less than 202 knots

HAP 001-013, 015-026, 028-054

- Flaps are down, gear is up, or CAS is less than 226 knots

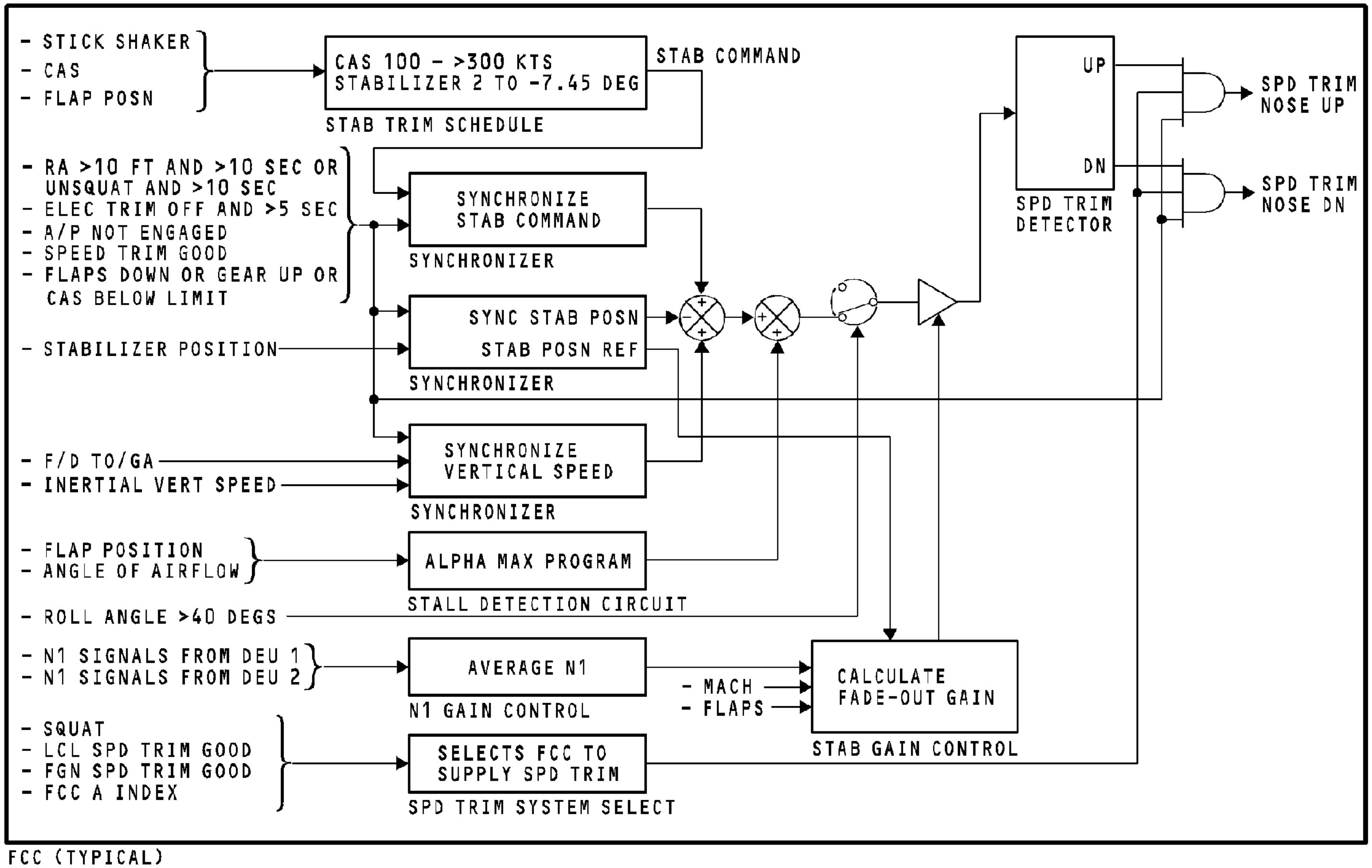
HAP ALL

- Speed trim function is valid
- FCC is selected to give the speed trim function.

Speed Trim System Selection

The speed trim select circuit looks at these signals to calculate if the FCC should control the speed trim function:

- Airplane is not on the ground
- Local and foreign FCC speed trim functions are good
- Which FCC is FCC A.



DFCS - FUNCTIONAL DESCRIPTION - SPEED TRIM FUNCTIONS

22-11-00-069

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DFCS - FUNCTIONAL DESCRIPTION - A/P STABILIZER TRIM FUNCTION

General

The FCC supplies trim signals to the stabilizer when the autopilot is engaged. The stabilizer trim function calculates these signals:

- A/P stab trim nose up
- A/P stab trim nose down.

The autopilot calculates how far it can move the elevator (elevator authority) and how far it commands the elevator to move (elevator command). If the ratio of the command to the authority is too large, the autopilot trims the stabilizer to decrease this ratio. If it did not do this, the elevator movement may reach its limit and the autopilot could no longer move the elevator in one direction.

Elevator Authority and Command

If the autopilot is in the pitch go-around (G/A) mode, the authority is 9 degrees. If the autopilot is not in the pitch go-around mode then the autopilot uses these signals to calculate the elevator authority:

- Total air pressure
- Static air pressure
- Stabilizer position.

If the flaps are between 0 and 7 degrees, the authority is limited to 3 degrees.

If the flaps are up, the autopilot uses the A/P elevator command. If the flaps are down, the autopilot uses these signals to calculate the elevator command:

- Elevator position
- Neutral shift sensor position
- Flare spring bias.

Flare Spring Bias

The flare spring bias commands the stabilizer to a nose up position. The autopilot commands the elevator to move down to hold the nose in the present attitude. If there is an autopilot disconnect, the elevators return to the neutral position. This flare spring bias then causes the airplane to pitch nose up.

These conditions must occur for the autopilot to calculate the flare spring bias:

- Airplane in dual approach mode
- Radio altitude below 400 feet
- Airplane not in pitch G/A mode.

The autopilot uses the stabilizer position and flap position to calculate the flare spring bias.

DFCS - FUNCTIONAL DESCRIPTION - A/P STABILIZER TRIM FUNCTION

Stabilizer Trim Detector

The trim detector looks at the ratio of the elevator command to the elevator authority. If the elevator command is between 10% and 25% of the elevator authority for a limited time, it supplies a trim nose up or trim nose down signal. It stops the signal when the elevator command is less than 2% of the elevator authority.

If the airplane is in the pitch G/A mode, the detector supplies a trim signal if the ratio is more than 10% for 500 out of 800 milliseconds.

A/P Stab Trim Commands

The autopilot must meet these conditions before the stab trim nose up or stab trim nose down signal from the detector becomes a trim command:

- A/P is engaged
- Airplane is not in flare
- Airplane is not in the pitch CWS out of detent mode.

When the radio altitude is less than 60 feet, the FCC does not allow a nose down command.

The stab trim nose up command also occurs for 5.5 seconds after these conditions occur:

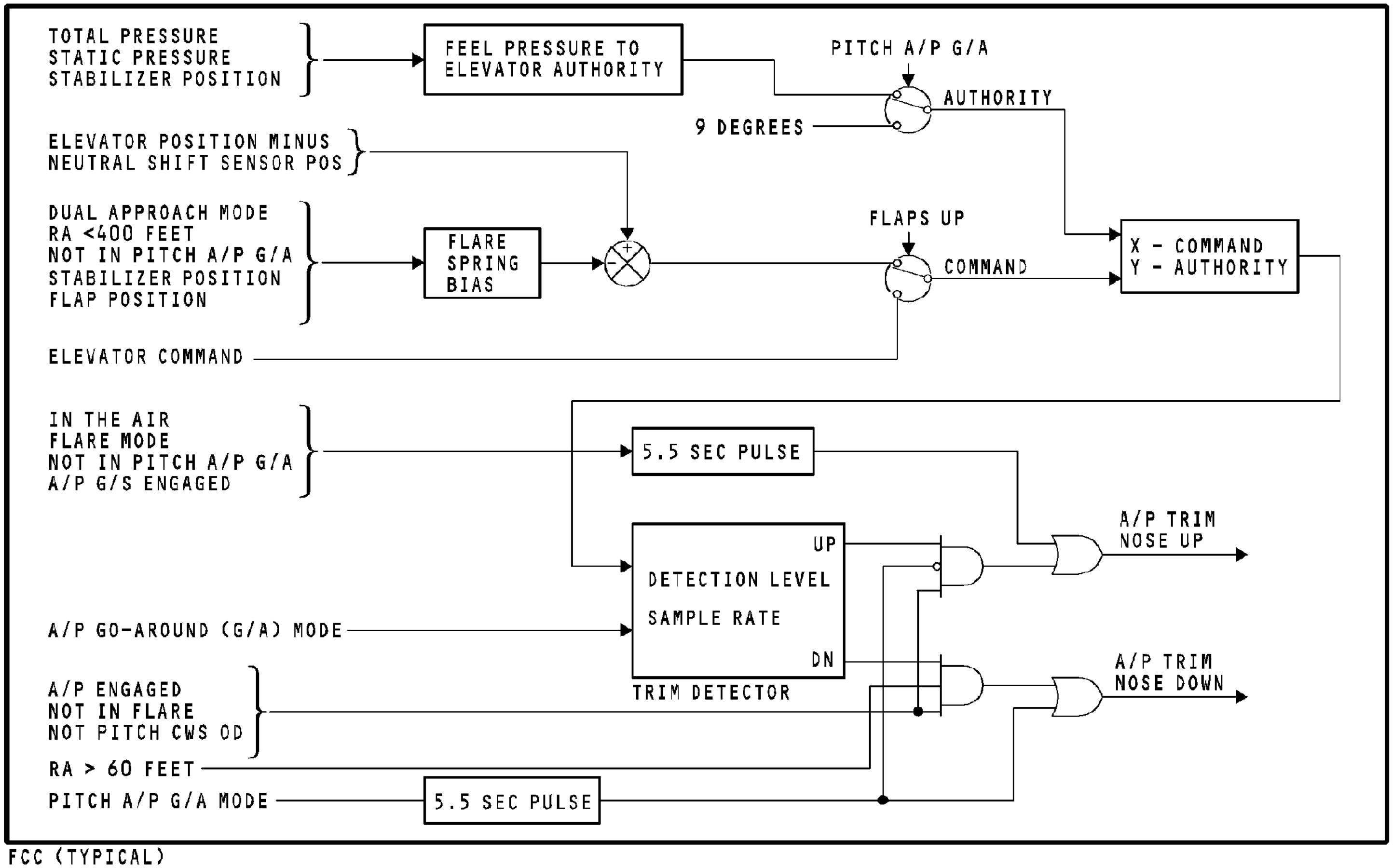
HAP 001-013, 015-026, 028-030
- Airplane is in the air and in the flare mode

HAP 031-054, 101-999
- Airplane is in the air and not in the flare mode

HAP ALL
- Airplane is not in the G/A mode
- A/P G/S is engaged.

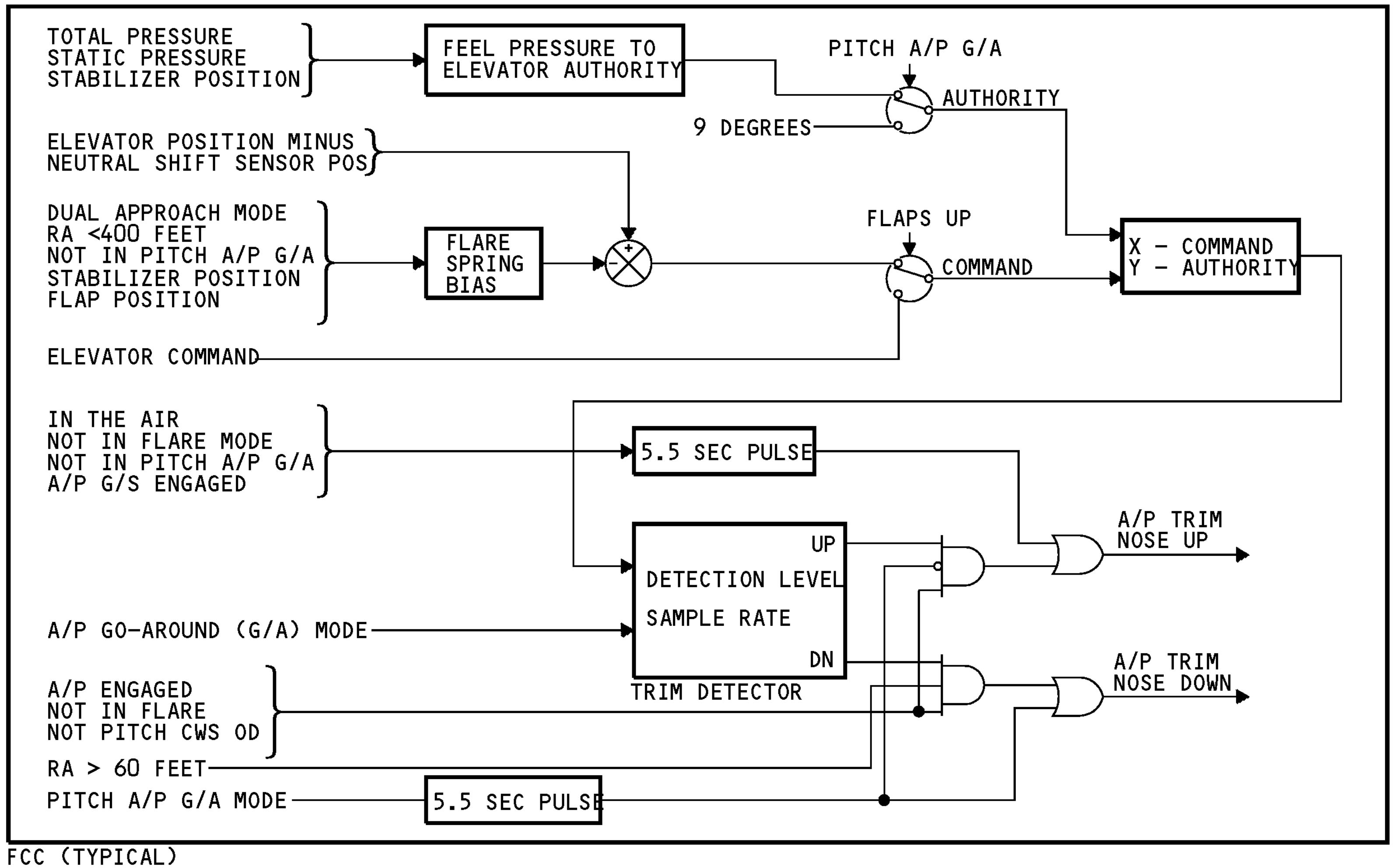
This stab trim nose up command causes the airplane to nose up as it starts the flare maneuver just before touchdown.

The stab trim nose down command also occurs from 0.2 to 5.5 seconds after the airplane is in the A/P G/A mode. Also during this time, the FCC does not allow any nose up commands.



DFCS - FUNCTIONAL DESCRIPTION - A/P STABILIZER TRIM FUNCTION

22-11-00-070



DFCS - FUNCTIONAL DESCRIPTION - A/P STABILIZER TRIM FUNCTION

DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM COMMANDS

General

The stabilizer trim system consists of these components:

- FCC A and FCC B
- Column switching module
- A/P stab trim cutout switch assembly
- Stab up and down limit switches
- Stab trim electric actuator.

FCC A and FCC B

The FCC can supply these commands:

- A/P trim nose up
- A/P trim nose down
- Speed trim nose up
- Speed trim nose down.

If the autopilot is engaged, the FCC can supply an A/P trim command. If the autopilot is not engaged, the FCC can supply a speed trim command.

The FCC makes sure that the control column is not forward before it supplies a nose up trim command. The FCC makes sure that the control column is not aft before it supplies a nose down trim command.

The FCC supplies a trim valid signal if it does not command a nose up and nose down trim at the same time.

The FCC supplies either an A/P engaged signal or the speed trim reference hold signal as a clutch signal to the stab trim electric actuator. This signal is also used as a clutch valid signal.

The FCC supplies a flaps up signal to the stab trim electric actuator.

Column Switching Module

When the main electric trim is in operation, switches in the column switching module open. This does not let the FCC clutch signal go to the trim actuator. The FCC and the main electric trim cannot control the trim actuator at the same time.

If the pilot moves the control column forward or aft, signals go to the two FCCs. These signals do not allow the FCC to supply trim commands that do not agree with the pilot.

A/P Stab Trim Cutout Switch Assembly

When the A/P stab trim cutout switches are in the cutout position, the FCC cannot control the stabilizer trim electric actuator. The 28V DC engage interlock power from the IFSAU is used to energize the cutout relay when the switch is in the cutout position. The switches open and do not let the trim commands and clutch signal go to the actuator. When the relay energizes, the 28V DC engage interlock power does not go to the FCC. This auto stab trim cutout signal tells the FCC that the switch is in the cutout position.

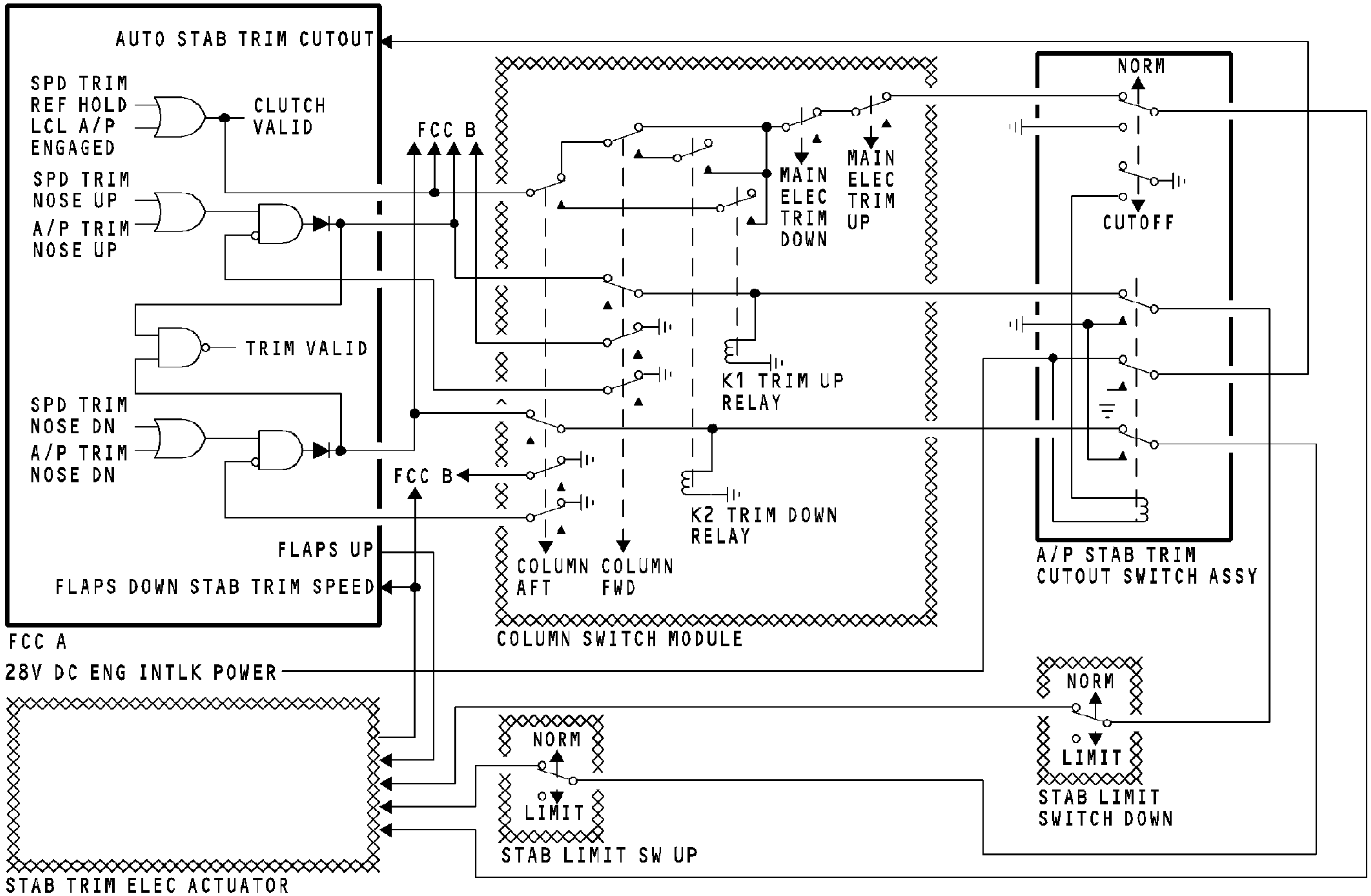
DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM COMMANDS

Stab Limit Up and Down Switches

The nose up and nose down trim commands go through the stab limit switches. If the stabilizer is out of limit, these switches will not let the commands go to the actuator.

Stabilizer Trim Electric Actuator

The trim actuator gets the trim commands from the FCC and moves the stabilizer. It sends a signal to the FCCs to tell them what speed the actuator is in. If the flaps are down, the actuator operates three times as fast as when the flaps are up.



DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM COMMANDS

22-11-00-071

EFFECTIVITY
HAP ALL

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DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM WARNINGS

General

The FCC sends a speed trim warning signal to the flight control module if it finds a failure in the speed trim function. The FCC sends a stab out of trim signal to the stab out of trim warning light if a stabilizer mistrim condition occurs.

Speed Trim Warning

The speed trim warning circuit supplies a warning signal if any of these conditions are not present:

- Air/ground sensors valid
- Stabilizer move in 10 seconds when commanded
- Engine N1s valid
- Stab trim position sensors valid
- Data from the air data inertial reference unit (ADIRU) valid
- Clutch valid and trim valid signals present.

The air/ground sensors are valid if these conditions are present:

- Engines N1s are more than 18%
- Computed airspeed (CAS) is less than 80 knots
- Angle of attack (AOA) less than 15 degrees
- The squat switch shows the airplane is on the ground.

The speed trim warning circuit also supplies a warning if the FCC commands a trim up and trim down signal at the same time.

Speed Trim Fail Warning Light

If the function fails in only one FCC, the light does not come on. However, if you push either master caution recall switch when there is one failure, the speed trim fail light comes on. If you push the master caution reset switch, the light goes off.

Stab Out Of Trim Warning

The stab out of trim warning circuit looks at these conditions and if any occur, the warning may be set:

- Stabilizer does not move in 10 seconds when commanded
- Too much A/P actuator movement for 10 seconds
- Too much elevator command for 10 seconds.

Too much actuator movement means the difference between the elevator A/P actuator position and the elevator position sensor is greater than 3 degrees. If in single channel operation, the difference between the elevator A/P actuator position and the neutral shift sensor position must be less than 0.5 degrees to reset the warning.

Too much elevator command occurs when the difference between the elevator A/P actuator position and the neutral shift sensor position plus a bias is more than 5 degrees. The bias is zero unless these conditions are present and then the bias is 3 degrees nose up:

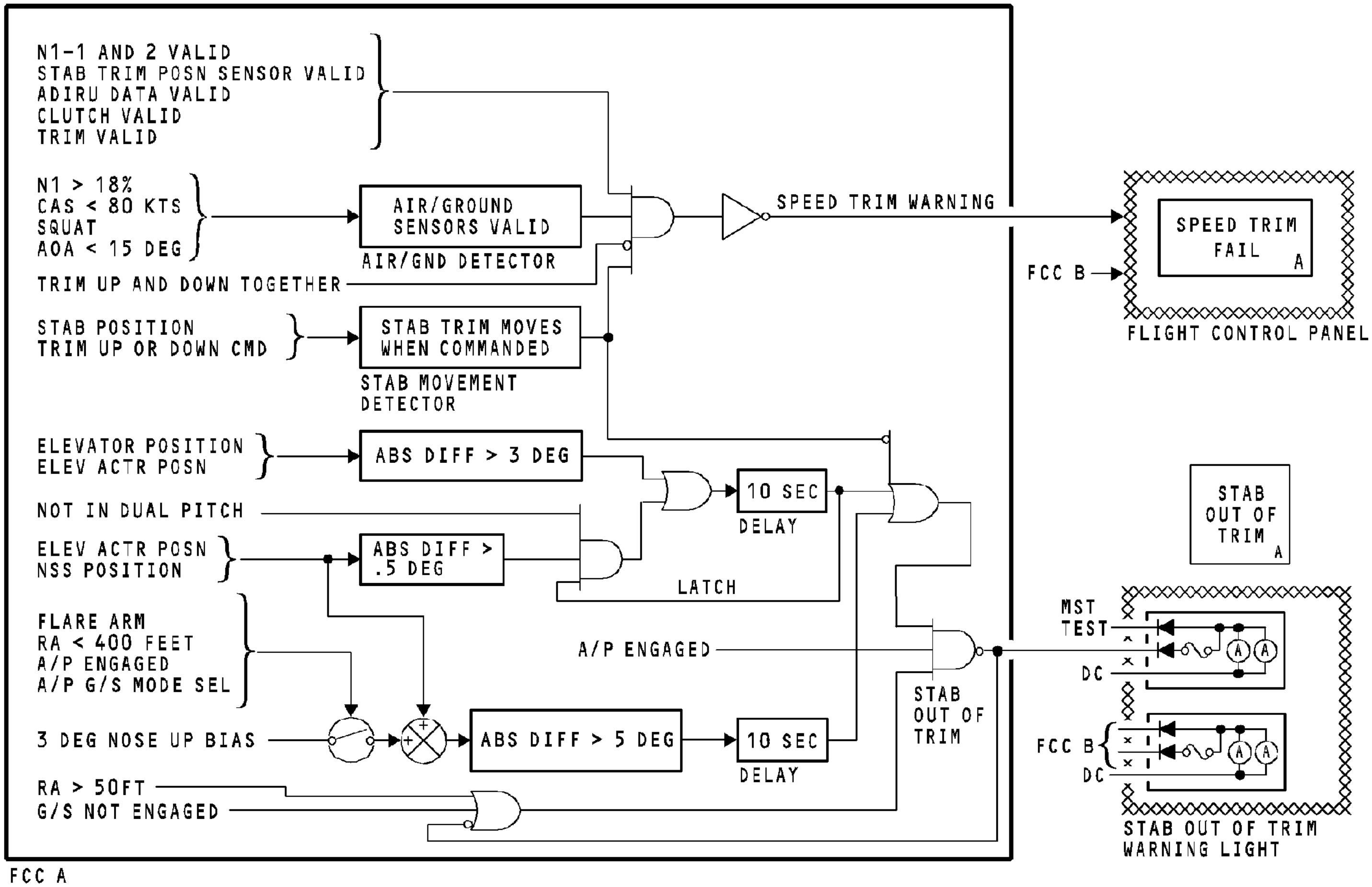
- Flare is armed
- Radio altitude is less than 400 feet

DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM WARNINGS

- A/P is engaged
- A/P G/S is engaged.

These conditions cause the stab out of trim annunciator to come on:

- Warning ready to set
- A/P engaged
- Radio altitude more than 50 feet or G/S not engaged or stab out of trim warning already set.



DFCS - FUNCTIONAL DESCRIPTION - SPEED AND STABILIZER TRIM WARNINGS

22-11-00-072

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DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM BLOCK DIAGRAM

General

HAP 101-999

The mach trim system moves the elevators to prevent a nose down maneuver at high speeds. This occurs when the speed is between Mach 0.615 and Mach 0.84. The mach trim system also moves the elevators to increase a nose up maneuver at takeoff.

HAP 001-013, 015-026, 028-054

The mach trim system moves the elevators to prevent a nose down maneuver at high speeds. This occurs when the speed is between Mach 0.615 and Mach 0.860. The mach trim system also moves the elevators to increase a nose up maneuver at takeoff.

HAP ALL

The air data inertial reference unit (ADIRU) sends the mach value to the FCC. The FCC calculates mach trim command signals. It sends the signals through the integrated flight system accessory unit (IFSAU) to the mach trim actuator. The FCC calculates the mach trim signals anytime it receives power.

The mach trim actuator is on the elevator feel and centering unit. When the actuator moves, it turns the feel and centering unit.

Autopilot Disengaged

When the autopilot is disengaged, the feel and centering unit supplies an input to the elevator power control units (PCU). This moves the elevators. A signal from the mach trim actuator tells the FCC how much it moves.

Autopilot Engaged

When the autopilot is engaged, the feel and centering unit cannot supply an input to the elevator PCUs. This is because the autopilot elevator actuators lock the elevator input torque tube. This will not let the input arms of the PCUs move. However, the mach trim actuator will turn the neutral shift sensor. The signals from the neutral shift sensor and the elevator position sensor go to the FCC. The FCC knows that the neutral shift position changes and the elevator position does not move. The FCC calculates an autopilot signal which then causes the autopilot elevator actuators to move the input to the PCUs.

FCC Selection For Mach Trim

The proximity switch electronics unit (PSEU) sends air/ground signals to the FCCs. When in the air, only one FCC supplies the mach trim signal to the mach trim actuator. FCC B controls which FCC to use and sends a signal to the IFSAU to make the selection.

DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM BLOCK DIAGRAM

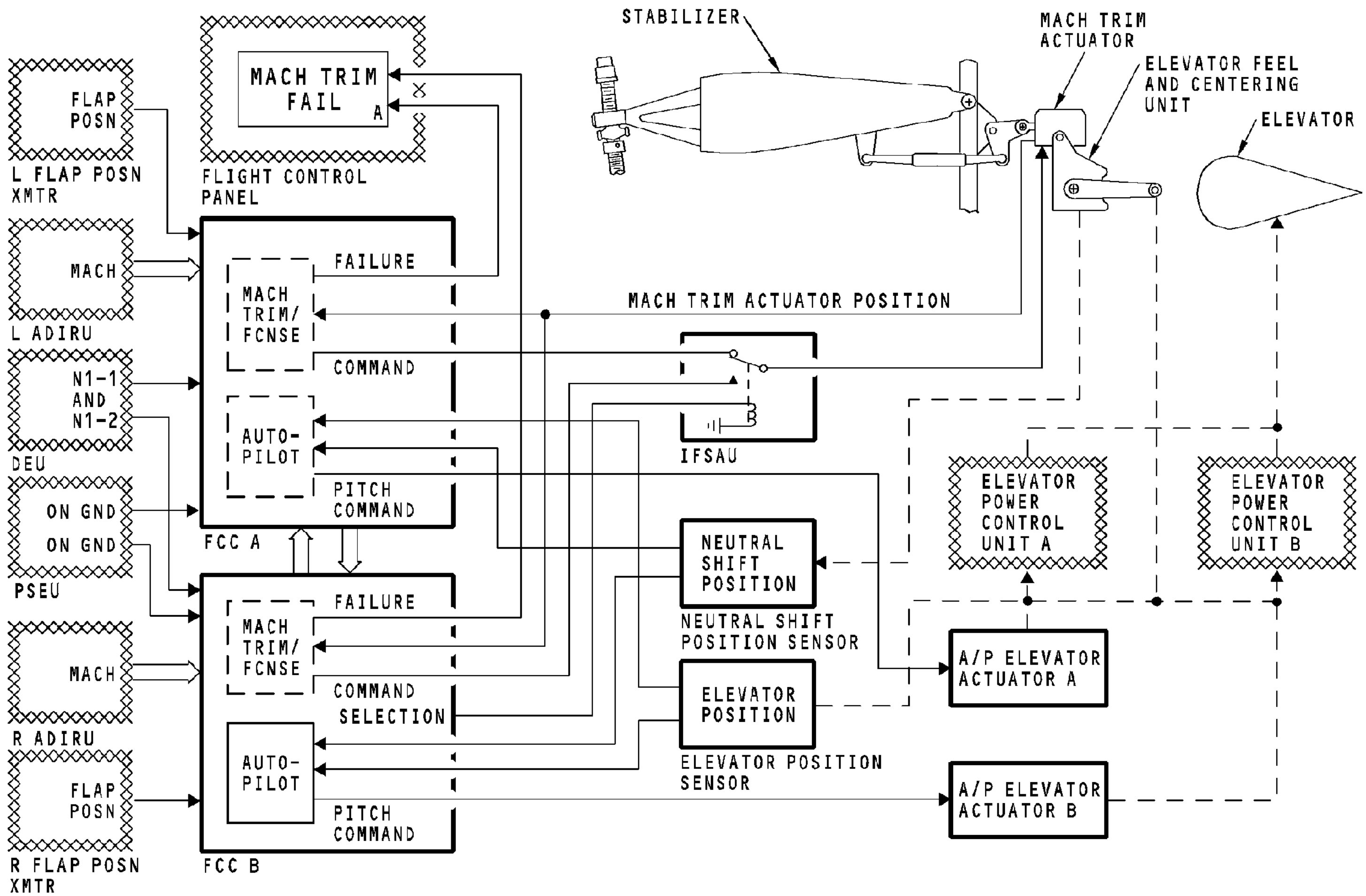
Mach Trim Failure Display

The mach trim fail annunciator on the flight control module shows when the mach trim function in the FCC meets certain failure conditions.

FCC Controlled Neutral Shift Enable (FCNSE) Function

The mach trim system also moves the elevators to do an auto neutral shift function when the airplane is in the FCNSE region. The FCNSE region is when the flaps are not up and either engine N1 is more than 18%. The movement of the elevators depends on the trailing-edge flap position and the horizontal stabilizer position.

This function allows the airplane to have a larger nose up attitude during takeoff.



DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM BLOCK DIAGRAM

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DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM FUNCTION

General

The FCC supplies these voltages and calculates these mach trim signals to operate the mach trim actuator:

- 26v ac mach trim excitation power
- 28v dc brake release power
- 115v ac motor excitation power
- Mach trim command signals
- Mach trim select signal
- Mach trim warning signal.

Mach Trim Excitation Power

The FCC power supply gets 115v ac from the electronics bus and changes this to the 26v ac, 400Hz position sensor excitation power.

Brake Release Power

The FCC supplies the 28v dc brake release power to the IFSAU if the FCC is in BITE or if it is in the FCC controlled neutral shift enable (FCNSE) region. The brake release power will stay for 20 seconds after the airplane exits the FCNSE region. The FCC also supplies the brake release power if all of these conditions are true:

- Airspeed is more than mach 0.60
- Airplane is in the air
- Mach trim select status signal is a ground
- Input 28v dc is good.

The FCC also supplies the 28v dc brake release power to the IFSAU if the airplane is in the FCNSE region. These conditions set the FCNSE region:

- Flaps not zero
- Either engine N1 more than 18 percent.

Motor Excitation Power

The FCC supplies the 115v ac motor excitation power to the IFSAU if the FCC is in BITE, in the FCNSE region or all of these conditions are true:

- Airspeed is greater than mach 0.60
- Airplane is in the air
- Mach trim select status signal is a ground
- Input 115v ac is good.

Mach Trim Commands

The FCC gets the mach from the ADIRU and calculates an elevator command from the mach speed. The FCC also gets the mach trim position signal from the mach trim actuator. The FCC compares the difference between these two signals and calculates the mach trim commands.

FCC Controlled Neutral Shift Enable Commands

The FCNSE command to the mach trim actuator does not change until one of these conditions occur:

- Manual electric trim occurs

DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM FUNCTION

- Autopilot electric trim occurs
- Flap position change occurs
- FCC enters FCNSE region because either engine N1 is more than 18 percent
- FCC exits FCNSE region because both engine N1s are less than 18 percent.

After the change occurs, the FCC calculates the new FCNSE command.

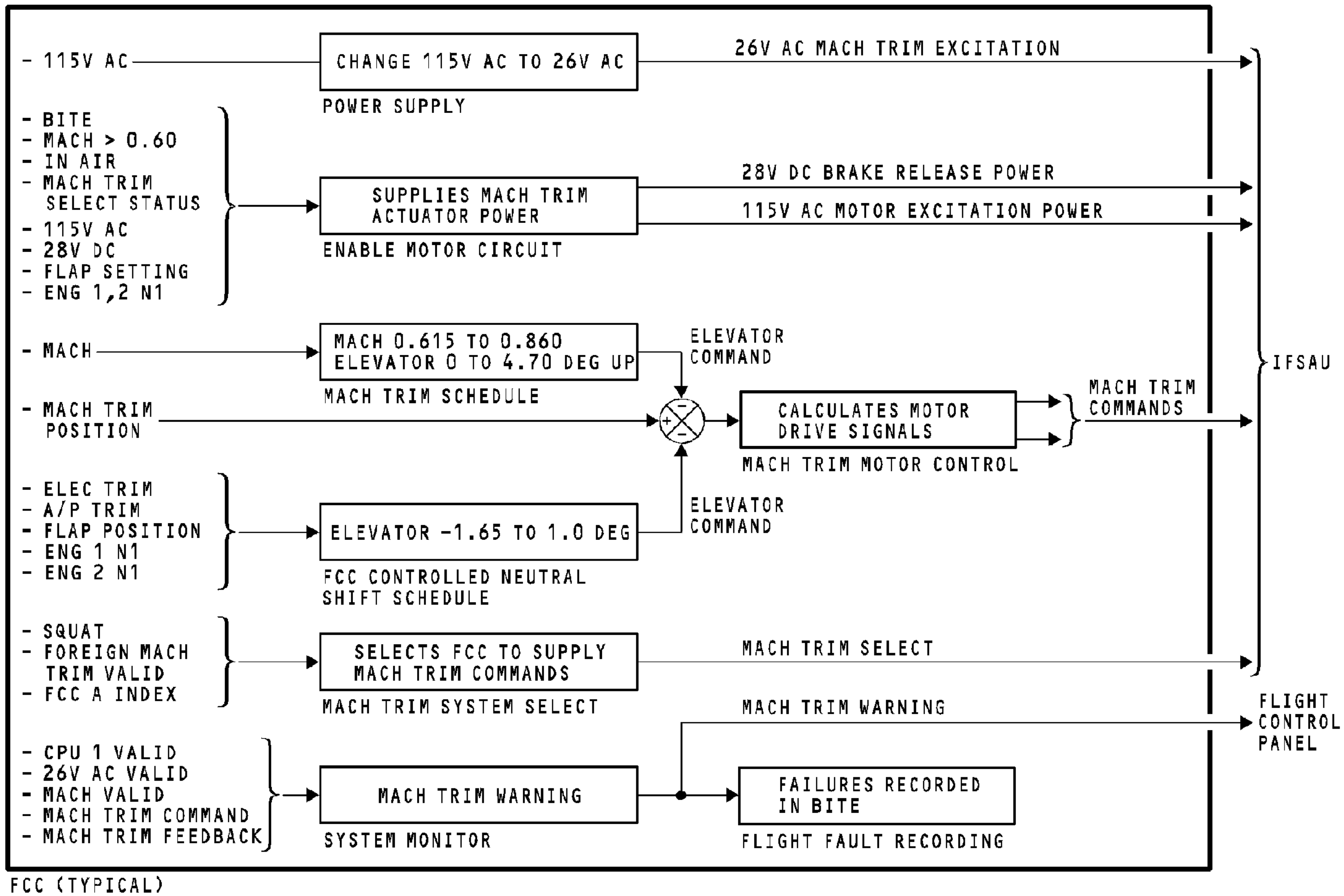
Mach Trim Select Signal

The FCC uses this data to find out which FCC should supply the mach trim signals:

- Airplane is on the ground
- Is the other, foreign, FCC good
- Which FCC is FCC A.

Mach Trim Warning Signal

If the FCC finds that the mach trim function is not good, it stores the failures in its BITE memory. It also supplies a mach trim warning signal.



DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM FUNCTION

22-11-00-074

EFFECTIVITY
HAP ALL

DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM COMMANDS

General

Both FCCs calculate the mach trim signals to control the mach trim actuator. However, only one FCC operates the actuator. The FCC also sends a mach trim warning signal to the flight control panel when the mach trim function fails in the FCC.

FCC Selection For Mach Trim Function

Both FCCs determine which FCC should supply the mach trim command signals, however, only FCC B sends the mach trim select signal to the IFSAU. In the IFSAU, K4 and K5 control which FCC supplies the mach trim signals to the actuator.

If the mach trim select signal is a high, the relays are not energized and FCC A supplies the signals. If the mach trim select signal is a low, the relays are energized and FCC B supplies the signals.

When you turn on power to the airplane, FCC A controls the mach trim actuator. If power is not turned off, each time the airplane lands, the FCCs change which FCC controls the mach trim actuator. If the mach trim function in one FCC fails, the other FCC always controls the mach trim actuator.

Mach Trim Signals

The mach trim excitation signals supplies 26v ac excitation power to the mach trim position sensor in the actuator. The sensor position signals goes directly to both FCCs.

The brake in the actuator holds the output shaft so it does not move. When the actuator receives the 28v dc brake release power, it releases the brake.

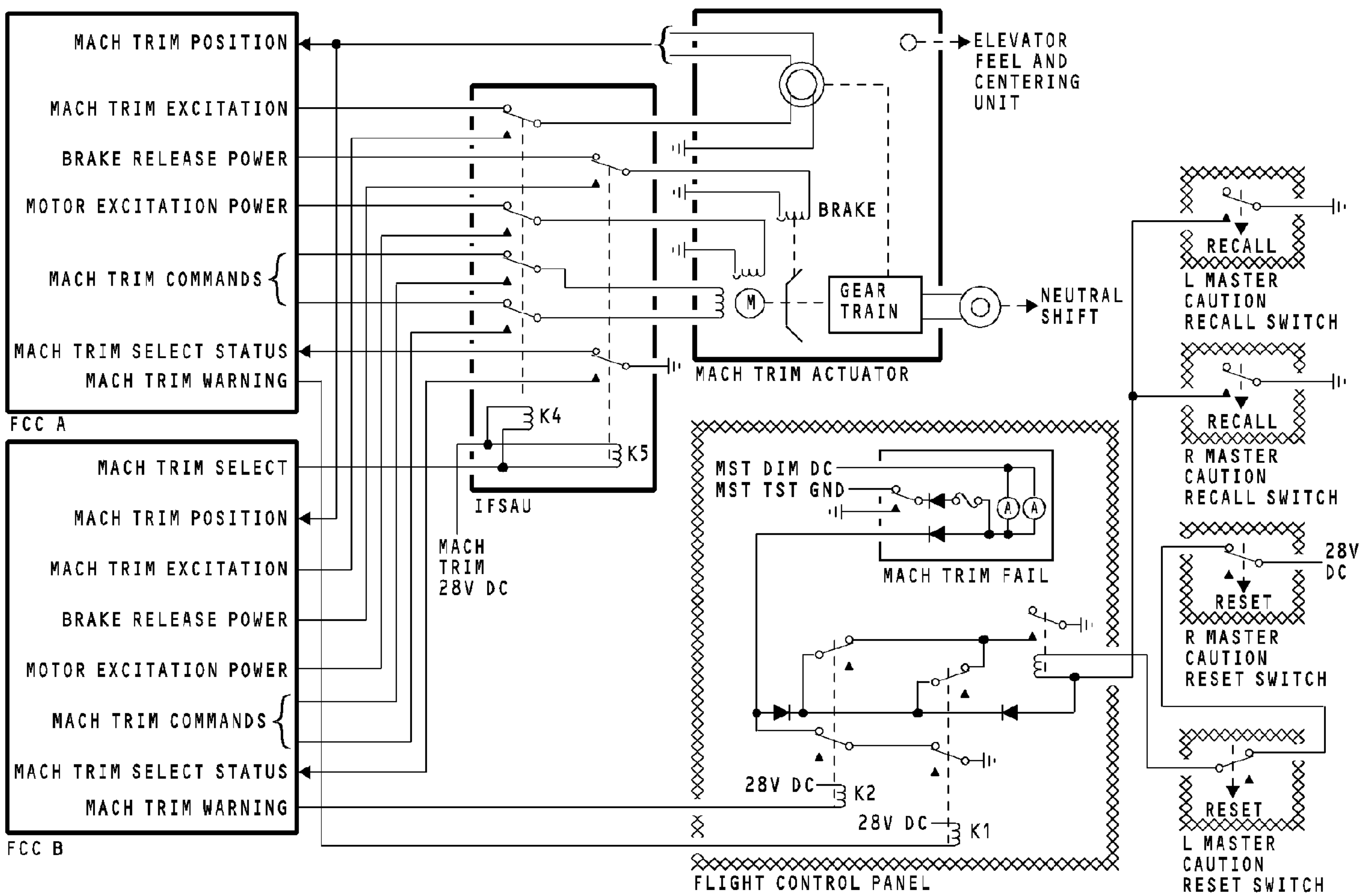
The 115v ac motor excitation power supplies the excitation signal to the actuator motor. The motor command signals can now turn the motor to drive the output arm in or out. This causes the elevator feel and centering unit and the neutral shift sensor to turn.

The mach trim select status signal in the FCC is a ground if that FCC was selected. If it is an open, the other FCC was selected.

Mach Trim Fail Warning Light

If the mach trim function in the FCC is good, it grounds its mach trim warning signal. These signals energize relays K1 and K2 in the flight control panel. The mach trim fail light does not come on. If both mach trim functions fail, both relays deenergize and the light comes on.

If only one function fails, the light does not come on. However, if you push either master caution recall switch when there is one failure, the mach trim fail light comes on. If you then push the master caution reset switch, the light goes off.



DFCS - FUNCTIONAL DESCRIPTION - MACH TRIM COMMANDS

22-11-00-075

DFCS - FUNCTIONAL DESCRIPTION - PROGRAM PIN OPTIONS

General

There are several FCC options available. The autopilot system A program switch module sets the options for FCC A. The autopilot system B program switch module sets the options for FCC B. These are your airplane options:

- Use 200/900 feet altitude limits in altitude alert option 3
- Use the airspeed warning function
- Do not permit CWS override on single channel approach

HAP 006, 007, 010-013, 015, 016, 031-037, 039, 040 POST SB 737-34-2083; HAP 001, 002, 008, 009, 017-026, 028-030, 038, 042-046, 054 POST SB 737-34-2107

- Use FAA VMO/MMO command limits in the control laws

HAP 041, 047-053, 101-999; HAP 006, 007, 010-013, 015, 016, 031-037, 039, 040 PRE SB 737-34-2083; HAP 008, 009, 017-026, 028-030, 038, 042-046, 054 PRE SB 737-34-2107

- Use JAA VMO/MMO command limits in the control laws

HAP ALL

- Use heading select as the F/D takeoff roll mode
- Inhibit GS capture before LOC capture
- Use the altitude and speed intervention functions
- Use the dual channel autopilot operation, CAT IIIA

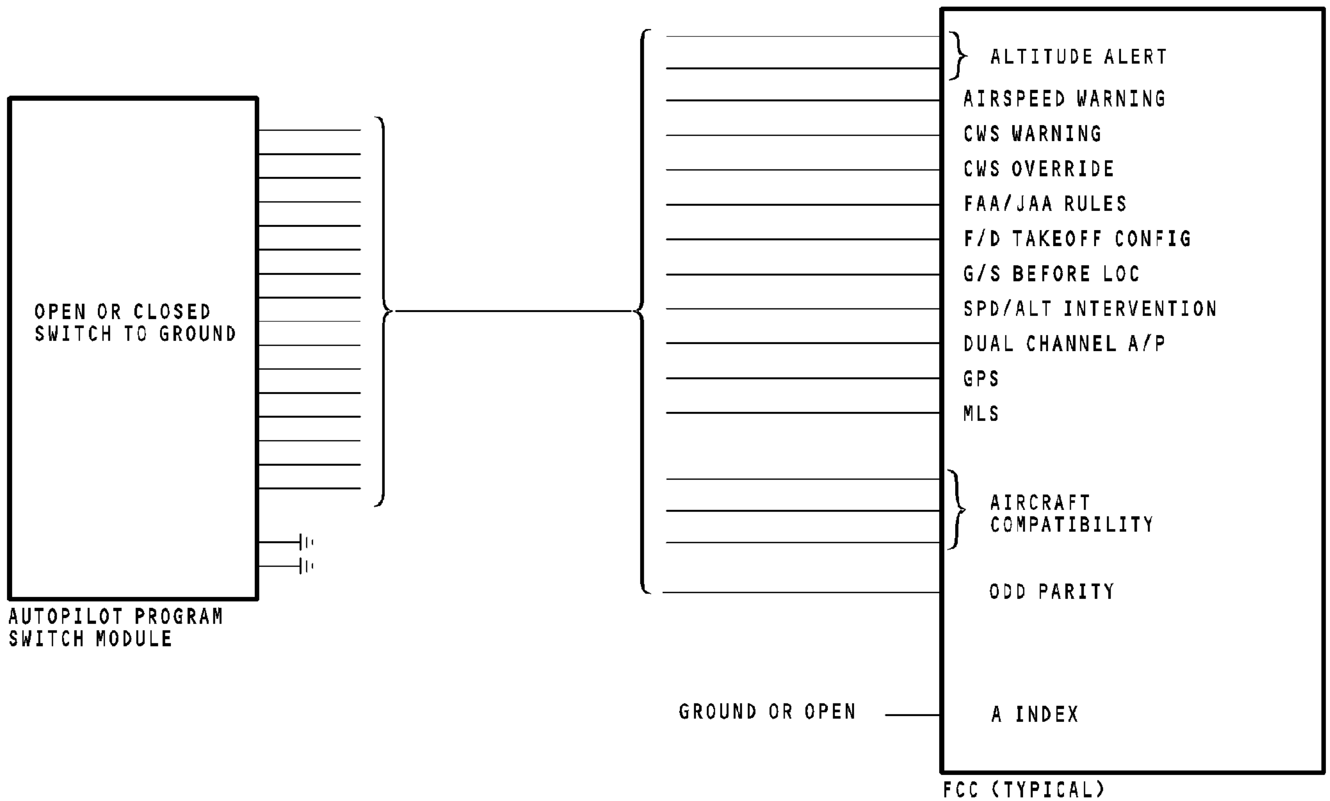
HAP 037

- The global landing system (GLS) is installed

HAP ALL

- The global positioning system (GPS) is installed
- This FCC is FCC A if open and FCC B if grounded.

You use the odd parity program pin to make the total number of pins that connect to ground an odd number.



DFCS - FUNCTIONAL DESCRIPTION - PROGRAM PIN OPTIONS

22-11-00-076

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DFCS - OPERATION - OVERVIEW

General

The DFCS calculates autopilot (A/P) and flight director (F/D) commands for these flight sequences:

- Climb
- Cruise
- Descent
- Approach

HAP 038, 042-046, 048, 051-053, 104-999

- Rollout

HAP ALL

- Go-around.

The DFCS calculates only F/D commands for the takeoff and only A/P commands for flare.

DFCS Modes

The pilots engage the A/P in CMD and turn on the F/Ds. The pilots use these mode selector switches on the MCP to select the roll and pitch modes for the flight sequences:

- Lateral navigation (LNAV)
- Vertical navigation (VNAV)
- Level change (LVL CHG)
- VHF omnirange (VOR)
- Localizer (LOC)
- Heading select (HDG SEL)
- Altitude hold (ALT HLD)
- Vertical speed (V/S)
- Approach (APP).

The takeoff/go-around (TO/GA) switches on the thrust levers can engage only the F/Ds in the takeoff mode. They can engage the A/Ps and F/Ds in the go-around mode.

The pilot can also engage an A/P in the CWS mode. The pilot can use roll and pitch CWS in these flight sequences:

- Climb
- Cruise
- Descent
- Approach.

Autoland

HAP 001-013, 015-026, 028-037, 039-041, 047, 049, 050, 054, 101-103

The autoland function consists of these three flight sequences:

- Approach
- Flare
- Go-around.

HAP 038, 042-046, 048, 051-053, 104-999

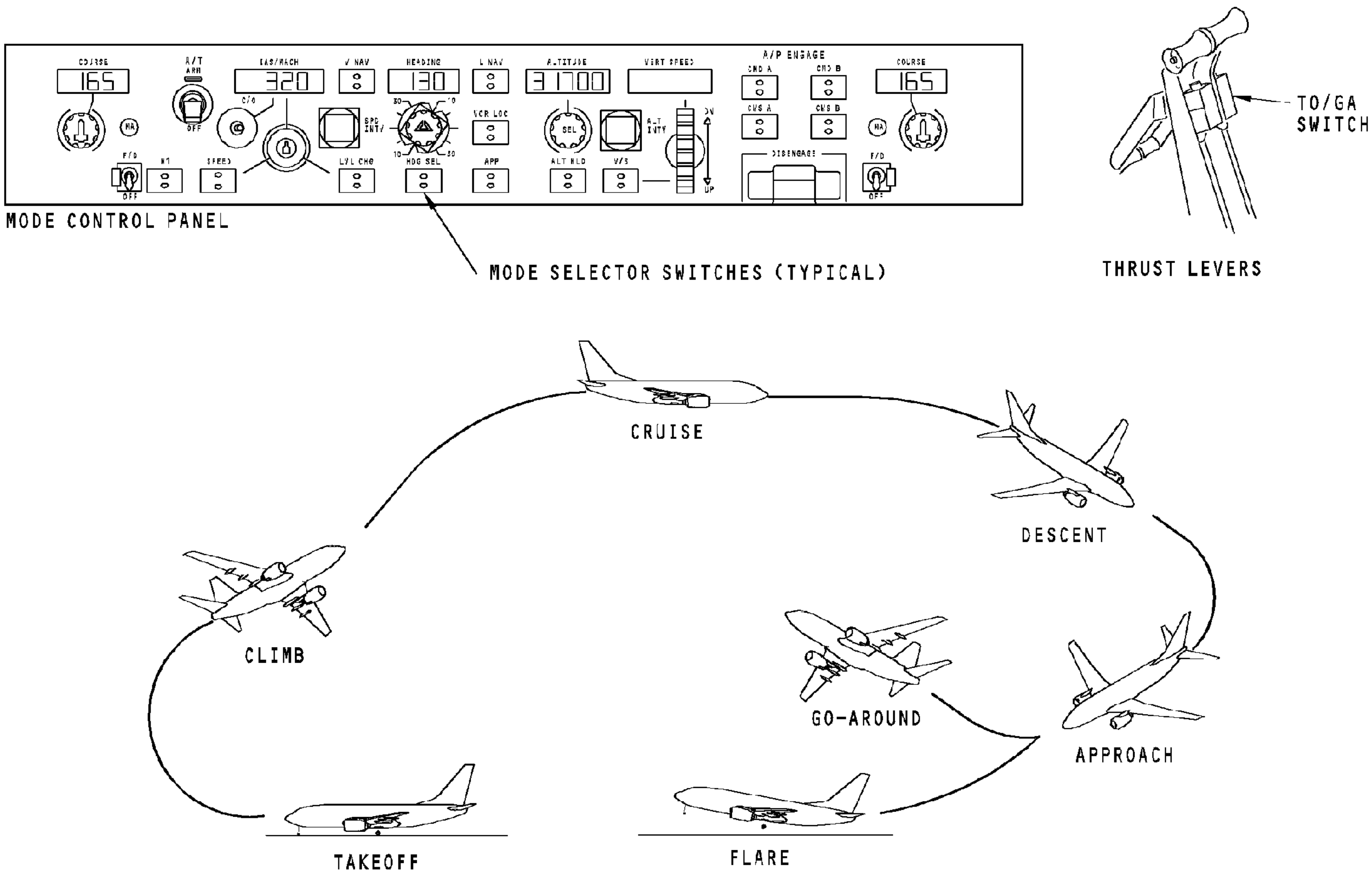
The autoland function consists of these four flight sequences:

- Approach
- Flare
- Go-around
- Rollout.

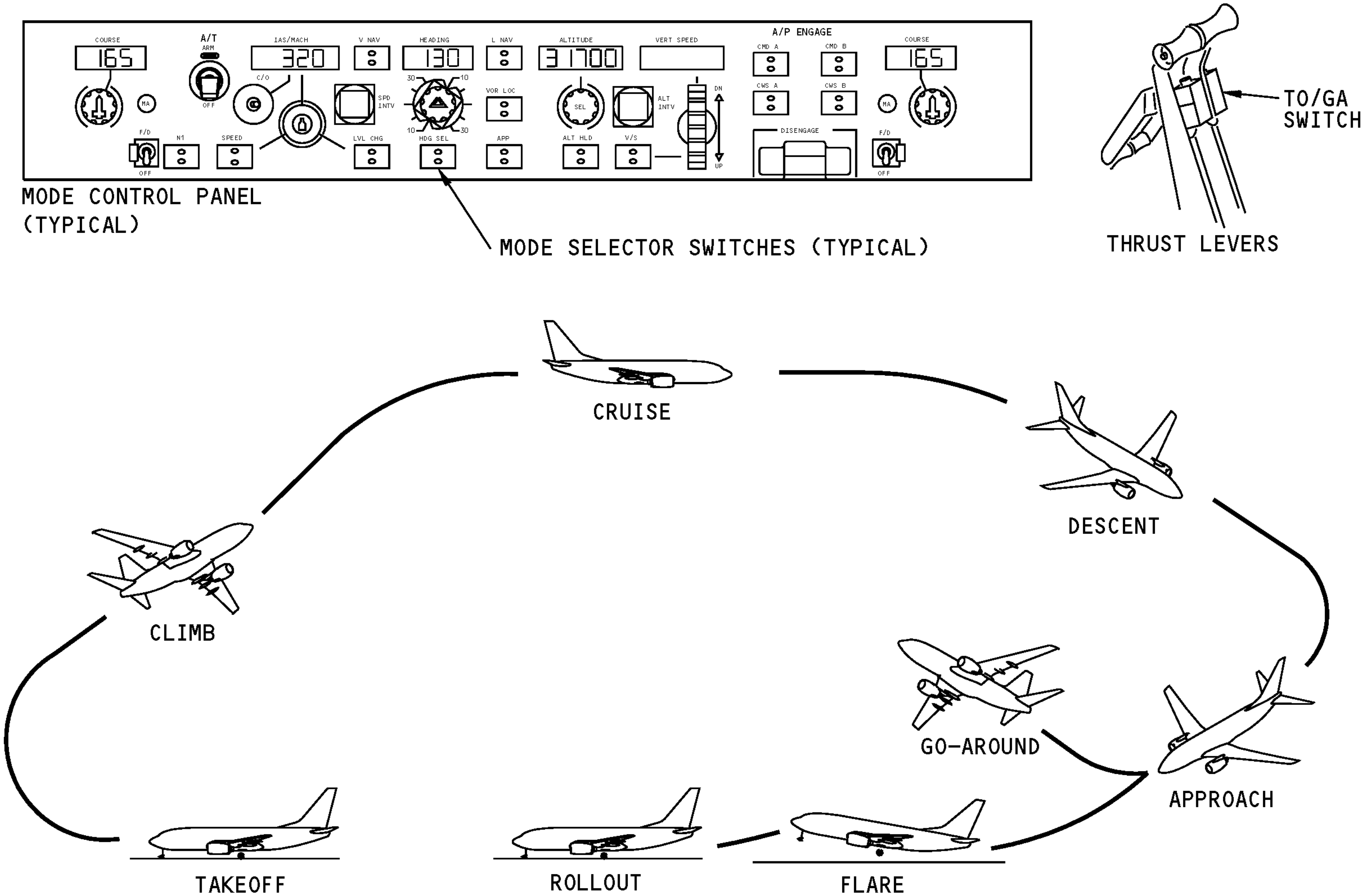
HAP ALL

DFCS - OPERATION - OVERVIEW

The DFCS will only go into autoland if the crew selects the APP mode selector switch and engages A/P A and A/P B in the CMD mode.



DFCS - OPERATION - OVERVIEW



DFCS - OPERATION - OVERVIEW

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DFCS - OPERATION - FLIGHT DIRECTOR/FLIGHT MODE ANNUNCIATOR

General

The DFCS has interface with the CDS to show these displays:

- Flight director (F/D) commands
- Flight mode annunciator (FMA)
- Selected target speed bug.

Flight Director Commands

The flight director commands show as magenta bars on the attitude indicator (AI). The F/D commands show on the AI when the F/D switches are in the ON position or if the F/Ds are in the pop-up mode.

Flight Mode Annunciator

The modes for these functions show on the top part of the PFD:

- Autothrottle
- Roll
- Pitch.

The DFCS status shows just above the attitude indicator.

Engaged modes show in green letters and armed modes show in white letters. When the DFCS engages a new mode, a green box shows around the new mode for 10 seconds.

DFCS status annunciation shows the flight crew the operating status of the DFCS. The DFCS status annunciations that show in green are CMD and FD.

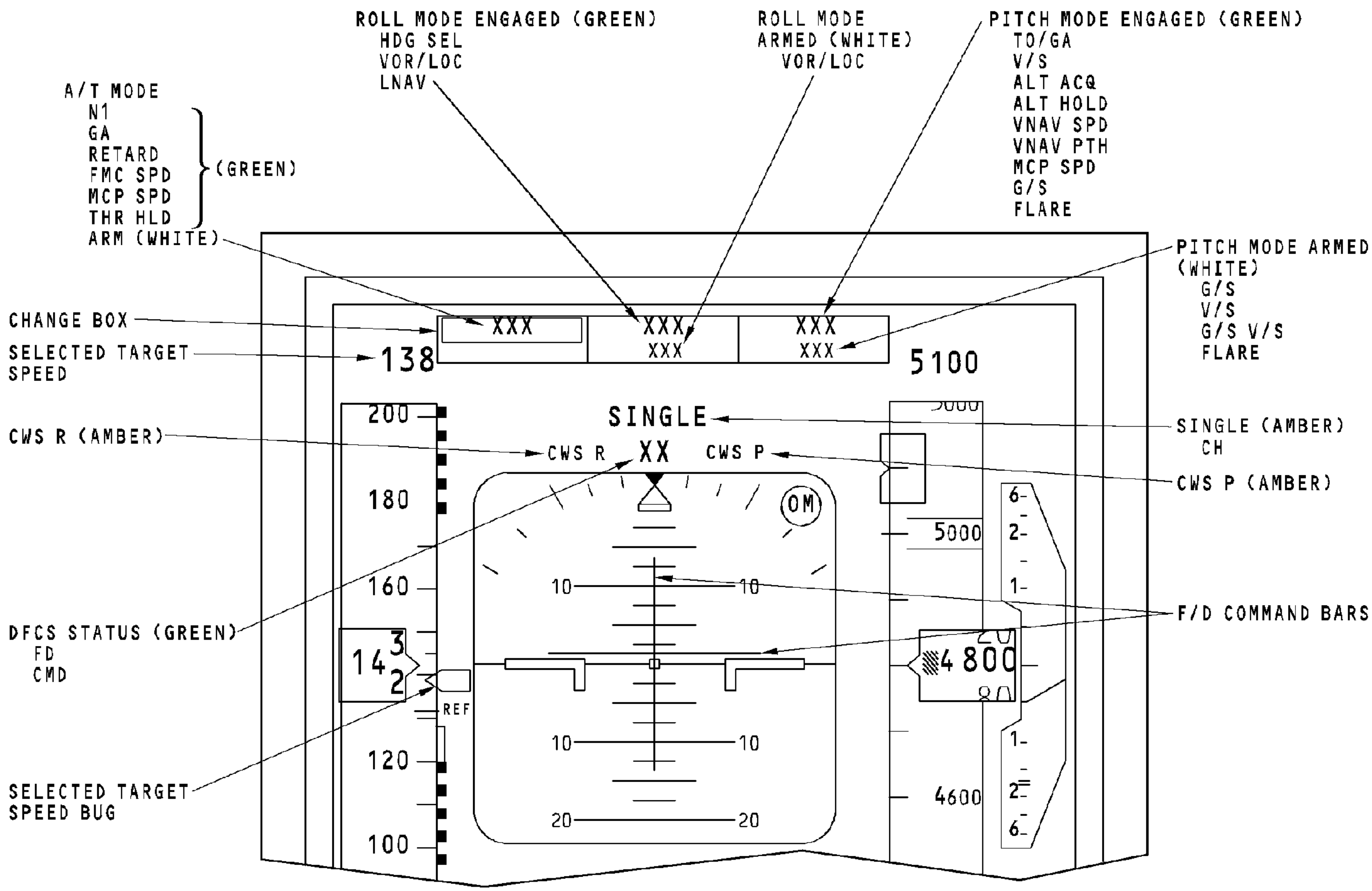
These DFCS status annunciations show in amber:

- SINGLE CH
- CWS R
- CWS P.

An amber box shows around the new CWS R, CWS P or SINGLE CH status annunciation for 10 seconds.

Selected Target Speed Bug

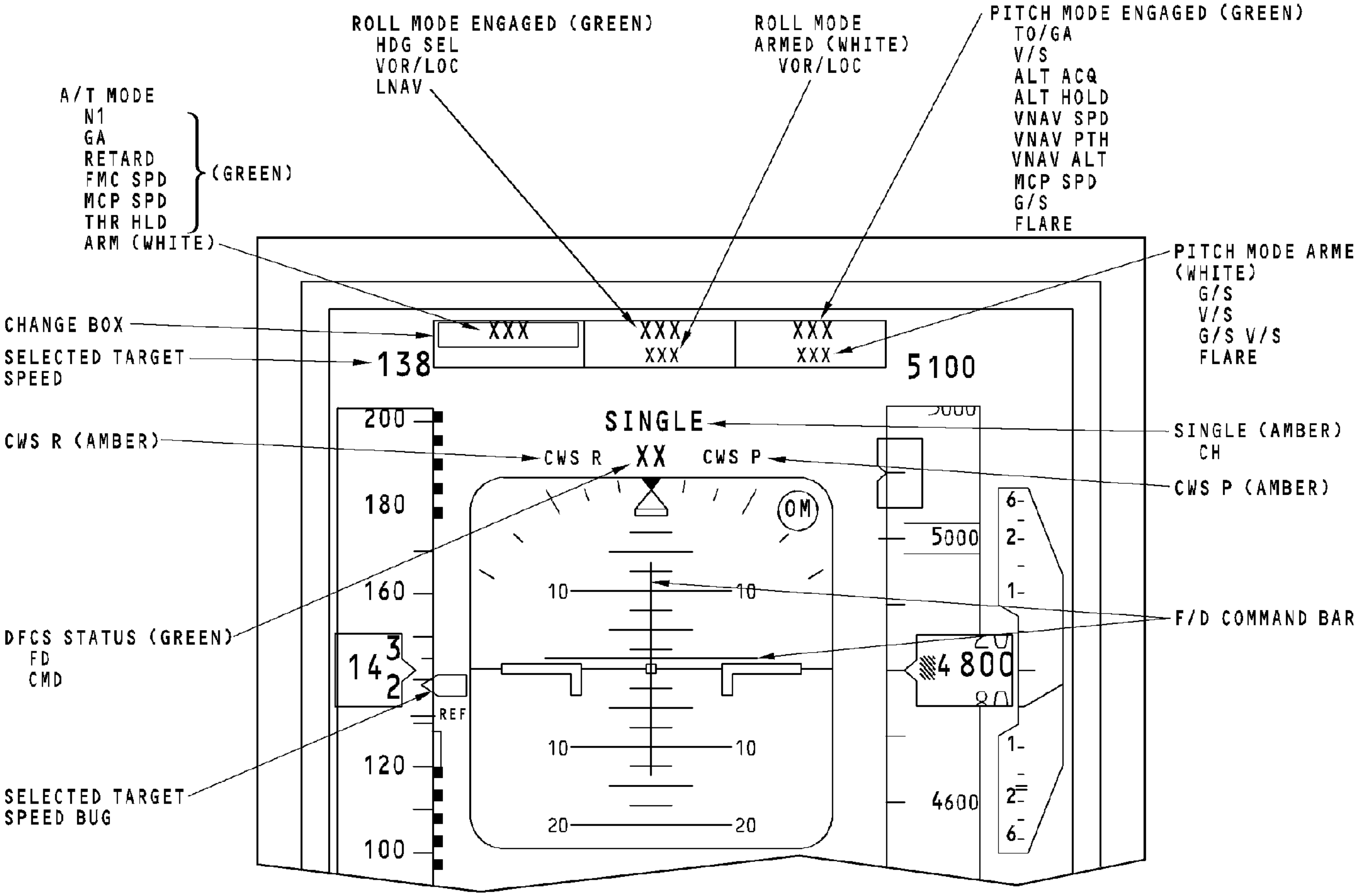
The selected target speed shows above the airspeed tape. The magenta selected target speed bug shows on the airspeed tape. The selected target speed shows the MCP speed when the MCP IAS/MACH indicator is active. It shows the FMC target speed when the indicator is blank.



DFCS - OPERATION - FLIGHT DIRECTOR/FLIGHT MODE ANNUNCIATOR

22-11-00-081

EFFECTIVITY
HAP 001-013, 015-026, 028-049, 051, 052, 101-999



DFCS - OPERATION - FLIGHT DIRECTOR/FLIGHT MODE ANNUNCIATOR

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DFCS - OPERATION - ALTITUDE DATA

General

The DFCS has interface with the CDS to show this information on the PFD:

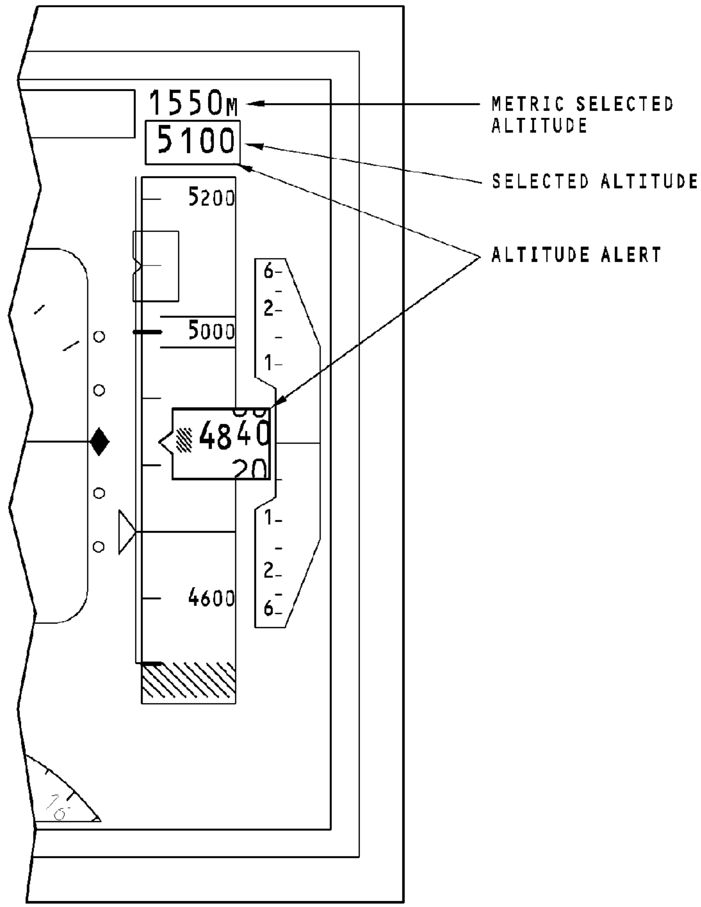
- Altitude alert
- Selected altitude
- Metric selected altitude.

Altitude Alert

The altitude alert annunciation shows as a white or amber border around the airplane altitude display. Also there can be a white box around the selected altitude.

Metric Selected Altitude

The MCP selected altitude in meters shows above the selected altitude in feet. Both are above the altitude tape. The altitude readout is in magenta numbers and the meter symbol is a small magenta letter.



DFCS - OPERATION - ALTITUDE DATA

DFCS - OPERATION - CDS FAILURE FLAGS

General

These are the failure flags that show on the captain and first officer displays:

- Flight director flag
- Selected target speed flag.

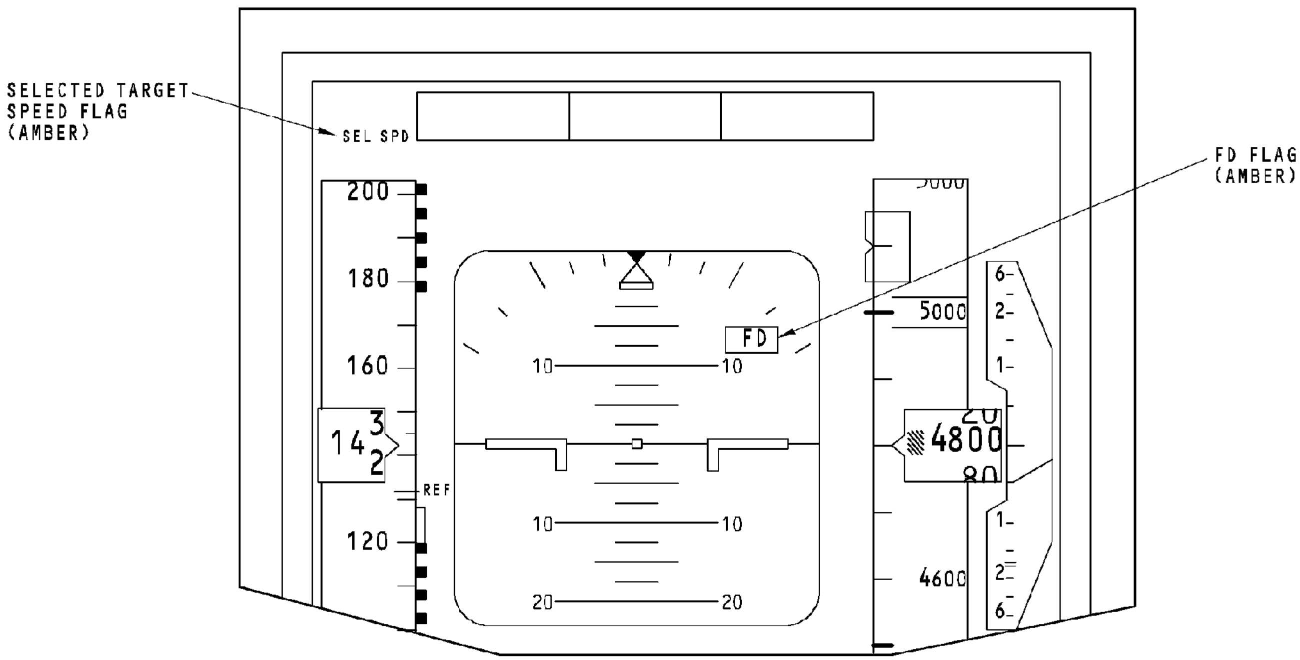
If the altitude alert fails, the altitude alert annunciation does not show. If the MCP selected altitude fails, the metric selected altitude does not show.

Flight Director Flag

An amber FD flag shows on the AI when the FCC is invalid or in BITE.

Selected Target Speed Flag

When the selected target speed is invalid, an amber SEL SPD message shows above the speed tape.



DFCS - OPERATION - CDS FAILURE FLAGS

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DFCS - OPERATION - ENGAGE AUTOPILOT

General

Autopilot engagement occurs when the pilot pushes an autopilot (A/P) CWS or CMD engage switch on the MCP. If the crew selects CWS, the A/P goes into CWS roll and CWS pitch modes. If you select CMD, the modes that the A/P goes into depend on many conditions.

Engage A/P With Flight Directors (F/D) Off

If you engage the A/P into CMD, the A/P goes to CWS roll and CWS pitch. When the crew selects a valid pitch and roll mode, the modes become active.

The F/D can be in an active roll and pitch mode while the A/P is in CWS. The mode annunciations on the FMA apply to the F/D.

Engage A/P With F/Ds On

These three conditions can occur with the F/Ds on:

- F/Ds are in TO/GA
- F/Ds are in valid roll and pitch modes. The difference between the airplane attitude and F/D commands is within valid limits
- F/Ds are in valid roll and pitch modes. The difference between the airplane attitude and F/D commands is not within valid limits.

F/Ds In TO/GA

HAP 037-054, 101-999

If you engage the A/P into CMD and the roll F/D takeoff mode is LNAV, the A/P and F/Ds go to LVL CHG for the pitch mode and stays in LNAV for the roll mode. If LNAV is not the F/D roll mode, the roll mode stays in HDG SEL.

HAP ALL

If you engage the A/P into CMD, the A/P and F/Ds go to LVL CHG for the pitch mode and stay in HDG SEL for the roll mode.

Airplane Attitude Within F/D limits

The A/P engages in CMD and the A/P modes are the same as the F/D modes.

Airplane Attitude Not Within F/D Limits

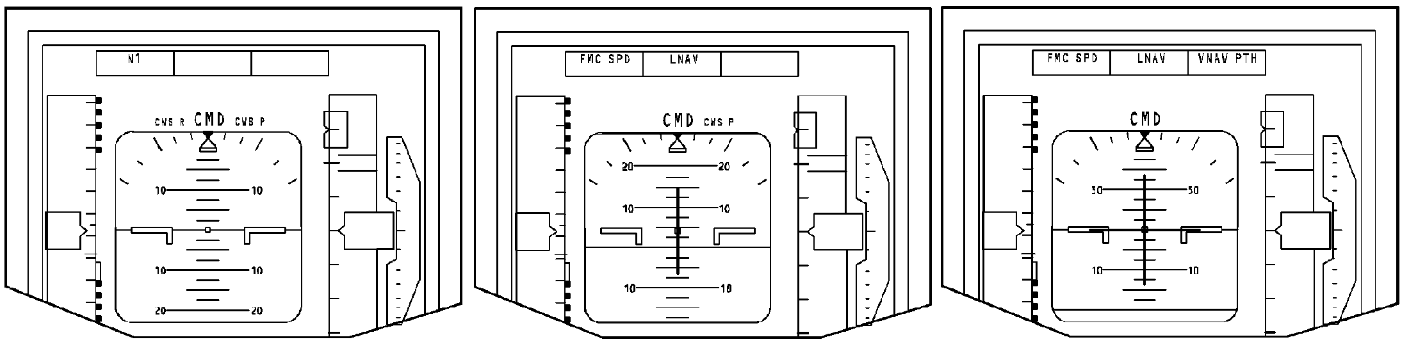
The airplane roll attitude must be within 7 degrees of the F/D commands for VOR/LOC on course or selected bank angle limit of 10 degrees. The airplane roll attitude must be within 14 degrees of the F/D commands for all other modes. If the airplane roll attitude is not within these limits, the A/P goes into CWS roll and the F/D roll mode is reset.

DFCS - OPERATION - ENGAGE AUTOPILOT

The airplane pitch attitude must be within 3 degrees of the F/D commands for slaved G/S engage and MCP ALT ACQ mode. The airplane pitch attitude must be within 6 degrees of the F/D commands for all other pitch modes. If the airplane pitch attitude is not within these limits, the A/P goes into CWS pitch and the F/D pitch mode is reset.

Training Information Point

The autopilot in the engaged mode is not certified for takeoff.



F/D OFF

- A/P ENGAGES TO CWS PITCH AND CWS ROLL

F/D ON AND PITCH LIMITS EXCEEDED

- A/P ENGAGES IN CMD FOR ROLL MODE
- A/P ENGAGES IN CWS FOR PITCH MODE

F/D ON AND WITHIN LIMITS

- A/P ENGAGES IN CMD FOR ROLL AND PITCH

22-11-00-107

DFCS - OPERATION - ENGAGE AUTOPILOT

DFCS - OPERATION - TAKEOFF

General

The F/D display shows roll and pitch commands during takeoff. The pilot cannot use the A/P for takeoff. The roll mode is heading select and the pitch mode is TO/GA. After the airplane goes through 400 feet radio altitude, the pilot can stay in the F/D takeoff mode or engage the autopilot to a roll and pitch mode.

The F/D does not give runway steering or rotation commands.

This is the takeoff sequence:

- Before takeoff roll
- Takeoff roll
- Lift-off
- Climbout.

Before Takeoff Roll

The pilots set all of these conditions before they start the takeoff roll:

- The captain and the first officer F/D switches are in the ON position
- Select the runway heading with the heading selector
- Select the bank angle limit with the bank angle limit control
- Set the MCP altitude with the altitude select control
- Arm the autothrottle
- Select V2 speed with the IAS/MACH select control.

These annunciations show on the captain and first officer displays:

- FD as the DFCS status
- No pitch mode annunciations
- The F/D roll and pitch command bars are biased out of view (BOV)
- The selected target speed bug on the MASI shows the V2 speed.

The master flight director indicator light adjacent to the F/D switch that was turned on first comes on.

HAP 031-054, 101-999

VNAV can be arm in F/D mode.

HAP ALL

Takeoff Roll

When the pilot pushes a TO/GA switch on the thrust levers, these events occur:

- The FMA shows TO/GA as the active pitch mode
- The F/D pitch command shows a pitch down attitude of 10 degrees
- The F/D roll command shows the heading error
- Both master lights come on to show that the F/Ds are independent
- The autothrottle engages in the takeoff thrust mode
- The FMA shows HDG SEL as the active roll mode.

DFCS - OPERATION - TAKEOFF

When the airspeed is 60 knots, the F/D shows a pitch up command of 15 degrees. If an engine fails, the AC bus transfers to the good engine. The FCC on the failed engine gets the F/D commands from the unswitched FCC. The F/Ds will then show a pitch command of 12.5 degrees.

In takeoff, the flight director commands show on the AIs automatically even if the flight director switches are in the OFF position. This is the pop-up mode. It occurs when these conditions are true:

- A flight director switch is not in the ON position
- The pilot pushes a TO/GA switch
- The airspeed is more than 80 knots.

The F/Ds stay in the pop-up mode for 150 seconds after the airspeed reaches 80 knots. To turn off the F/Ds while in the pop-up mode, you must set a F/D switch to the ON position and then to the OFF position.

When both F/Ds are on, you can turn one off and the other stays on.

Lift-Off

For a normal lift-off, the F/D goes from a 15 degree nose up command to a speed or attitude command. The initial speed target is V2 plus 20 knots. The change to speed control is a function of altitude rate.

If the climb rate is less than 300 FPM, the pitch command holds the pitch attitude. For a climb rate between 300 FPM and 1200 FPM, the pitch command holds a mixture of pitch and airspeed. For a climb rate more than 1200 FPM, the pitch command holds the target airspeed.

If an engine fails during takeoff, the target airspeed may change to these values:

- Failure at less than V2 - V2 is the target airspeed
- Failure between V2 and V2 plus 20 - the existing IAS is the target airspeed
- Failure at more than V2 plus 20 - there is no change to the target airspeed.

The maximum airspeed limit is the flap placard speed until the airplane reaches the MCP speed. The F/D bank angle limit is 8 degrees when the airplane is below 400 feet altitude.

Ten seconds after lift-off, the speed trim engages.

Climb Out

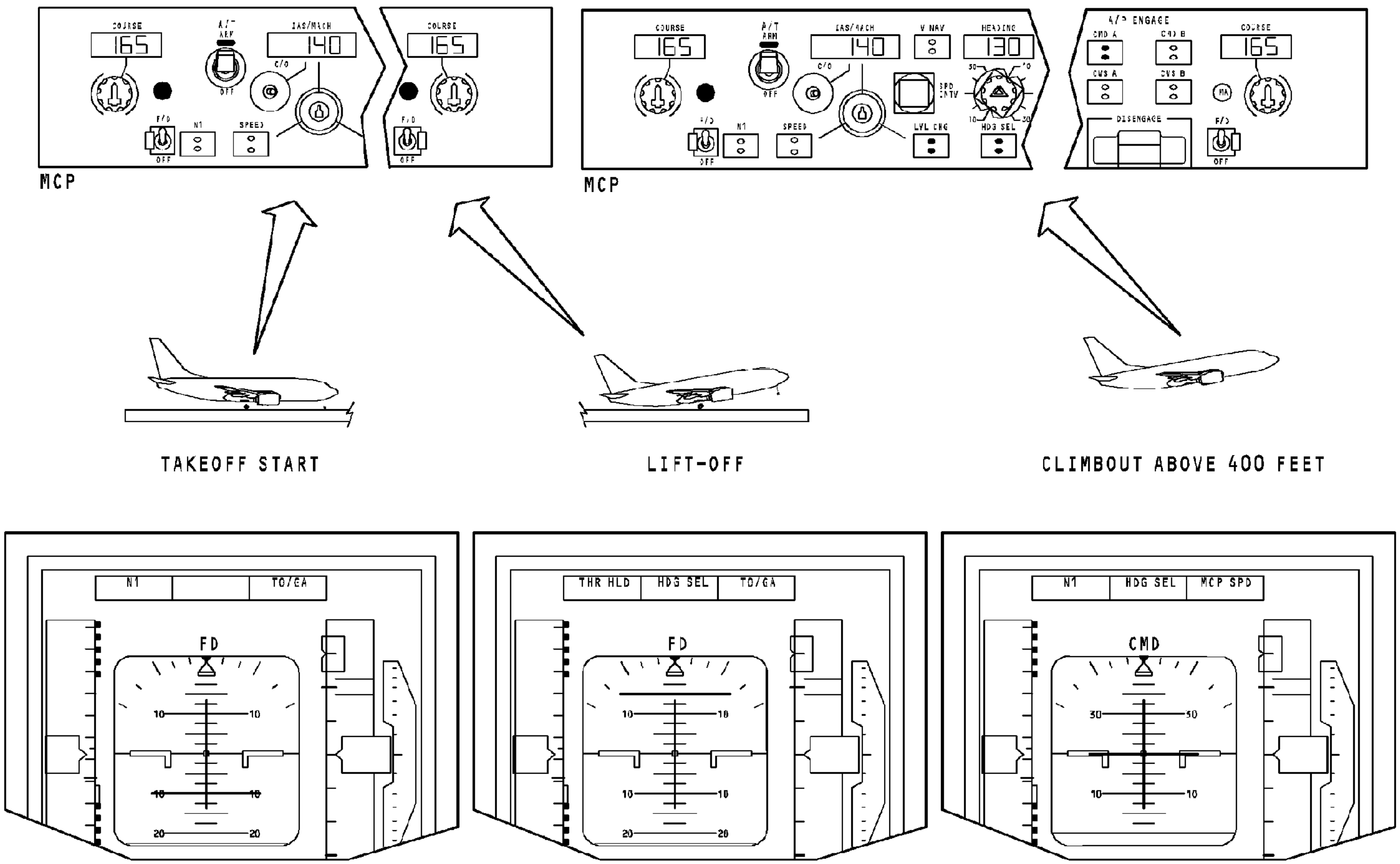
At a radio altitude of 400 feet, the master flight director indicator light for the F/D that was the second one turned on, goes off.

DFCS - OPERATION - TAKEOFF

The roll command continues to hold the selected heading and the annunciation is HDG SEL. The pitch command continues in TO/GA to hold speed, attitude, or a mixture of speed and attitude. The pitch annunciation is still TO/GA. FD stays as the active DFCS status until the pilot engages the autopilot.

When the radio altitude is more than 400 feet, you can change the F/D pitch and roll modes. If you change just the pitch mode, the roll mode stays in HDG SEL. In this case the F/D stays in LNAV. You can change the roll mode without a change in the pitch mode.

When the radio altitude is more than 400 feet, you can also engage the autopilot in CMD. When you engage the A/P in CMD, the pitch mode goes to LVL CHG and shows MCP SPD in the FMA. The roll mode stays in HDG SEL. Only the master flight director indicator light for the A/P in CMD is on. When you engage the A/P, the speed trim stops and the auto stabilizer trim starts.



DFCS - OPERATION - TAKEOFF

DFCS - OPERATION - TAKEOFF - LNAV SELECTED

General

The pilot can select LNAV as the F/D roll mode during takeoff if the FMCS transfer switch is in the NORMAL position and both FMCs are operational.

Before Takeoff Roll

The pilots push the LNAV mode selector switch to select the LNAV mode. This is done before they push the TO/GA switch.

The LNAV annunciation shows in the FMA roll mode with the normal annunciations that show on the captain's and first officer's displays.

Takeoff Start

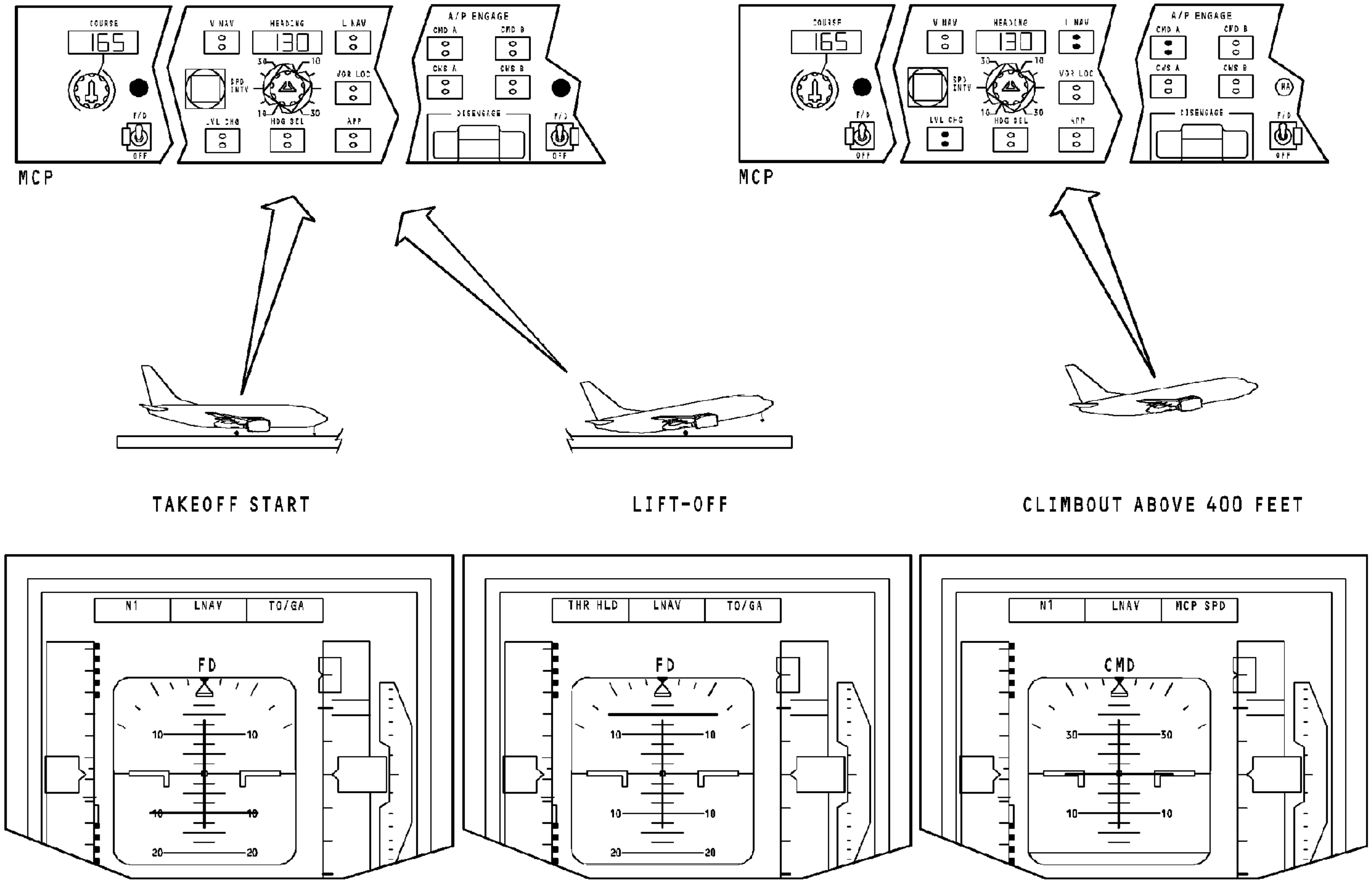
After the pilot pushes a TO/GA switch on the thrust levers, the FMA still shows LNAV in the roll mode. The pitch mode shows TO/GA. The light on the LNAV mode selector switch goes out. This means that the pilot cannot deselect the LNAV mode.

Lift-Off

If LNAV is selected, the roll mode is wings level until the airplane reaches 50 feet. The roll mode then changes to LNAV. If they push the TO/GA switch again between 50 and 400 feet, the roll mode changes to heading select.

Climb Out

If LNAV was selected, the light on the LNAV mode selector switch comes back on. when the airplane reaches 400 feet. The pilot can now deselect LNAV. The pitch annunciation is still TO/GA and the roll annunciation is still LNAV. If you change only the pitch mode, the roll mode stays in LNAV. If you engage the A/P in CMD, the pitch mode goes to LVL CHG and the roll mode stays in LNAV.



DFCS - OPERATION - TAKEOFF - LNAV SELECTED

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DFCS - OPERATION - CLIMB/CRUISE/DESCENT INTRODUCTION

General

After the climbout from takeoff, the crew can continue with the F/Ds and/or engage an A/P in CMD or CWS. The crew can engage only one A/P in these flight sequences.

If the F/Ds are on or an A/P is in CMD, the crew can choose DFCS modes with the mode selector switches on the MCP. If the lights on the selector switches are on, the crew can deselect that mode if they push the mode selector switch again.

The crew can use these roll mode selector switches during climb, cruise and descent:

- LNAV
- HDG SEL
- VOR.

The crew can use these pitch mode selector switches during climb, cruise and descent:

- VNAV
- V/S
- ALT HLD
- LVL CHG.

The roll and pitch modes show on the flight mode annunciators (FMAs). This includes the engaged modes and the armed modes.

LNAV

The roll commands come from the FMC when there is a valid navigation data base and an active flight plan.

HDG SEL

In this mode, the airplane turns to the heading that shows in the heading display on the MCP. The FCC calculates the command from the difference between the airplane magnetic heading and the MCP selected heading.

VOR

In this mode, the autopilot commands the airplane to fly a VOR course that shows in the course indicator on the MCP. The VOR receiver sends the FCC VOR radial data that the airplane is on. The MCP sends the FCC the VOR course that the pilot wants to fly. The difference or deviation is used to calculate the VOR command.

VNAV

The pitch commands come from the FMC when these are present:

- A valid navigation data base
- An active flight plan
- Valid performance data.

When the crew selects VNAV, the DFCS goes to either the VNAV SPD or the VNAV PTH mode.

VNAV cannot be active on the ground.

V/S

In this mode, the A/P commands the airplane to climb or descend at the MCP selected vertical speed.

ALT HLD

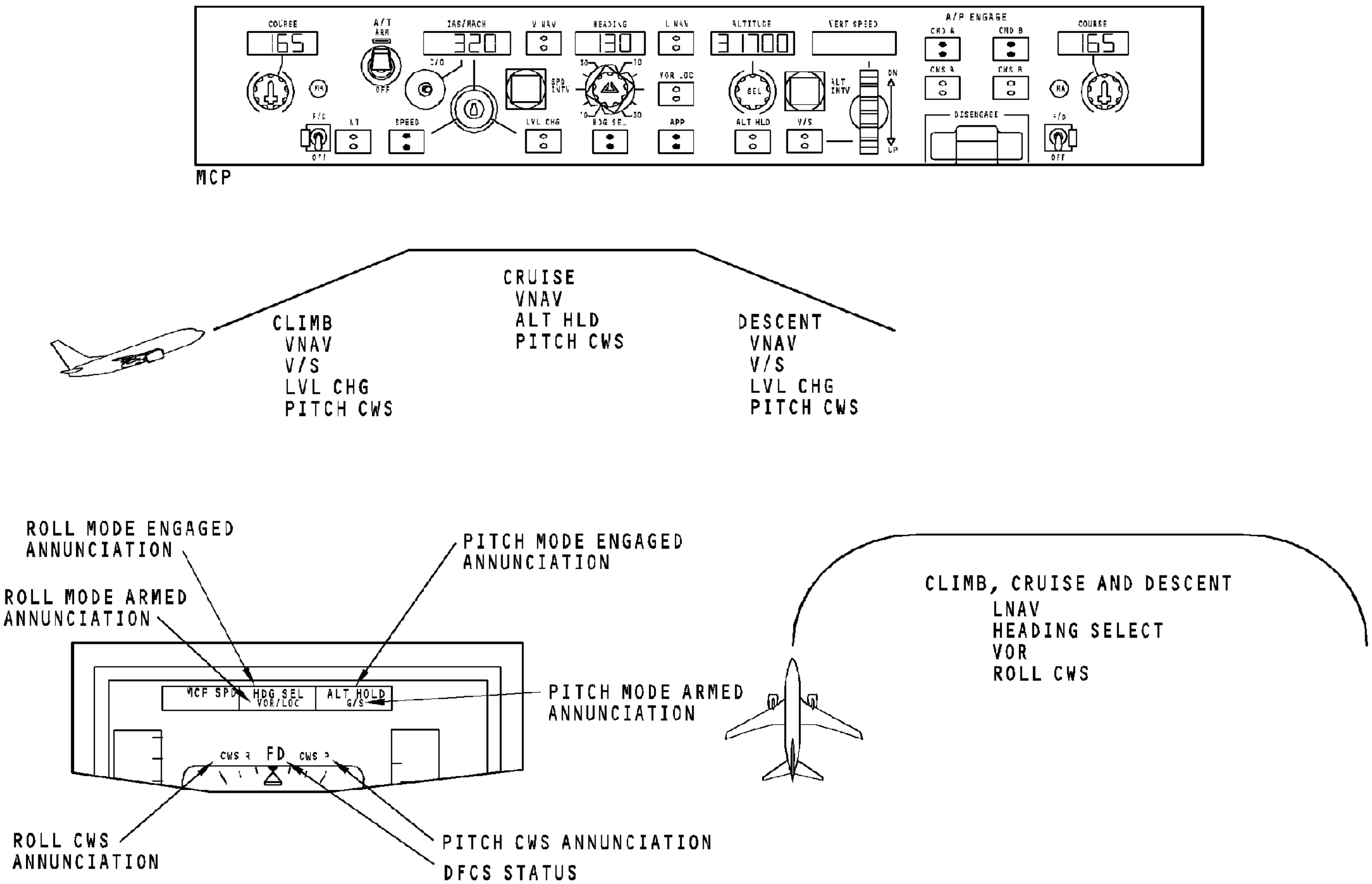
In this mode, the A/P commands the airplane to hold the altitude that the airplane was at when the crew selected ALT HLD or the MCP selected altitude.

LVL CHG

In this mode, the airplane changes altitude with the A/P and the autothrottle (A/T). LVL CHG commands the airplane to the MCP selected altitude at the selected airspeed. The A/P commands airspeed and the A/T controls the thrust.

Roll and Pitch CWS

You can also engage the A/P in roll and/or pitch CWS. In CWS, the pilot controls the airplane as if the autopilots are disengaged. Control of the airplane is from CWS force transducers that send signals through the FCCs to the A/P actuators.



DFCS - OPERATION - CLIMB/CRUISE/DESCENT INTRODUCTION

DFCS - OPERATION - LNAV

General

The LNAV commands come from the FMC and guide the airplane on the assigned flight path. When the DFCS is in the LNAV mode, the LNAV mode annunciation shows on the FMA.

LNAV Active

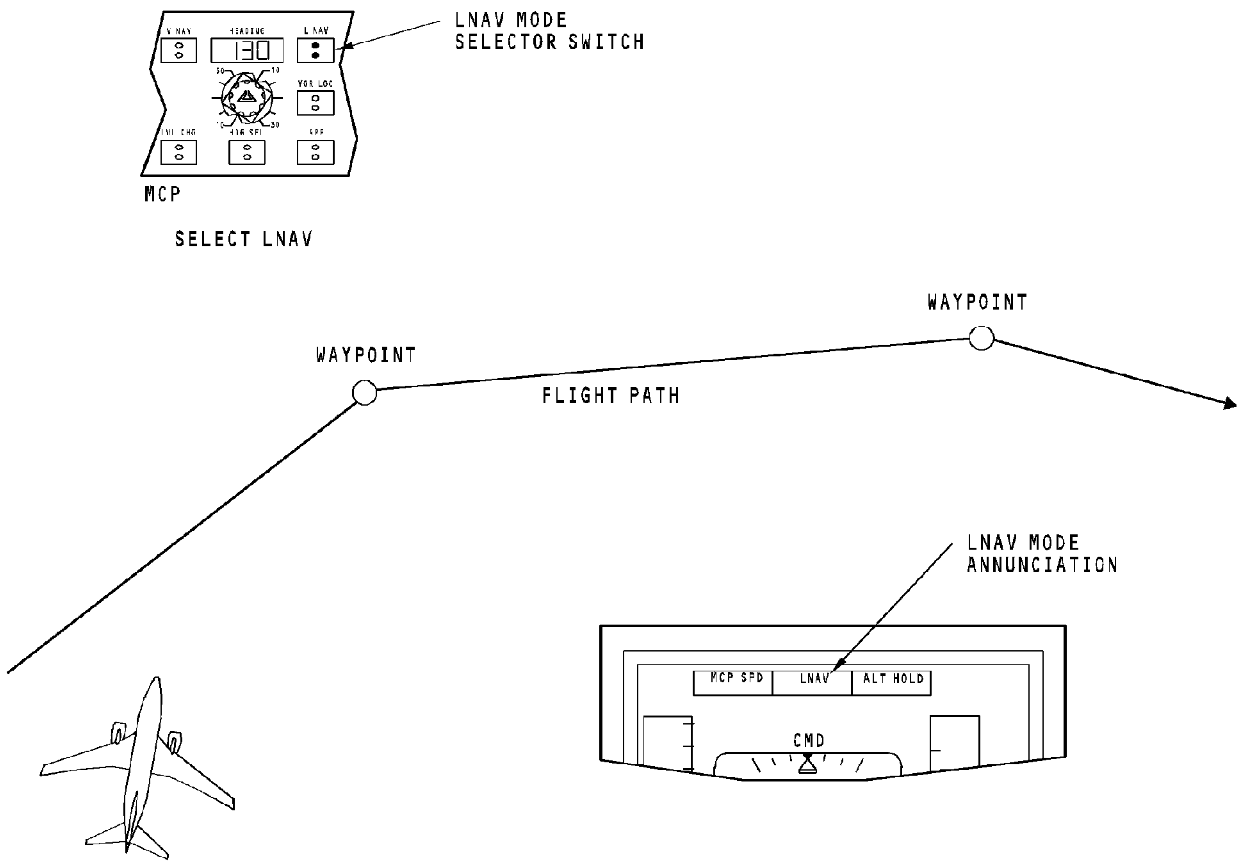
To make the LNAV active, push the LNAV mode selector switch on the MCP. These conditions must be valid for LNAV to engage:

- LNAV is valid
- Baro corrected altitude is valid
- Data to calculate the lateral guidance command in the FMC is valid
- The airplane heading is towards the flight path before the next waypoint or is within 3 nm of the flight plan path.

Deselect LNAV

You can deselect LNAV if any of these conditions occur:

- Push the LNAV mode selector switch when the LNAV mode selector switch light is on
- Set the A/P to CMD with a F/D command more than 14 degrees
- A force more than 10 pounds on the control wheel with the A/P in CMD
- Activate another roll mode
- LNAV is not valid
- The airplane did not capture the localizer
- The airplane reaches the final waypoint or a route discontinuity.



DFCS - OPERATION - LNAV

DFCS - OPERATION - HEADING SELECT

General

The crew uses the heading select mode to change the airplane heading. The heading that the airplane will go to is the heading value in the MCP heading indicator. The maximum bank angle in the turn is the bank angle limit set on the MCP.

The crew can engage the HDG SEL mode when they push the HDG SEL mode selector switch on the MCP. The DFCS automatically goes into the HDG SEL mode when the crew pushes the TO/GA switch for takeoff and the flight directors come on.

These are the two ways to use the mode:

- Set heading before you push the HDG SEL mode selector switch
- Push the HDG SEL mode selector switch and then set the heading.

Set Heading Before Mode

Set a heading in the heading indicator and push the HDG SEL mode selector switch. These things happen:

- HDG SEL shows on the FMA
- The airplane turns in the direction for minimum heading change
- The airplane captures and holds the heading set on the MCP.

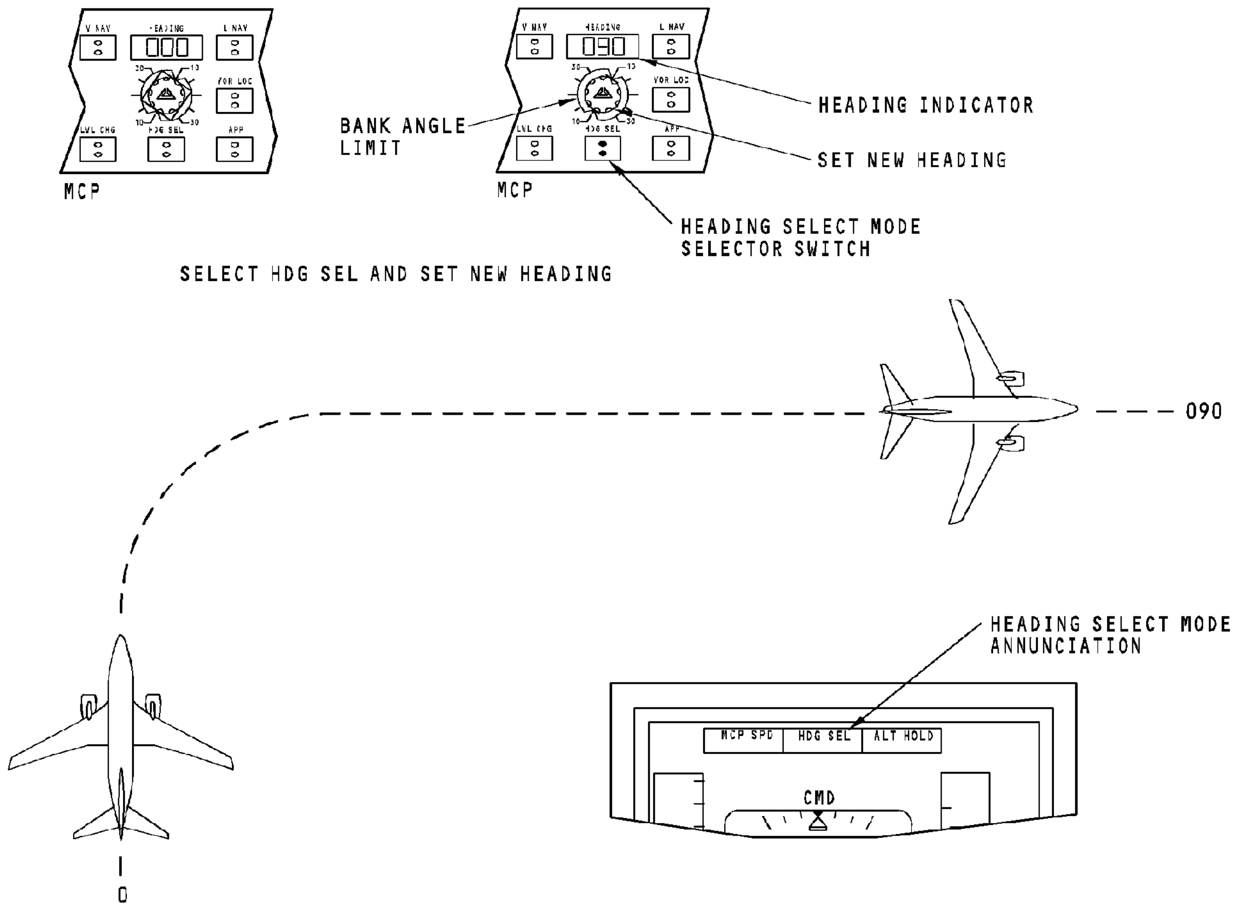
Select Mode Before Heading Is Set

Push the HDG SEL mode selector switch and set a heading in the heading indicator. These things happen:

- HDG SEL shows on the FMA
- When the pilot turns the heading knob clockwise, the airplane banks to the right
- When the pilot turns the heading knob counterclockwise, the airplane banks to the left
- The airplane captures and holds the heading set on the MCP.

Deselect HDG SEL

You deselect HDG SEL when you select another roll mode. You can also deselect HDG SEL if you push the HDG SEL mode selector switch when the switch light is on.



DFCS - OPERATION - HEADING SELECT

DFCS - OPERATION - VOR

General

The VOR mode supplies automatic beam capture and guidance through the on-course and over-station-sensor phases for cruise and approach control.

To use the VOR mode, the VOR receiver must be set to the VOR frequency. The pilot uses one of the course selectors on the MCP to select the desired course. The course shows on the course display. The bank angle limit is also set on the MCP. Push the VOR LOC mode selector switch to select the VOR mode. If the VOR mode engages, the VOR LOC mode selector switch lights to show it can also be deselected.

These are the four submodes of the VOR mode:

- Arm
- Capture
- On-course (OC)
- Over-station-sensor (OSS).

Arm Submode

When you push the VOR LOC mode selector switch, the mode is the VOR arm submode. When the VOR is in the arm submode, VOR/LOC shows in small white letters on the second line of the roll position of the FMA. The FCC stays in this submode until the airplane satisfies the capture logic.

In this submode, the FCC uses this data to calculate the capture point which is where the airplane should start the turn to be on course:

- Beam deviation
- True airspeed
- Course error
- Selected bank angle limit
- Closure rate.

The FCC uses this data to calculate the closure rate:

- True airspeed
- Course error
- DME distance.

If DME distance is not available, the FCC uses the rate of change of the beam deviation to calculate the closure rate.

Capture Submode

When the airplane reaches the capture point, the VOR mode changes to the capture submode. The FCC makes sure that these conditions are valid for at least 3 seconds before the capture mode is active:

- VOR LOC mode selector switch is engaged
- Course selector was not moved
- Beam deviation is less than 22 degrees
- VOR receiver is valid.

DFCS - OPERATION - VOR

If the FCC could not calculate the capture point, but the beam deviation is less than 0.5 degrees, the VOR mode changes to the capture submode. Also if the FCC could not calculate the capture point, but the beam deviation is less than 2 degrees for 10 seconds, the VOR mode changes to the capture submode.

The airplane will not bank more than the selected bank angle limit. The maximum roll rate is 4.0 degrees per second.

When the VOR is in the capture submode, VOR/LOC shows in large green letters on the first line of the roll position of the FMA. The FCC stays in this submode until the airplane satisfies the on-course logic.

On-Course Submode

These conditions inhibit the on-course submode:

- VOR not in the capture submode
- Bank angle is more than 7 degrees
- The over-station-sensor (OSS) is in effect.

The VOR on-course submode is active when these conditions occur for at least 5 seconds:

- Beam deviation is less than 1 degree
- Course error is less than 18 degrees.

The VOR on-course submode is also active when the deviation beam rate of change is less than 0.15 degrees per second for at least 10 seconds.

The airplane will not bank more than 8 degrees. The maximum roll rate is 1.3 degrees per second.

When the VOR is in the on-course submode, VOR/LOC shows in large green letters on the first line of the roll position of the FMA. The FCC stays in this submode until the airplane satisfies the OSS logic.

If the crew selects a new VOR course while in the on-course submode, the FCC goes back to the VOR capture submode.

Over-Station-Sensor Submode

The OSS logic monitors the VOR deviation beam signal for quick changes. This occurs when the airplane flies over the VOR station in the cone-of-confusion. If the deviation beam rate of change is more than 0.75 degrees per second, the FCC goes to the OSS submode. If the magnitude of the deviation beam changes is more than 6.0 degrees, the VOR also goes to the OSS submode.

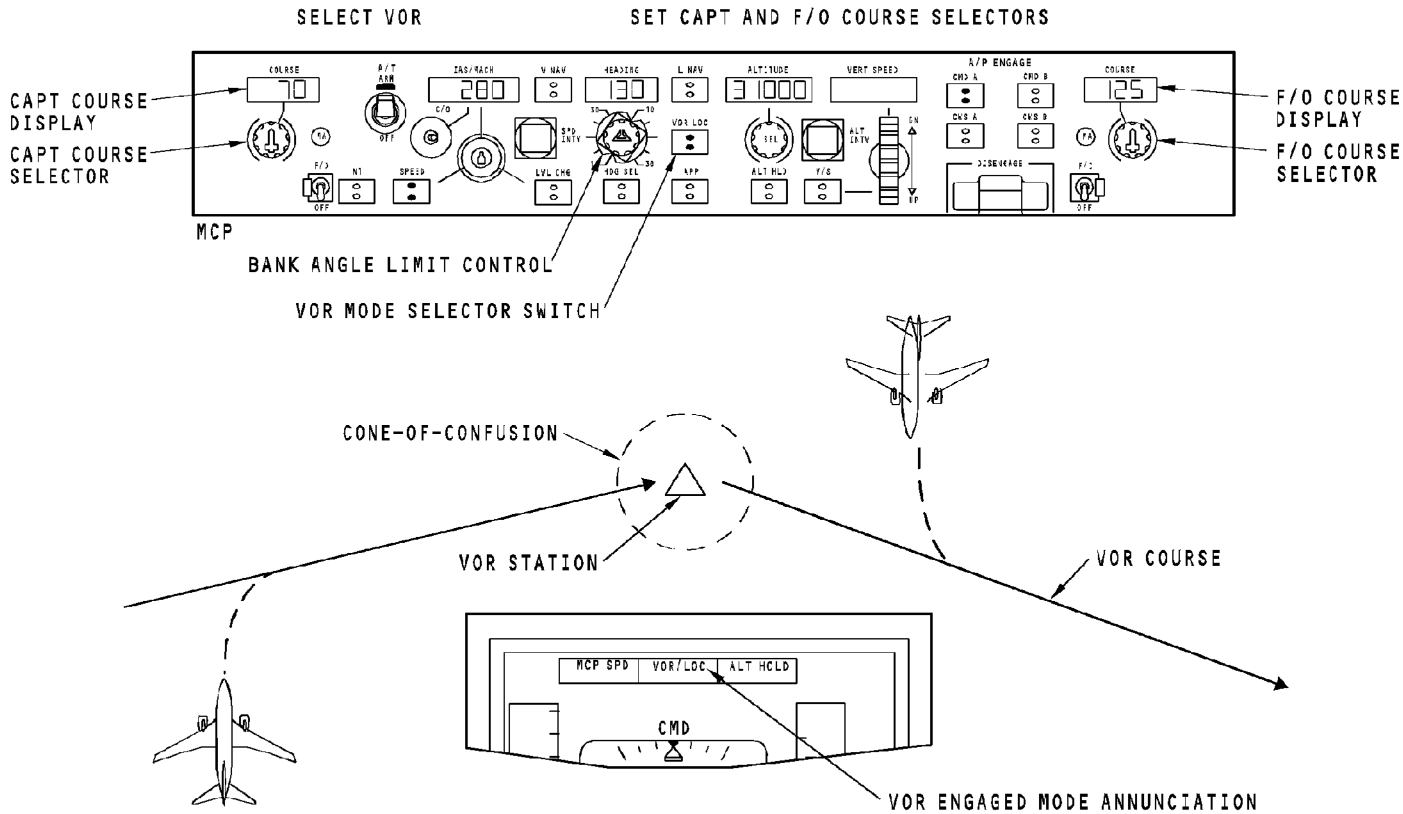
The FCC stays in the OSS submode for 23 seconds after the beam deviation changes go below these OSS levels. If a DME is collocated with the VOR, the FCC also goes into the OSS submode if the absolute value of the airplane altitude minus the DME range is less than 5000 feet. This allows the airplane to go through the cone-of-confusion and also make a turn.

DFCS - OPERATION - VOR

The airplane will not bank more than the selected bank angle limit. The maximum roll rate is 4.0 degrees per second.

When the VOR is in the OSS submode, VOR/LOC shows in large green letters on the first line of the roll position of the FMA. The FCC stays in this submode until the airplane satisfies the on-course logic.

If the crew pushes the VOR LOC mode selector switch or selects another roll mode, the VOR mode is deselected. The VOR mode is also deselected if the VOR signal is not valid for more than 8 seconds and the A/P is in CMD.



DFCS - OPERATION - VOR

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DFCS - OPERATION - ROLL CWS

General

In roll control wheel steering (CWS), the pilot controls the airplane as if the A/P is disengaged. The control of the airplane is from a roll CWS force transducer and through the FCC. The CWS mode has these submodes:

- Attitude hold
- Heading hold
- Roll CWS out-of-detent (O/D).

These are the three ways to engage the roll CWS mode:

- Push the CWS A/P engage switch
- Push the CMD A/P engage switch and do not select a roll mode
- When a roll CMD mode is active, apply a wheel force of more than 10 pounds (hi detent).

The FMA annunciation is the amber CWS R in the DFCS status.

The force on the control wheel, while in CWS, is one of these three levels:

- In-detent, less than 2.25 pounds if bank angle is 30 degrees or less, or less than 3.0 pounds if bank angle more than 30 degrees
- Low detent, more than in-detent level but 10 pounds or less
- Hi detent, more than 10 pounds of force.

Attitude Hold Submode

If the bank angle is more than 6 degrees when you engage the CWS mode, the A/P goes to the attitude hold submode. In this submode, the A/P holds the airplane bank to the roll attitude at the time the A/P enters the CWS mode.

The bank limit is 30 degrees. If the bank angle is more than 30 degrees when the A/P is in CWS and the control wheel force is in-detent, it decreases to and holds 30 degrees. The bank rate of change limit is 4.0 degrees per second.

Heading Hold Submode

If the bank angle is less than 6 degrees when you engage the CWS mode, the A/P goes to the heading hold submode. In this submode, the A/P decreases the bank angle to 0 degrees within 3 seconds. The A/P then maintains the airplane heading.

If the bank angle is more than 30 degrees when you engage the CWS mode, the bank angle decreases to 30 degrees. The bank rate of change limit is 4.0 degrees per second.

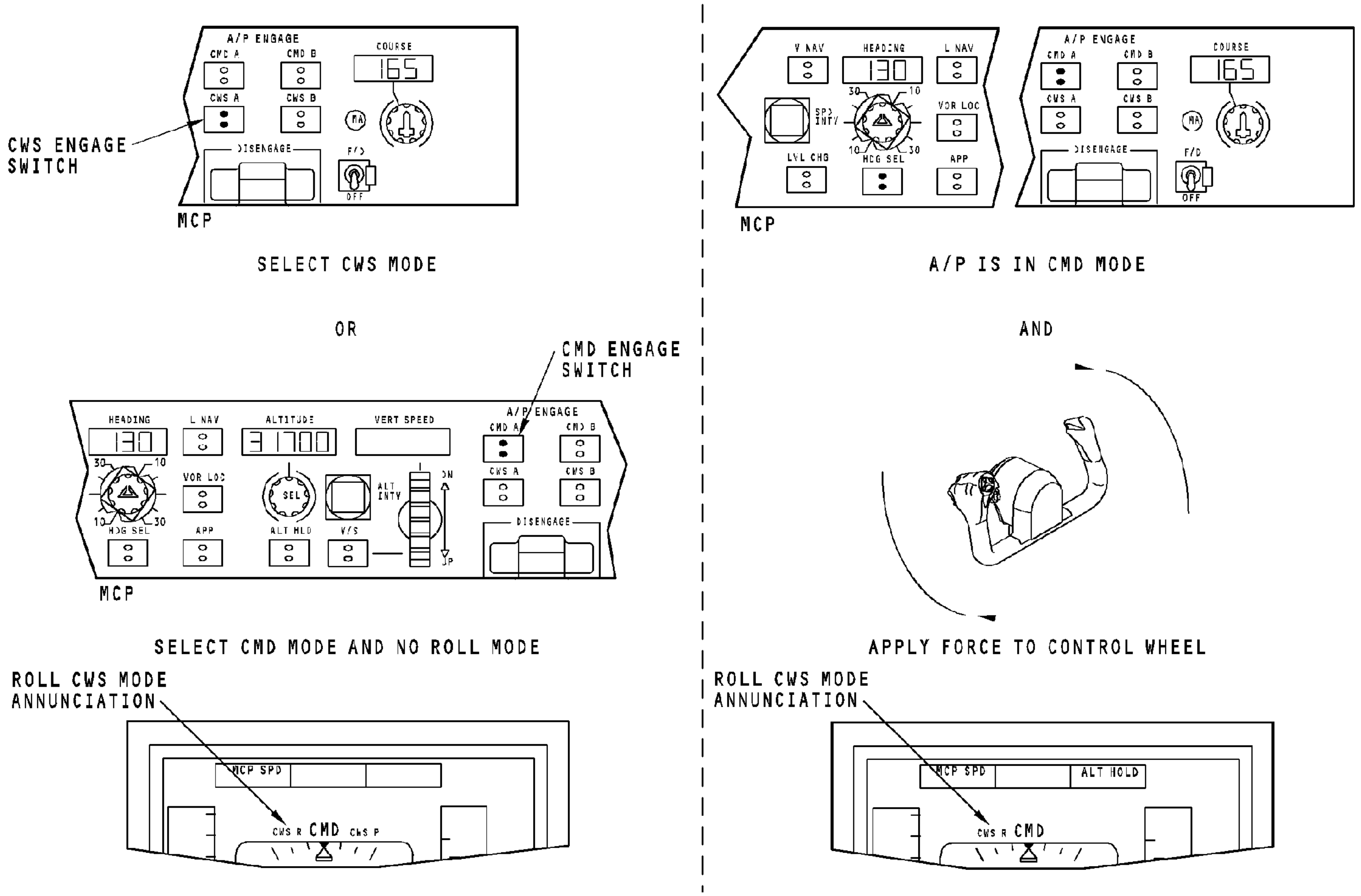
Roll CWS O/D

When the control wheel force is not in-detent, the pilot controls the airplane bank. The roll CWS force transducer sends a signal to the FCC and the FCC sends a control signal to the A/P actuators.

DFCS - OPERATION - ROLL CWS

When the control wheel force is in-detent, the A/P goes to the attitude submode if the bank angle is more than 6 degrees. The A/P goes to the heading hold submode if the bank angle is less than 6 degrees.

If the A/P is in another roll CMD mode, such as HDG SEL, and the control wheel is in hi detent, the A/P goes to the roll CWS mode. This cannot occur if the A/P is in the approach mode.



DFCS - OPERATION - ROLL CWS

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DFCS - OPERATION - VNAV

General

The vertical navigation (VNAV) mode supplies pitch control in response to vertical navigation data from the FMC. VNAV commands the airplane to climb or descend to the FMC target altitude at the FMC target speed. If the airplane reaches the MCP selected altitude first, it levels off at the MCP selected altitude.

Push the VNAV mode select switch to activate VNAV. VNAV becomes active when all these conditions are true:

- VNAV flight plan is active
- The airplane is more than 400 feet above the ground
- Data required to calculate the vertical guidance command is valid.

HAP 001-013, 015-026, 028-049, 051, 052, 101-999

VNAV has these two active modes:

- VNAV SPD (speed)
- VNAV PTH (path).

HAP 050, 053, 054

VNAV has these three active modes:

- VNAV SPD (speed)
- VNAV PTH (path)
- VNAV ALT (path).

HAP 001-013, 015-026, 028-049, 051, 052, 101-999

VNAV SPD

The VNAV SPD mode controls the elevator to hold the FMC target speed. The mode is active while the airplane is climbing to the FMC altitude. If it gets to the MCP altitude first, the A/P disengages from VNAV SPD and goes into ALT HOLD. The VNAV mode selector light does not go out because the autothrottle is still in the FMC SPD mode.

When the crew resets the MCP altitude to the FMC altitude, the VNAV mode selector light goes out. To go back to VNAV, the crew pushes the VNAV mode selector switch. This reengages VNAV SPD and the airplane starts to climb to the FMC target altitude at the FMC target speed.

HAP 050, 053, 054

VNAV SPD And VNAV ALT

The VNAV SPD mode controls the elevator to hold the FMC target speed. The mode is active while the airplane is climbing to the FMC altitude. If it gets to the MCP altitude first, the A/P disengages from VNAV SPD and goes into VNAV ALT. The VNAV mode selector light does not go out.

HAP 050, 053, 054 (Continued)

To go back to VNAV SPD to continue the climb, the crew selects a new higher MCP altitude and pushes the altitude intervention pushbutton. This reengages VNAV SPD and the airplane starts to climb to the FMC target altitude or new MCP altitude at the FMC target speed.

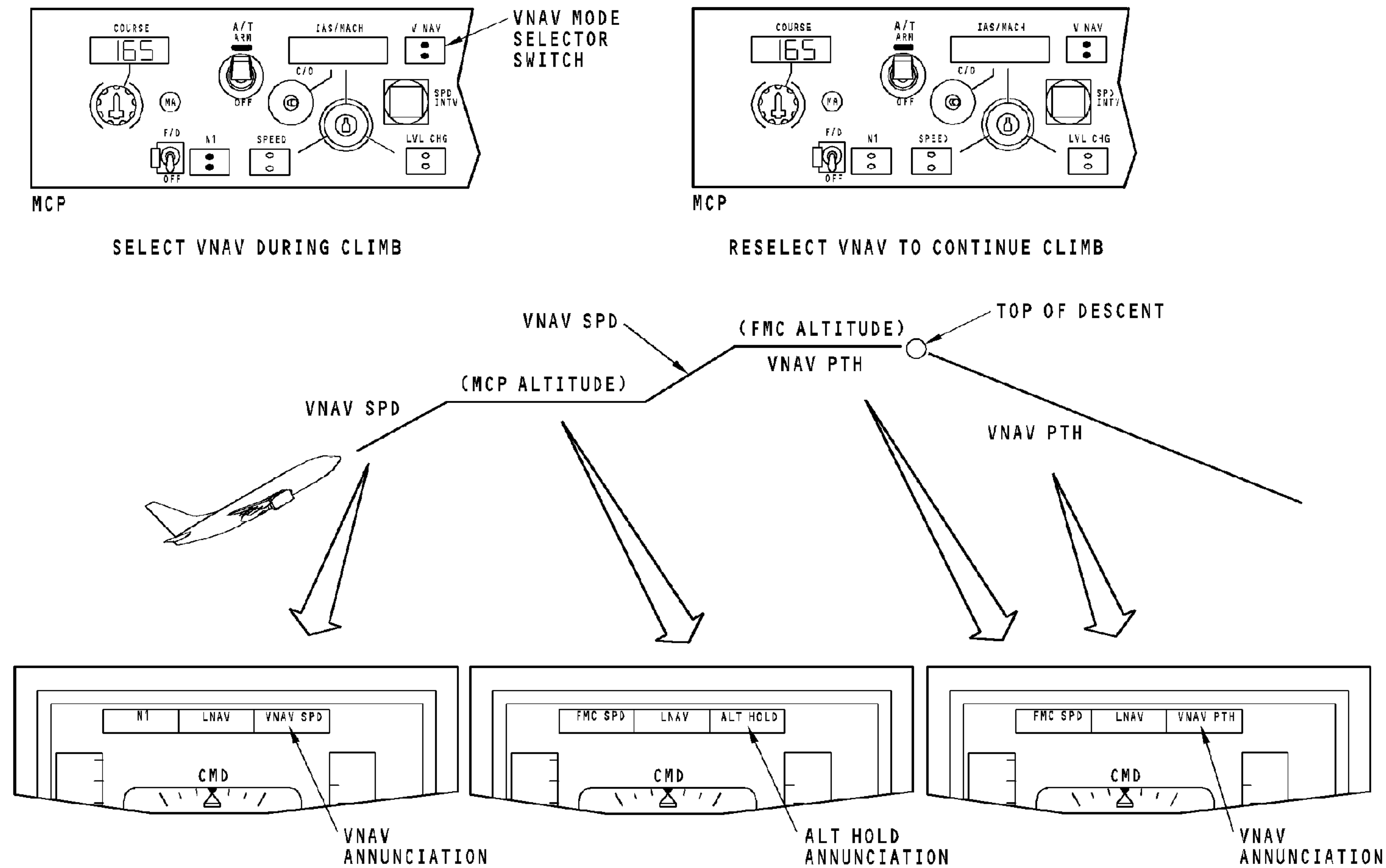
HAP ALL

VNAV PTH

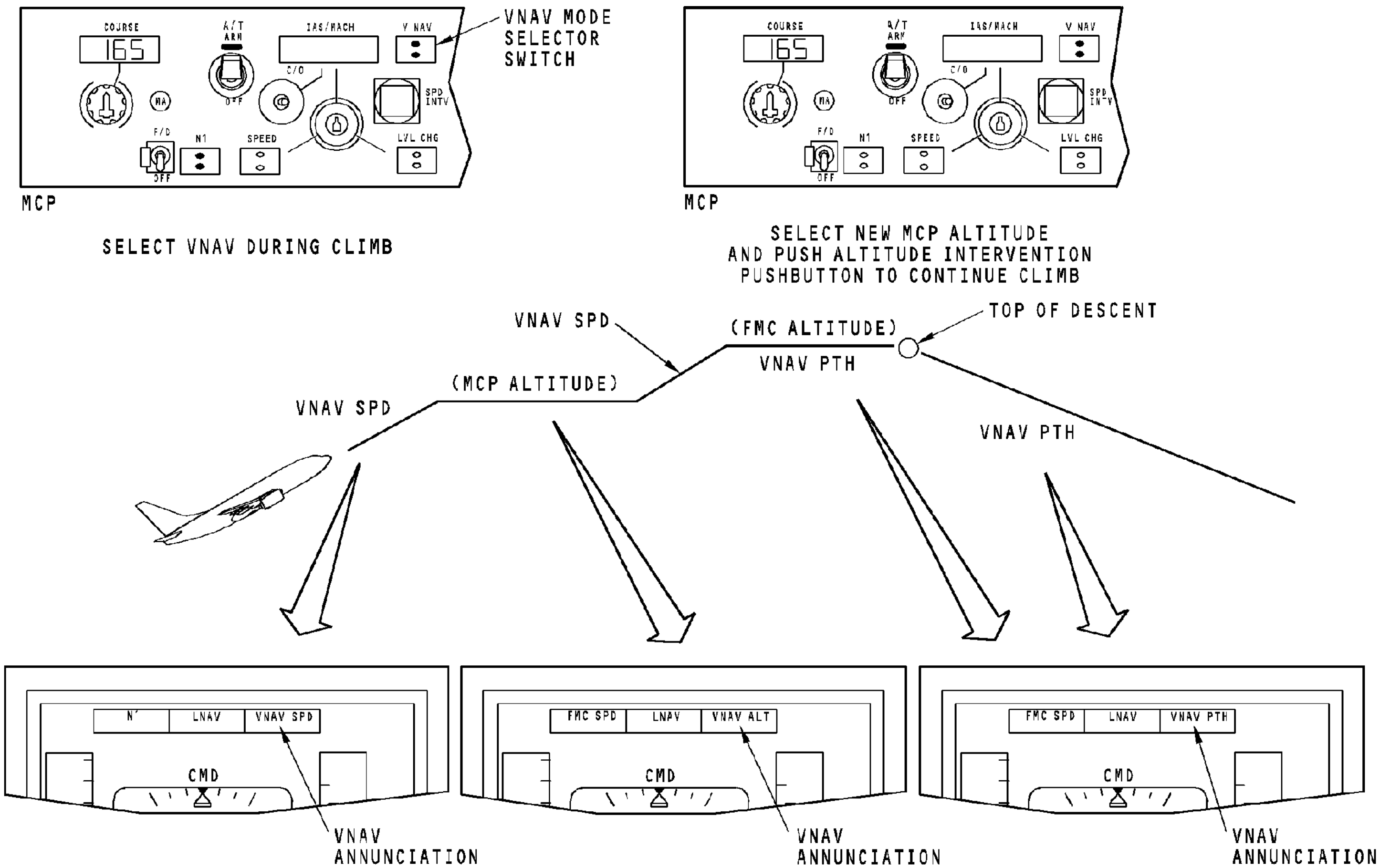
In climb, VNAV SPD changes to VNAV PTH to capture the FMC target altitude. In the VNAV PTH mode, the airplane holds the FMC altitude.

Before descent, the pilot sets an approach altitude on the MCP. At the top of descent, the throttle retards and the A/T FMA shows RETARD then ARM. The pitch mode remains in VNAV PTH and the airplane descends. LNAV must be active during the VNAV PTH descent mode. If LNAV is not active, VNAV PTH mode will disengage, but the crew can select VNAV SPD for the descent.

The VNAV PTH mode continues in descent until the airplane is near the approach altitude. The autothrottle mode returns to FMC SPD. VNAV PTH remains active and holds the approach altitude.



DFCS - OPERATION - VNAV



DFCS - OPERATION - VNAV

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DFCS - OPERATION - VNAV - SPEED INTERVENTION

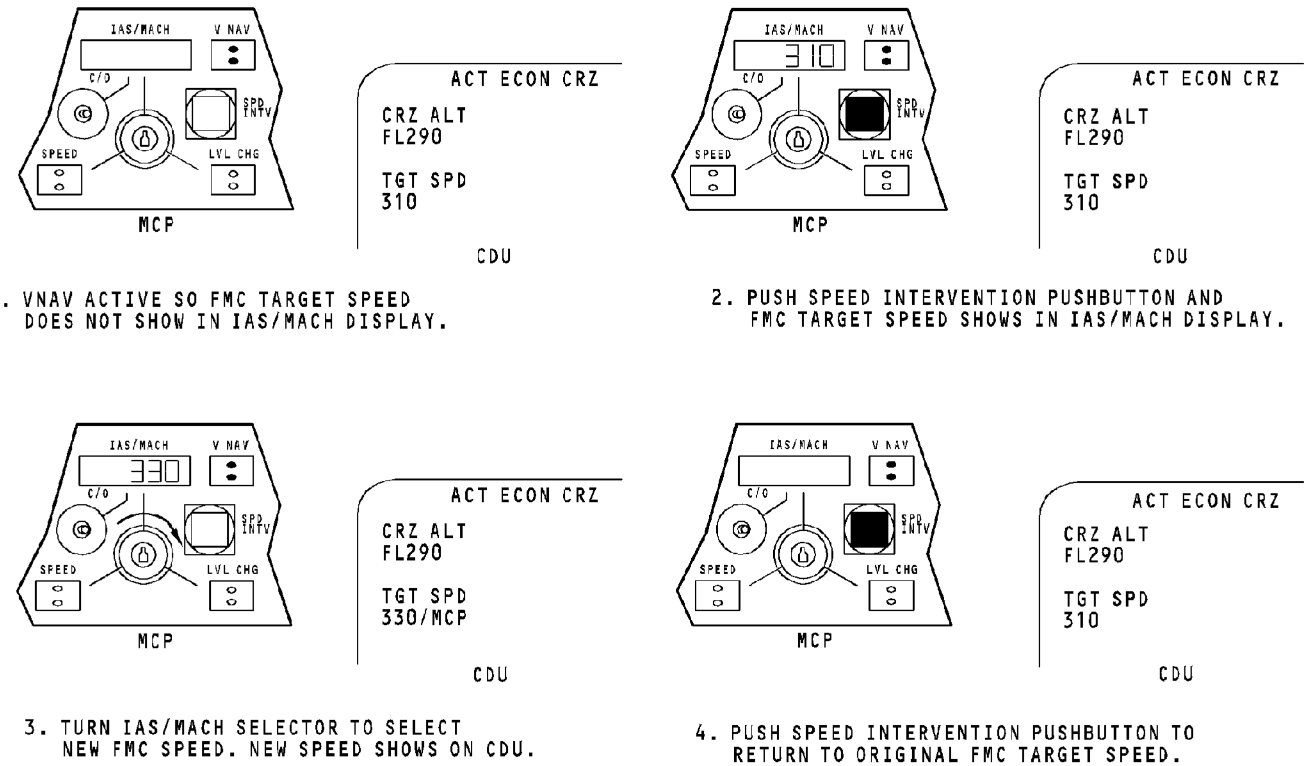
General

The speed intervention pushbutton lets the crew change the FMC target speed with the MCP IAS/MACH selector and stay in the VNAV mode. The target speed that shows on the active CDU cruise page will change to the new target speed.

Speed Intervention Operation

When in VNAV, the FMC target speed does not show in the MCP IAS/MACH display window. This display is blank. When the pilot pushes the speed intervention pushbutton, the current FMC speed target speed shows in the IAS/MACH display and you can change the speed with the IAS/MACH selector. The new speed shows in the MCP IAS/MACH display and on the CRZ page on the CDU. An MCP shows after the speed on the CDU to show that this speed is set by the MCP IAS/MACH selector. The DFCS pitch mode is still VNAV.

To return to the original FMC target speed, push the speed intervention pushbutton again. This blanks the IAS/MACH display and the speed on the CDU returns to the original FMC target speed.



DFCS - OPERATION - VNAV - SPEED INTERVENTION

DFCS - OPERATION - VNAV - ALTITUDE INTERVENTION

General

The altitude intervention push-button lets the crew change the FMC target altitude with the MCP altitude selector. It lets the crew climb or descend from an interim level-off altitude set by the MCP and stay in VNAV. It also lets the crew remove an altitude restriction in the flight plan each time that the altitude intervention push-button is pushed. You can push the push-button up to eight times to remove eight altitude restrictions. You can use the altitude intervention in a climb or descent.

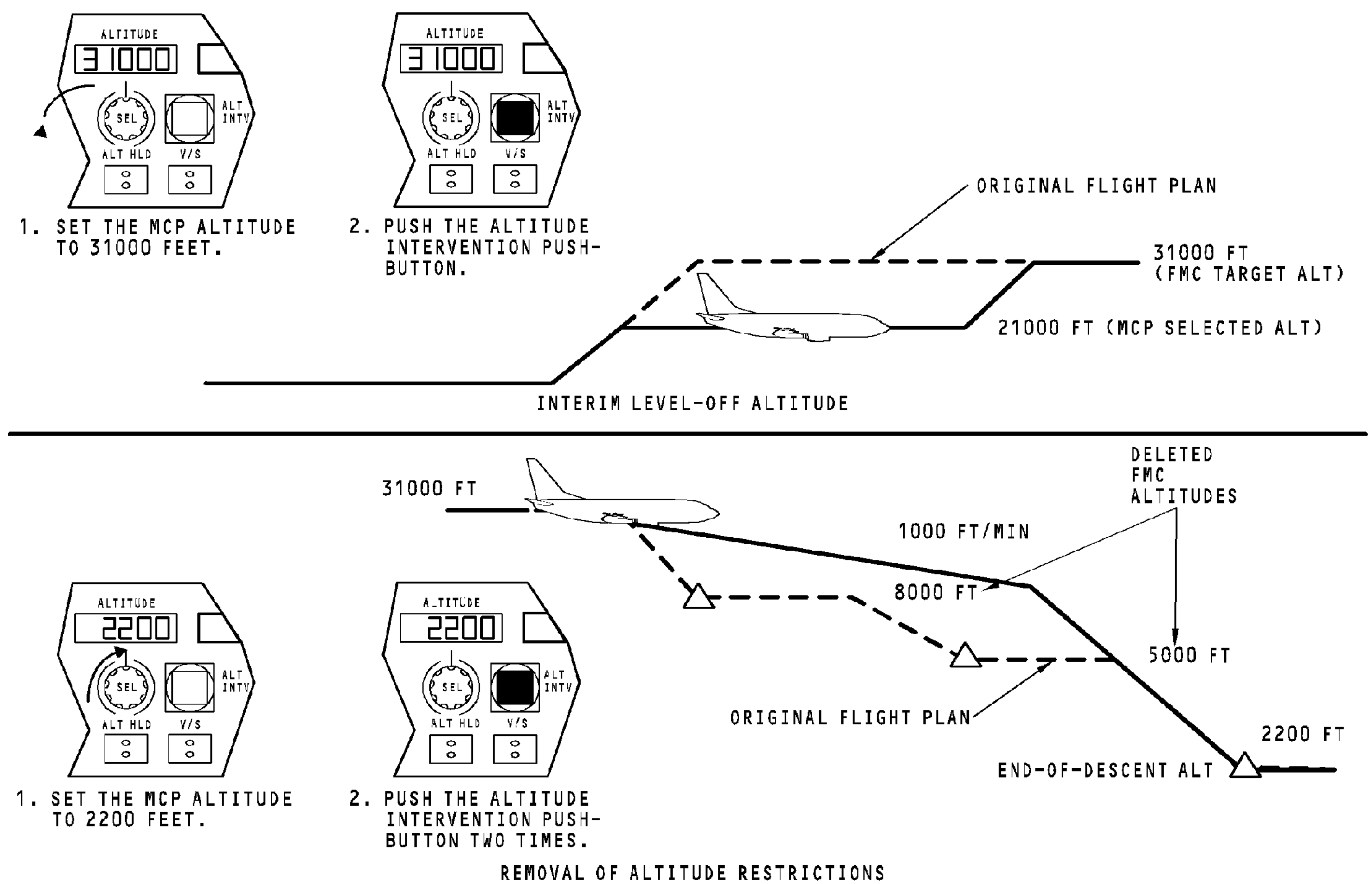
Interim Level-off Altitude Operation

If the new MCP altitude is between the airplane altitude and the FMC target altitude, the airplane levels off at the MCP altitude. The DFCS stays in VNAV. To continue the climb or descent, change the MCP altitude to the FMC target altitude and push the altitude intervention push-button. This removes the altitude restriction at the intermediate MCP altitude and the climb or descent continues.

Removal of Altitude Restrictions Operation

Select the new FMC altitude with the altitude selector on the MCP. If there is one altitude restriction in the flight plan between the present airplane altitude and the new FMC altitude, push the altitude intervention pushbutton once. If there are two altitude restrictions, push the pushbutton twice. You can remove up to eight altitude restrictions.

If the airplane is in a descent and the new FMC altitude is at or above the end-of-descent altitude, the airplane descends at a rate of 1000 feet/minute until it gets to a position where it can make the planned descent rate. The DFCS pitch mode stays in VNAV path. If the new FMC altitude is below the end-of-descent altitude, the airplane starts an immediate descent and the DFCS pitch mode changes to VNAV speed. The descent speed is the speed that was in the original flight plan.



DFCS - OPERATION - VNAV - ALTITUDE INTERVENTION

DFCS - OPERATION - VERTICAL SPEED

General

The crew uses the V/S mode to climb or descend to the altitude set in the MCP. You cannot use the V/S mode if the airplane is at the MCP selected altitude or in the capture of the MCP selected altitude. If the airplane is at the MCP selected altitude and the crew changes the MCP selected altitude by more than 100 feet, the V/S mode will arm.

The crew can use the V/S mode to level the airplane at a set altitude.

Climb/Descend to MCP Selected Altitude

These occur when the pilot pushes the V/S mode selector switch and sets a positive or negative V/S on the MCP:

- V/S shows on the FMA in green letters
- The V/S mode selector switch LEDs turn on
- The airplane climbs or descends at the selected V/S.

When the crew pushes the V/S mode selector switch, the present vertical speed of the airplane shows in the V/S display. The crew changes the vertical speed with the V/S control wheel.

When the airplane reaches the altitude set on the MCP, the DFCS mode changes from V/S to altitude acquire (ALT ACQ) and then to altitude hold (ALT HOLD). When the DFCS goes into the ALT ACQ mode, the V/S mode selector switch LEDs go out.

Change the MCP Selected Altitude

If the crew changes the MCP selected altitude, this occurs:

- ALT HOLD is the engaged mode and shows on the FMA in green letters
- The ALT HLD mode selector switch LEDs turn on
- The V/S arms and V/S shows on the FMA in smaller white letters.

The crew turns the V/S control wheel to set the climb or descent rate. The pitch mode changes to V/S so this occurs:

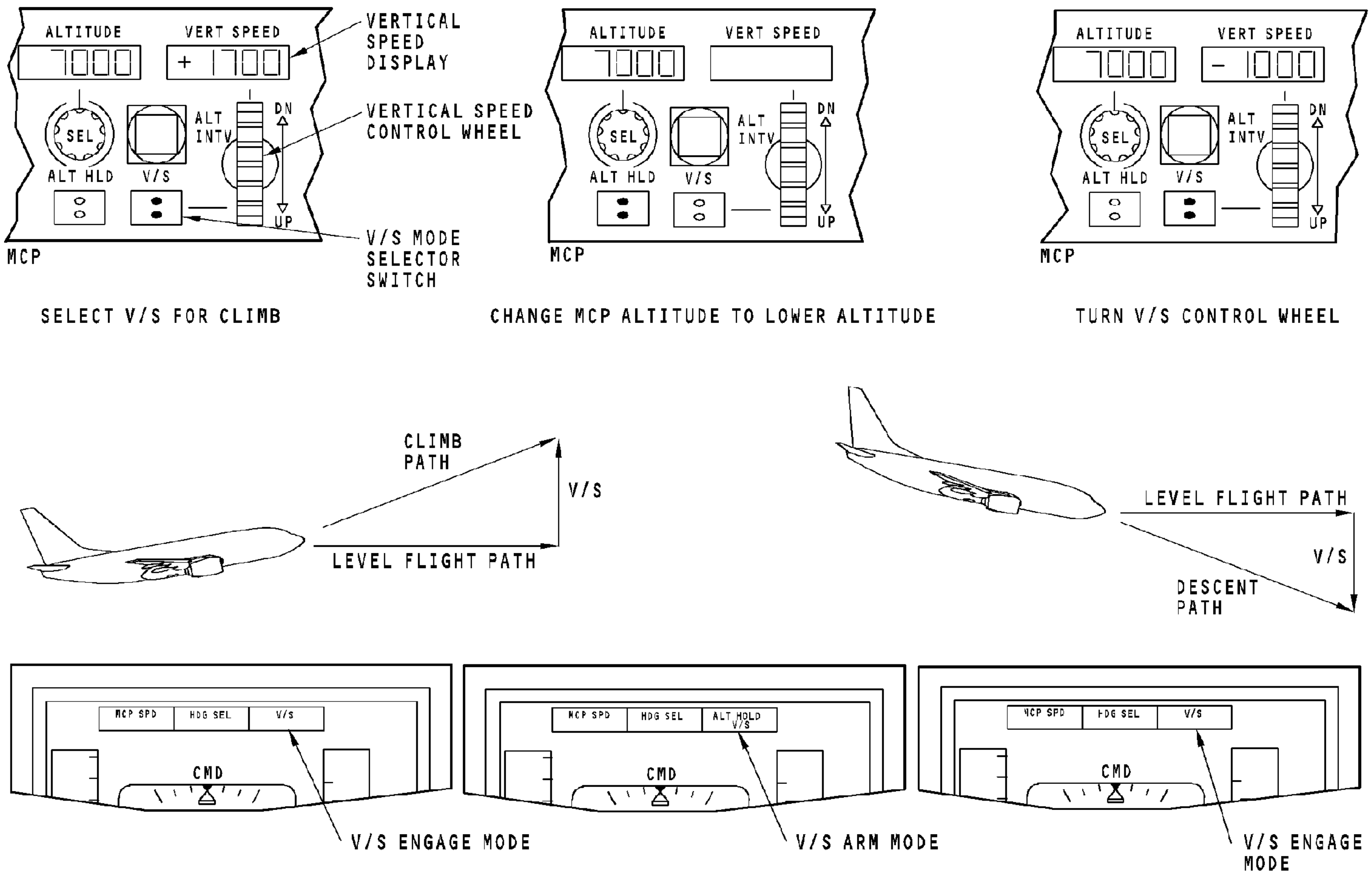
- The LEDs on the ALT HLD mode selector switch go out
- The LEDs on the V/S mode selector switch turn on
- The pitch mode annunciation is V/S in green letters.

Level Off

As the airplane approaches the altitude, the crew can slowly decrease the V/S to zero with the V/S control wheel. The airplane will stop its climb or descent and fly level.

Reversion Mode

If the airspeed decreases to 1.3 times the stall speed, the DFCS will change to LVL CHG. If the airspeed increases to VMO, the DFCS will change to LVL CHG.



DFCS - OPERATION - VERTICAL SPEED

DFCS - OPERATION - ALTITUDE HOLD

General

When the crew pushes the ALT HLD mode selector switch, the airplane will try to hold the present altitude. The DFCS can also automatically go into the altitude hold mode when it reaches the altitude set on the MCP.

ALT HLD Mode Selector Switch

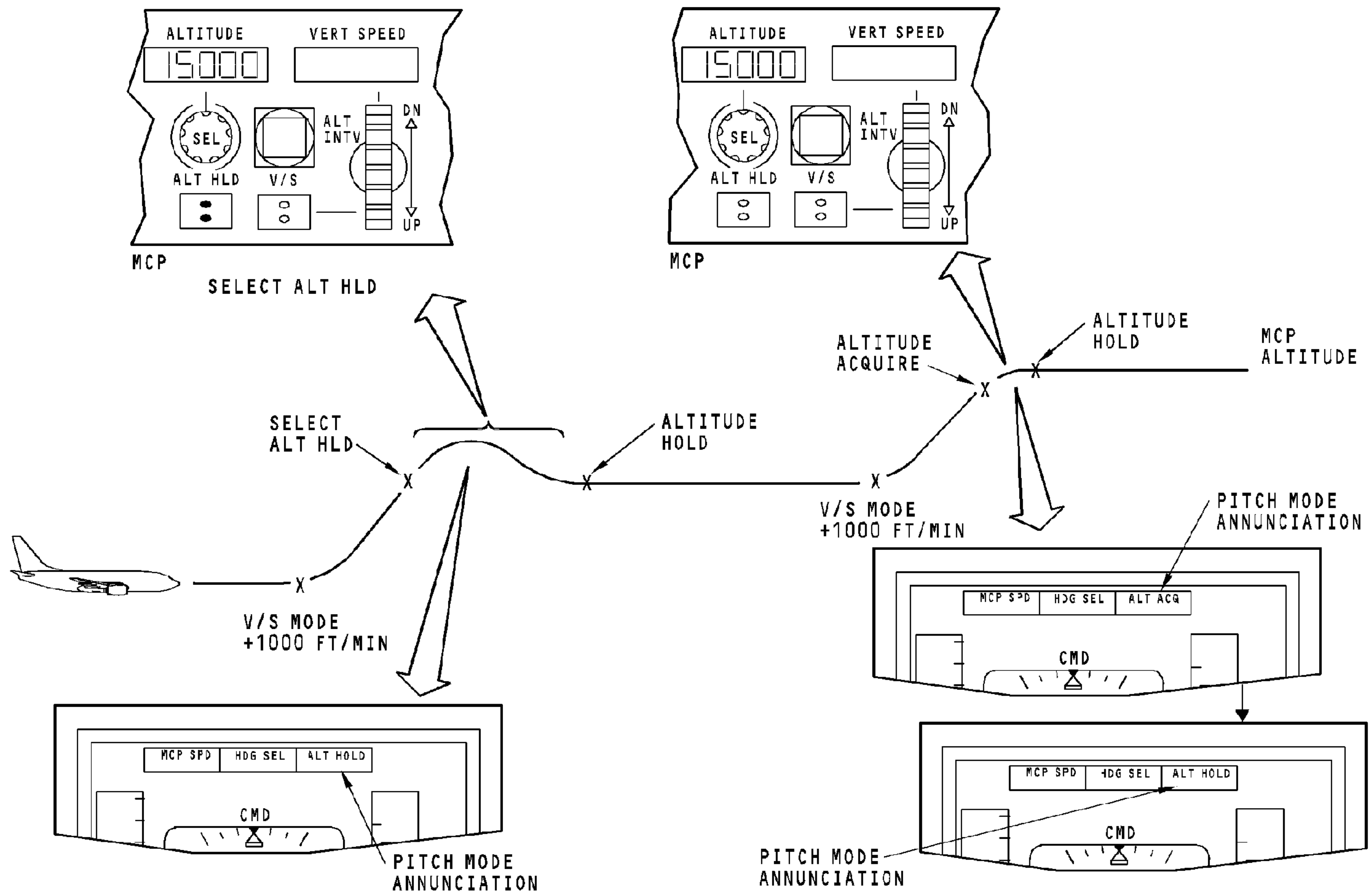
These things occur when the pilot pushes the ALT HLD mode selector switch on the MCP:

- The DFCS tries to hold the present inertial altitude, if available, or uncorrected barometric altitude if not available. The airplane will overshoot the altitude and return to it
- The ALT HLD mode selector switch LEDs turn on
- The FMA shows ALT HOLD in green letters.

Reach MCP Altitude

This altitude hold sequence starts as the airplane approaches the MCP selected altitude:

- The FMA shows ALT ACQ in green letters and the airplane starts to level off
- The airplane holds the altitude set on the MCP
- The ALT HLD mode selector switch LEDs turn on
- The FMA changes to ALT HOLD in green letters.



DFCS - OPERATION - ALTITUDE HOLD

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DFCS - OPERATION - LEVEL CHANGE

General

The level change (LVL CHG) mode lets the pilot change flight levels with the DFCS and the A/T. The LVL CHG mode always commands the airplane to the MCP selected altitude. If the airplane is at the MCP selected altitude, LVL CHG will not become active.

During LVL CHG, the autothrottle controls thrust. The DFCS controls airspeed with the elevator. The speed reference is the MCP selected speed.

LVL CHG Mode Selector Switch

The pilot must set a target altitude on the MCP before they push the LVL CHG mode selector switch.

If the pilot pushes the LVL CHG mode selector switch when in VNAV, the MCP IAS/MACH indicator shows the FMC target speed. The DFCS controls to this speed until the pilot sets a new speed in the window.

If the pilot pushes the LVL CHG mode selector switch when in TO/GA, the MCP IAS/MACH indicator shows the higher of these:

- Present airspeed
- Speed set in the MCP.

If the pilot pushes the LVL CHG mode selector switch when in another mode, the MCP IAS/MACH indicator shows the present airspeed.

For all selection methods, the DFCS controls to the speed on the MCP IAS/MACH indicator until the pilot sets a new speed.

The airplane speed stays within these limits:

- Flap and gear placard speeds
- Maximum operating velocity and mach (VMO/MMO)
- Alpha floor minimum speed.

With the LVL CHG mode active, the LEDs on the LVL CHG mode selector switch are on. MCP SPD shows on the FMA in green letters.

Altitude Capture

When the airplane is at the altitude set on the MCP, the DFCS pitch mode changes to ALT ACQ and then to ALT HOLD.

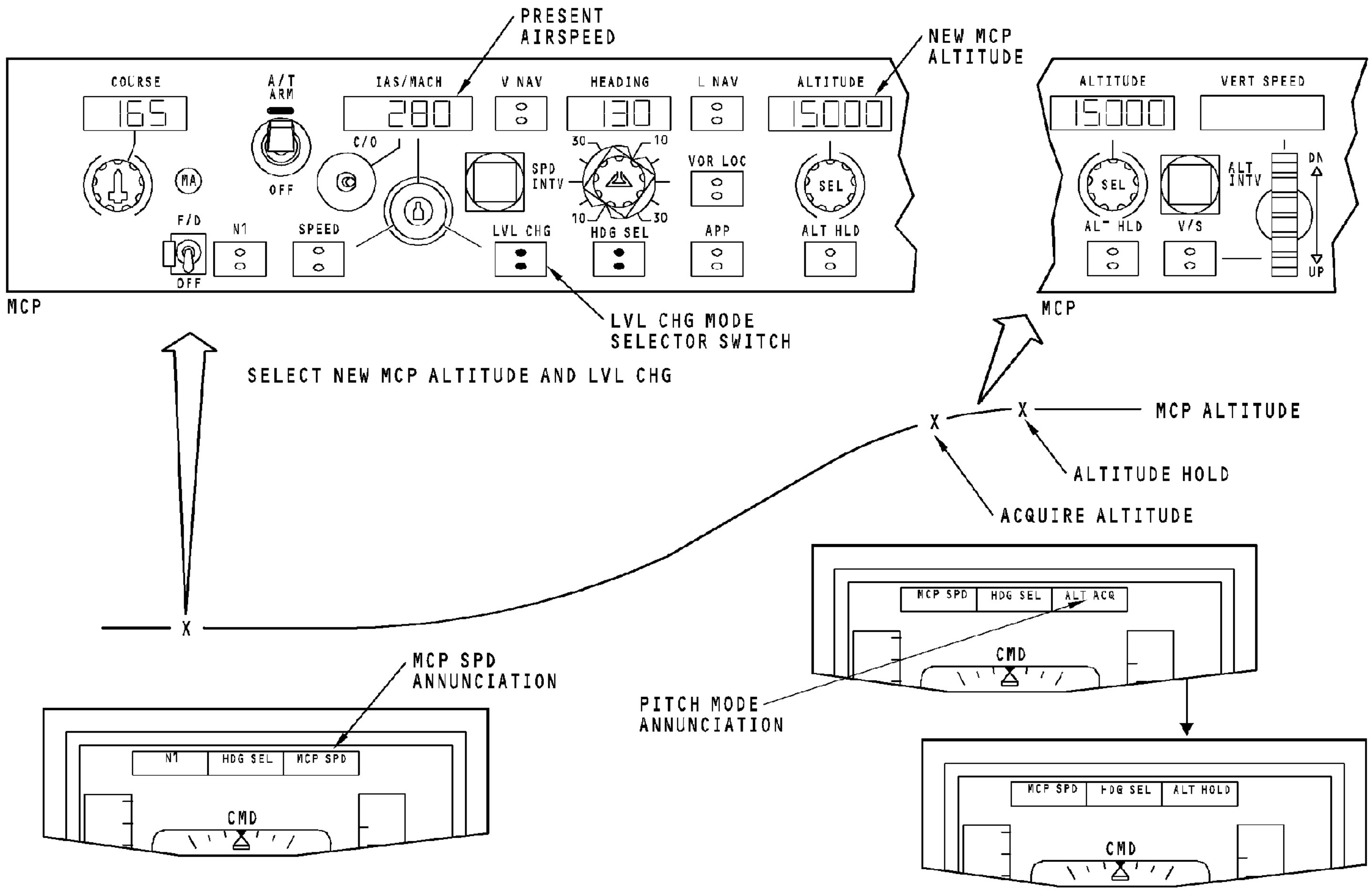
Reversion Modes

The DFCS automatically switches to the LVL CHG mode if any of these conditions occur:

- When in V/S or VNAV and the speed decreases to within 1.3 times the stall speed
- When in V/S or VNAV and the A/T is disengaged or engaged at aft stop and the speed approaches VMO/MMO

DFCS - OPERATION - LEVEL CHANGE

- When in V/S and the airplane cannot get to the MCP selected speed.



DFCS - OPERATION - LEVEL CHANGE

DFCS - OPERATION - PITCH CWS

General

In pitch control wheel steering (CWS), the pilot controls the airplane as if the A/P is disengaged. The control of the airplane is from two CWS force transducers and through the FCC. The pitch CWS mode has an attitude hold and an out-of-detent (O/D) submode.

These are the three ways to engage the pitch CWS mode:

- Push the CWS A/P engage switch
- Push the CMD A/P engage switch and do not select a pitch mode
- When a pitch CMD mode is active, apply a column force of more than 21 pounds, hi detent.

The FMA annunciation is the amber CWS P in the DFCS status column.

The force on the control column, while in pitch CWS, is one of these three levels:

- In-detent, less than 5.0 pounds
- Low detent, more than in-detent level but 21 pounds or less
- Hi detent, more than 21 pounds of force.

Attitude Hold Submode

When you engage the CWS mode, the A/P goes to the attitude hold submode. In this submode, the A/P holds the airplane pitch atitude to the pitch attitude at the time the A/P enters the CWS mode.

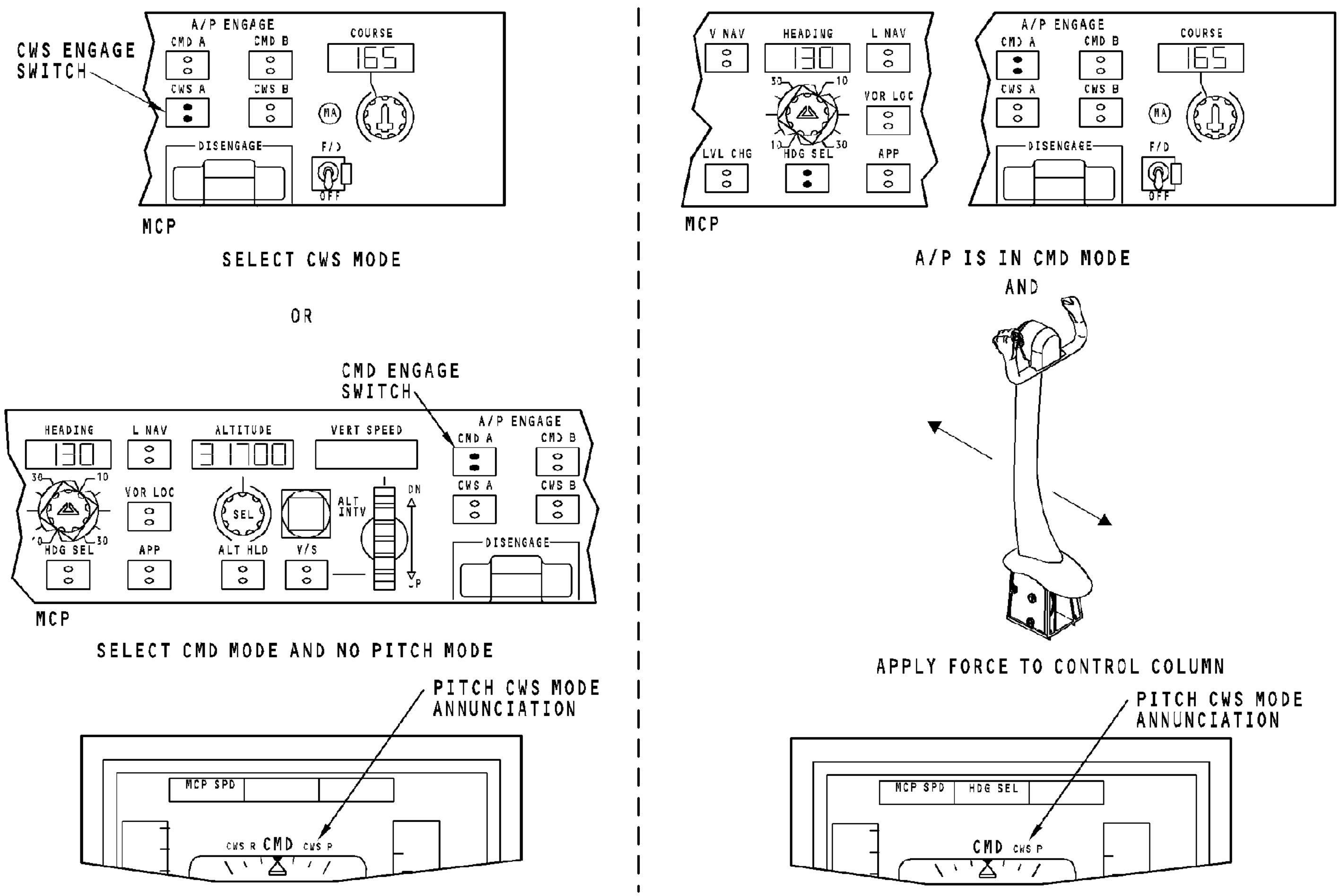
Pitch CWS O/D

When the control column force is out-of-detent, low or hi detent, the pilot controls the airplane pitch attitude. The captain and first officer pitch CWS force transducers send a signal to the FCC. The FCC averages the two signals and the FCC sends a control signal to the A/P actuators.

When the control column force goes back to in-detent, the A/P goes to the attitude hold submode.

If the A/P is in another pitch CMD mode, such as V/S, and the control column is in hi detent, the A/P goes to the pitch CWS mode. This cannot occur if the A/P is in the approach mode.

If the A/P was in the ALT HOLD or the ALT ACQ mode, the force on the control column must remain until the airplane is more than 250 feet from the MCP altitude. If not, the A/P will return to the ALT HOLD or ALT ACQ mode and stay in CMD.



DFCS - OPERATION - PITCH CWS

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DFCS - OPERATION - APPROACH INTRODUCTION

General

HAP 001-013, 015-026, 028-036, 038-054, 101-999

You can push the VOR LOC mode selector switch to select a VOR or LOC roll approach mode for landing. If the frequency set in the navigation control panel is a VOR frequency, the VOR roll approach mode is selected. If the frequency set in the navigation control panel is an ILS frequency, the LOC roll approach mode is selected.

HAP 037

You can push the VOR LOC mode selector switch to select a VOR or LOC roll approach mode for landing. If the frequency set in the navigation control panel is a VOR frequency, the VOR roll approach mode is selected. If the frequency set in the navigation control panel is an ILS frequency or a GLS channel, the LOC roll approach mode is selected.

You can push the APP mode selector switch to select the LOC and the glideslope (G/S) modes for the approach.

If you select APP and a GLS channel, then the GLS is the source of vertical and horizontal guidance.

You can engage one A/P in CMD for a single approach or you can engage both A/Ps in CMD for a dual approach. You can turn on the F/Ds for all of these approach modes.

HAP ALL

You can also engage the A/P in CWS and use the roll CWS for A/P only commands for an approach.

VOR Approach Mode

You can select a VOR approach to the runway. The VOR approach mode is very similar to the VOR cruise mode. When in the VOR approach sequence, the beam deviation and course error signal gains are smaller than when in the cruise mode.

The VOR mode changes to approach when these conditions occur:

- True airspeed is less than 250 knots
- Radio altitude is below 1500 feet
- Landing gear is down.

LOC Approach Mode

HAP 001-013, 015-026, 028-036, 038-054, 101-999

When in the localizer mode, the ILS receiver supplies lateral guidance to capture and track the localizer beam. The flight crew uses the localizer only approach when glideslope is not available or they use a different vertical path for descent.

DFCS - OPERATION - APPROACH INTRODUCTION

HAP 001-013, 015-026, 028-036, 038-054, 101-999 (Continued)

HAP 037

When in the localizer mode, the ILS receiver or the GLS receiver supplies lateral guidance to capture and track the lateral path. The flight crew uses the localizer only approach when they use a different vertical path for descent.

HAP ALL

G/S Approach Mode

HAP 001-013, 015-026, 028-036, 038-054, 101-999

When in the glideslope mode, the ILS receiver supplies vertical guidance to capture and track the glideslope beam. To get into the G/S mode you have to push the APP mode selector switch.

HAP 037

When in the glideslope mode, the ILS receiver or the GLS receiver supplies vertical guidance to capture and track the vertical path. To get into the G/S mode you have to push the APP mode selector switch.

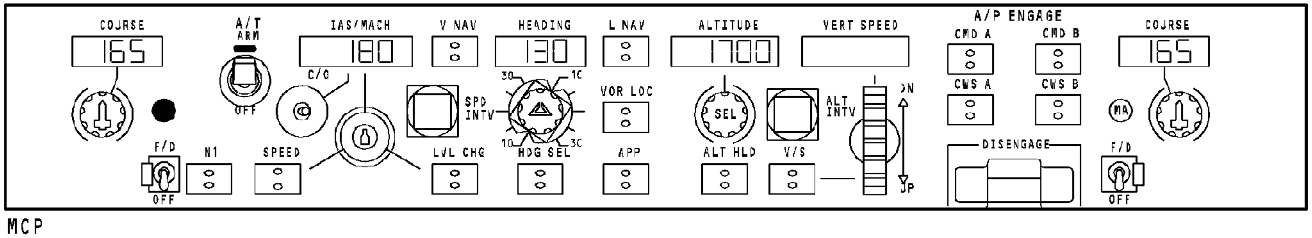
HAP ALL

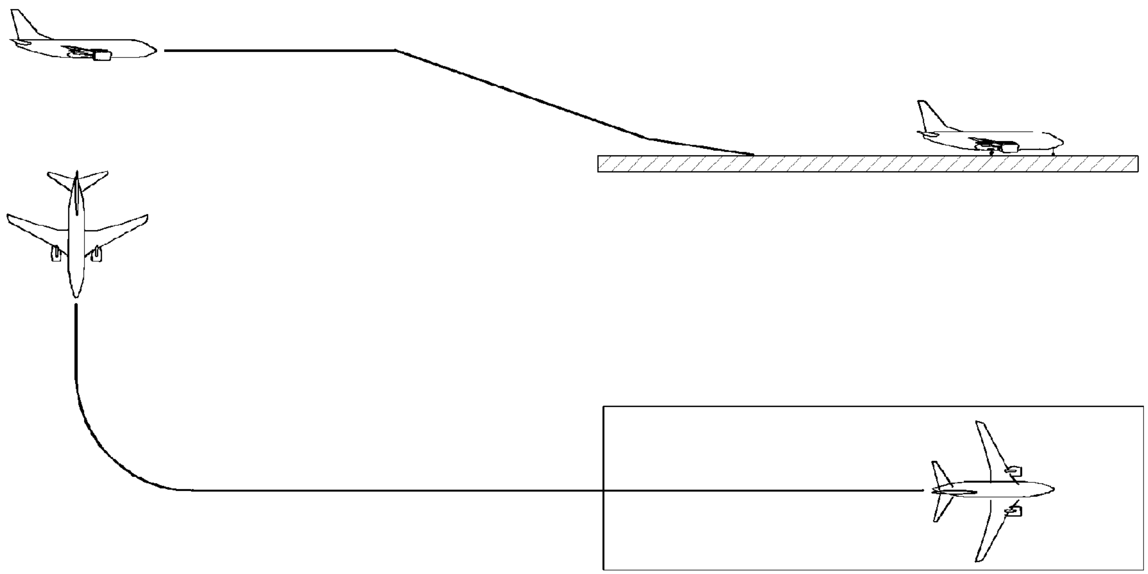
CWS Approach

You can use roll CWS for an approach. The heading hold submode does not operate but the attitude hold submode does.

The roll CWS approach mode occurs when any of these conditions are present:

- The F/D is in LOC engaged mode and the A/P is in CWS
- VOR engaged below 250 knots and A/P in CWS
- Gear is down below 1500 feet and A/P is in CWS or in CMD with no modes selected.





DFCS - OPERATION - APPROACH INTRODUCTION

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DFCS - OPERATION - LOCALIZER

General

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The flight crew can use the VOR LOC mode selector switch on the MCP to select a localizer only approach. The flight crew uses the localizer only approach when glideslope is not available or when they use a different vertical path for descent.

HAP 037

The flight crew can use the VOR LOC mode selector switch on the MCP to select a localizer only approach. The flight crew uses the localizer only approach when they use a different vertical path for descent.

HAP 001-013, 015-026, 028-036, 038-054, 101-999

An ILS frequency must be set into the navigation control panel and the ILS course set on the MCP.

HAP 037

An ILS frequency or GLS channel must be set into the navigation control panel and the ILS or GLS course set on the MCP.

HAP ALL

The flight crew can use another roll mode to fly the airplane to the localizer. In this example, the flight crew uses the heading select mode.

The LOC mode has these three submodes:

- Localizer arm
- Localizer capture
- Localizer on course.

Localizer Arm

The LOC mode arms when these conditions are valid:

HAP 001-013, 015-026, 028-036, 038-054, 101-999
- The crew selects an ILS frequency

HAP 037
- The crew selects an ILS frequency or GLS channel

HAP ALL
- A/P is engaged in roll CWS, HDG SEL or LNAV mode
- The crew pushes the VOR LOC mode selector switch.

The VOR LOC mode selector switch on the MCP arms only the localizer mode. The CDS shows VOR/LOC in white letters. The VOR LOC mode switch light comes on.

Localizer Capture

The FCC determines the capture point of the localizer beam from this data:

- Airplane track angle
- Airplane speed
- Localizer deviation

HAP 001-013, 015-026, 028-036, 038-054, 101-999
- ILS course error

DFCS - OPERATION - LOCALIZER

HAP 001-013, 015-026, 028-036, 038-054, 101-999 (Continued)
HAP 037
- ILS or GLS course error

HAP ALL
- Airplane distance to runway.

When the airplane reaches the capture point, the active roll mode changes to VOR/LOC. The FMA shows VOR/LOC in green letters. When in the VOR capture mode, the bank angle limit is 30 degrees and the roll rate limit is 7 degrees per second.

Localizer On Course

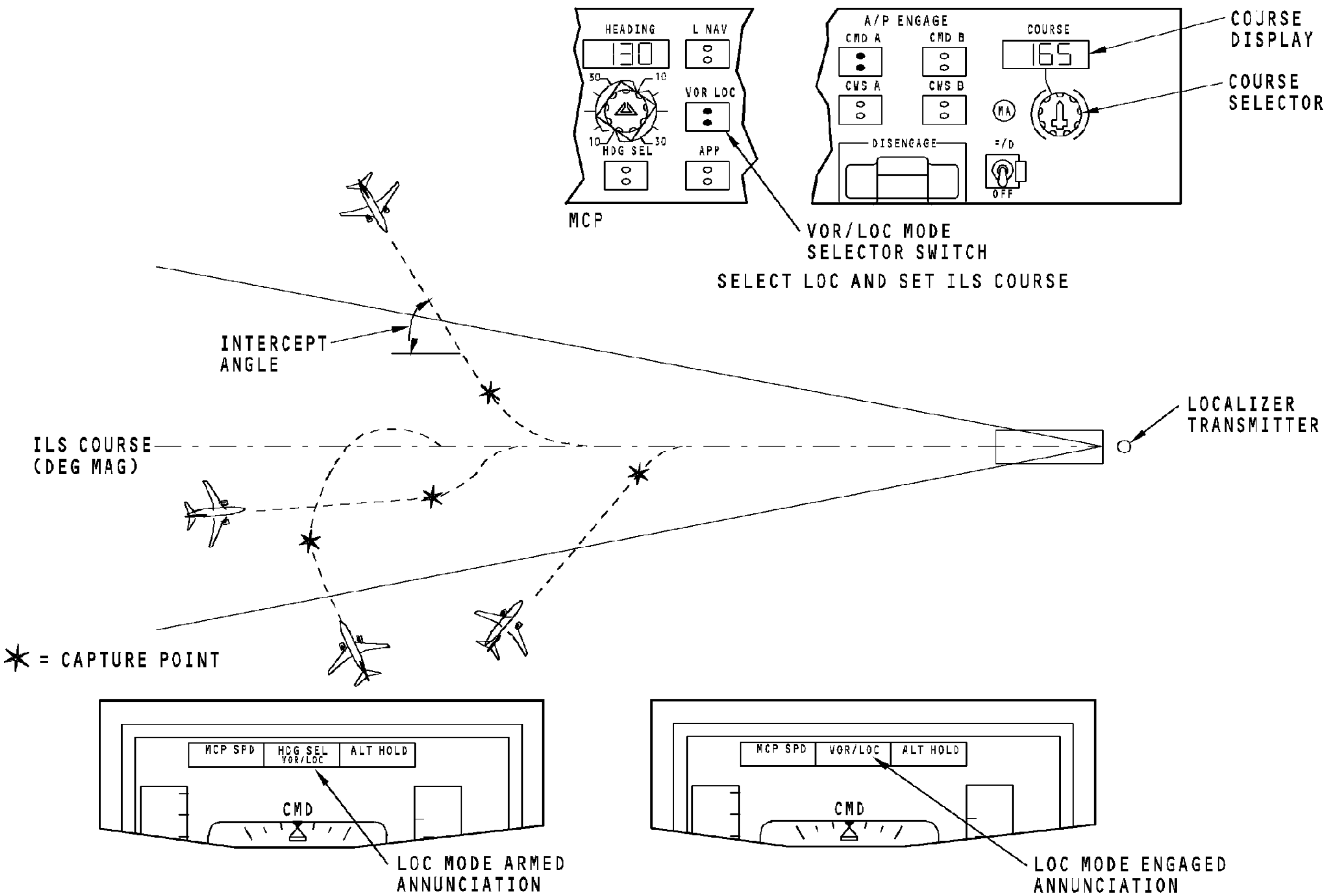
Localizer on course occurs when these conditions are valid:

- Localizer deviation is less than 0.8 degrees
- Beam rate is less than 0.045 degrees/second
- Bank angle is less than 6 degrees.

Localizer on course also occurs for these conditions:

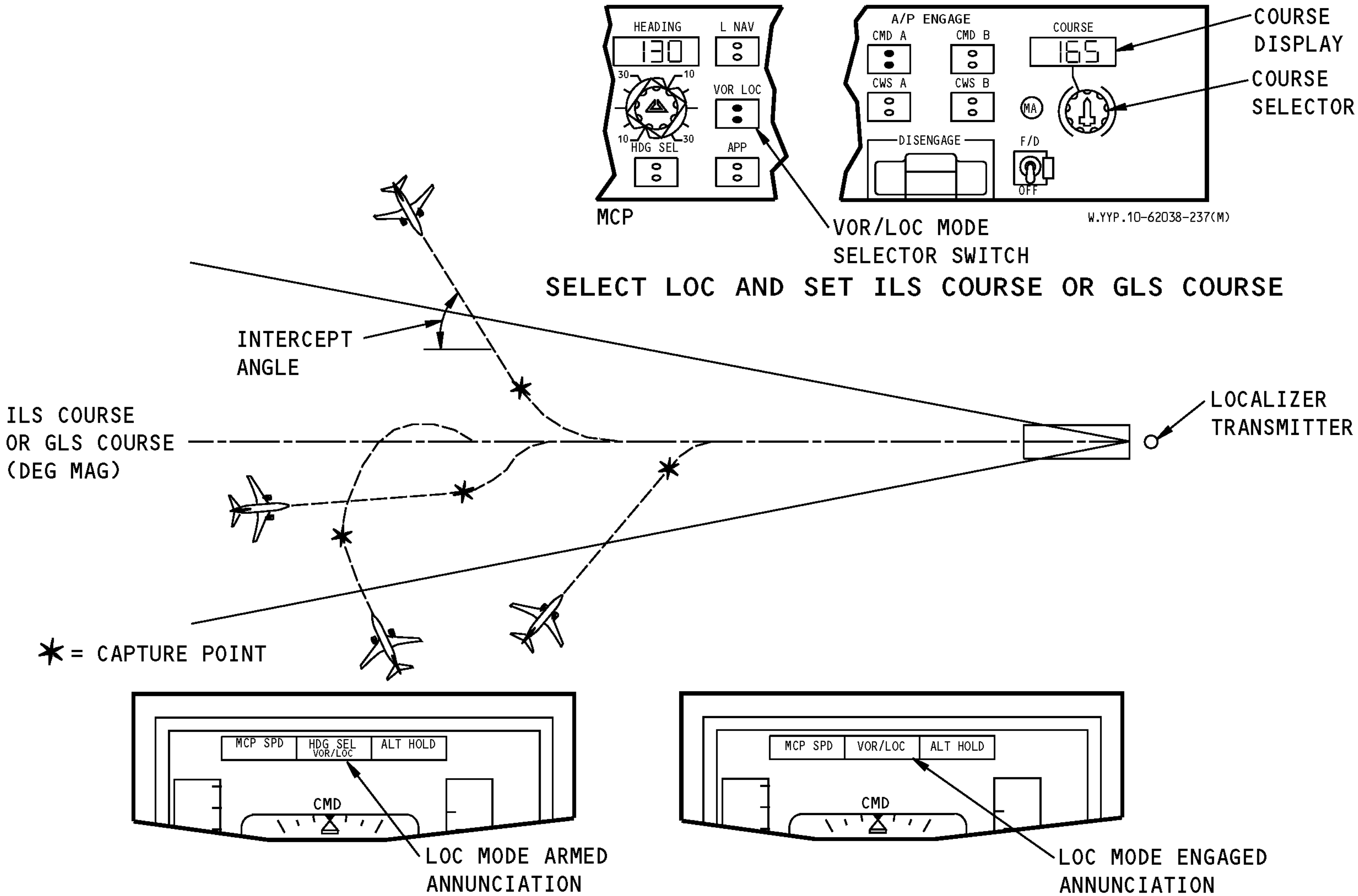
- The localizer was in the capture mode for more than 135 seconds
- The localizer deviation is less than 0.8 degrees.

The FCC starts to make crosswind corrections.



DFCS - OPERATION - LOCALIZER

22-11-00-095



DFCS - OPERATION - LOCALIZER

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DFCS - OPERATION - GLIDESLOPE

General

To select the glideslope as the approach pitch mode, the crew must push the APP mode selector switch. These are the glideslope submodes:

- Glideslope arm
- Glideslope capture.

Glideslope Arm

The glideslope mode arms when these conditions are valid:

HAP 001-013, 015-026, 028-036, 038-054, 101-999
- The crew selects an ILS frequency

HAP 037
- The crew selects an ILS frequency or GLS channel

HAP ALL
- The autopilot or flight directors are on
- The crew pushes the APP mode selector switch.

The FMA shows G/S in white letters. The APP mode selector switch light comes on.

Glideslope Capture

HAP 001-013, 015-026, 028-036, 038-054, 101-999

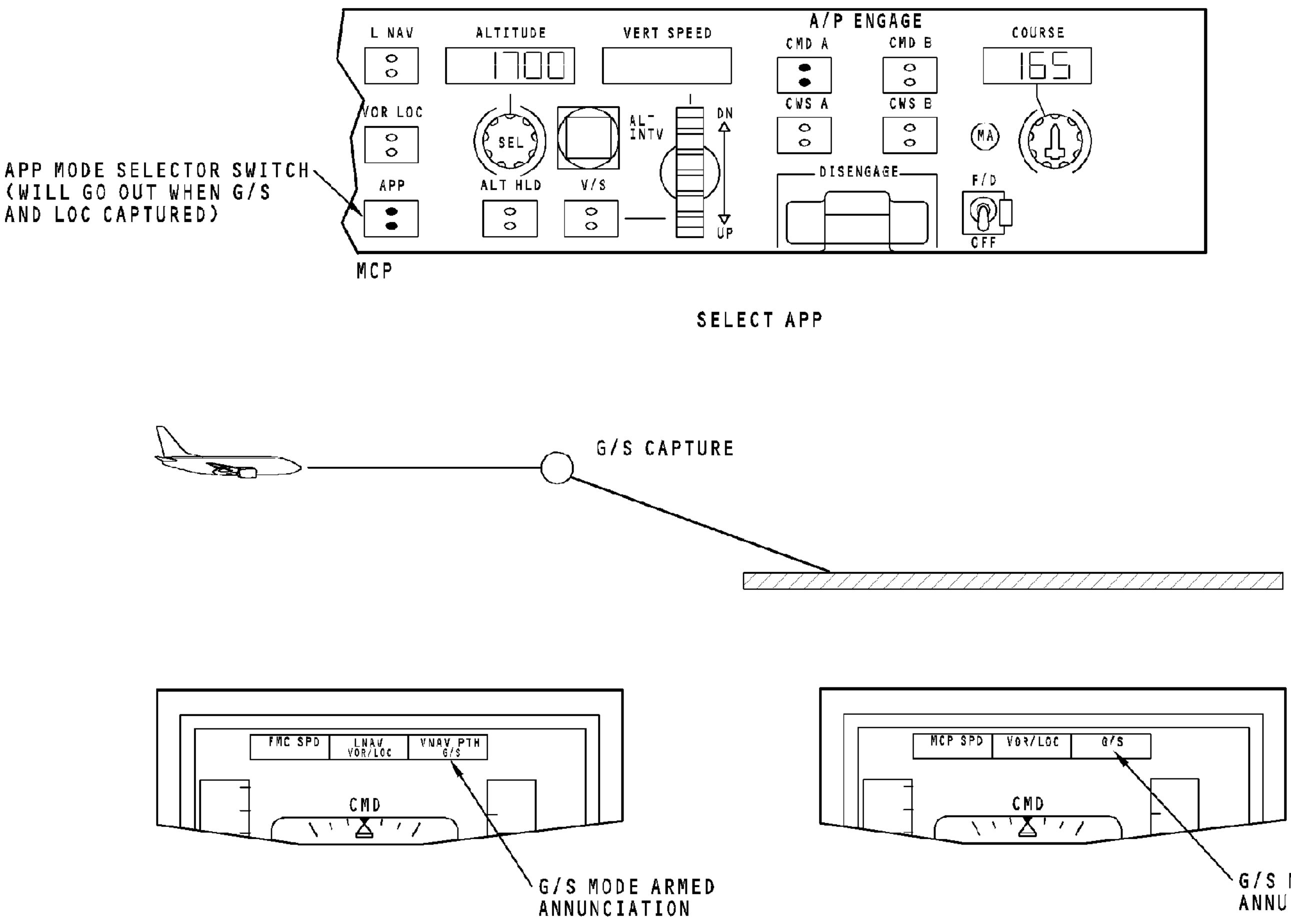
Glideslope capture occurs when the airplane is within 0.19 degrees of beam deviation for at least 2 seconds. The pitch cruise mode is automatically disengaged and further selection of pitch cruise modes are inhibited. The FMA shows G/S in green letters.

HAP 037

Glideslope capture occurs when the airplane is within 0.19 degrees of the vertical glide path deviation for at least 2 seconds. The pitch cruise mode is automatically disengaged and further selection of pitch cruise modes are inhibited. The FMA shows G/S in green letters.

HAP ALL

When both the glideslope and the localizer are in the capture mode, the APP mode selector switch light goes out. This means that the crew cannot deselect the approach mode by pushing the APP mode selector switch.



DFCS - OPERATION - GLIDESLOPE

DFCS - OPERATION - SINGLE CHANNEL APPROACH

General

HAP 001-013, 015-026, 028-036, 038-054, 101-999

When the crew wants to make an ILS approach, they push the APP mode selector switch. The single channel approach is made with only one A/P engaged. There can be one, two or no F/Ds on.

HAP 037

When the crew wants to make an ILS or GLS approach, they push the APP mode selector switch. The single channel approach is made with only one A/P engaged. There can be one, two or no F/Ds on.

HAP ALL

In the approach sequence, the autopilot captures the localizer and the glideslope. The autopilot must capture the localizer before it can capture the glideslope.

After localizer and glideslope capture, the A/P goes into the approach-on-course mode.

The flight mode annunciator (FMA) shows SINGLE CH in amber in the DFCS status column from the time of localizer capture until the crew disengages the autopilot.

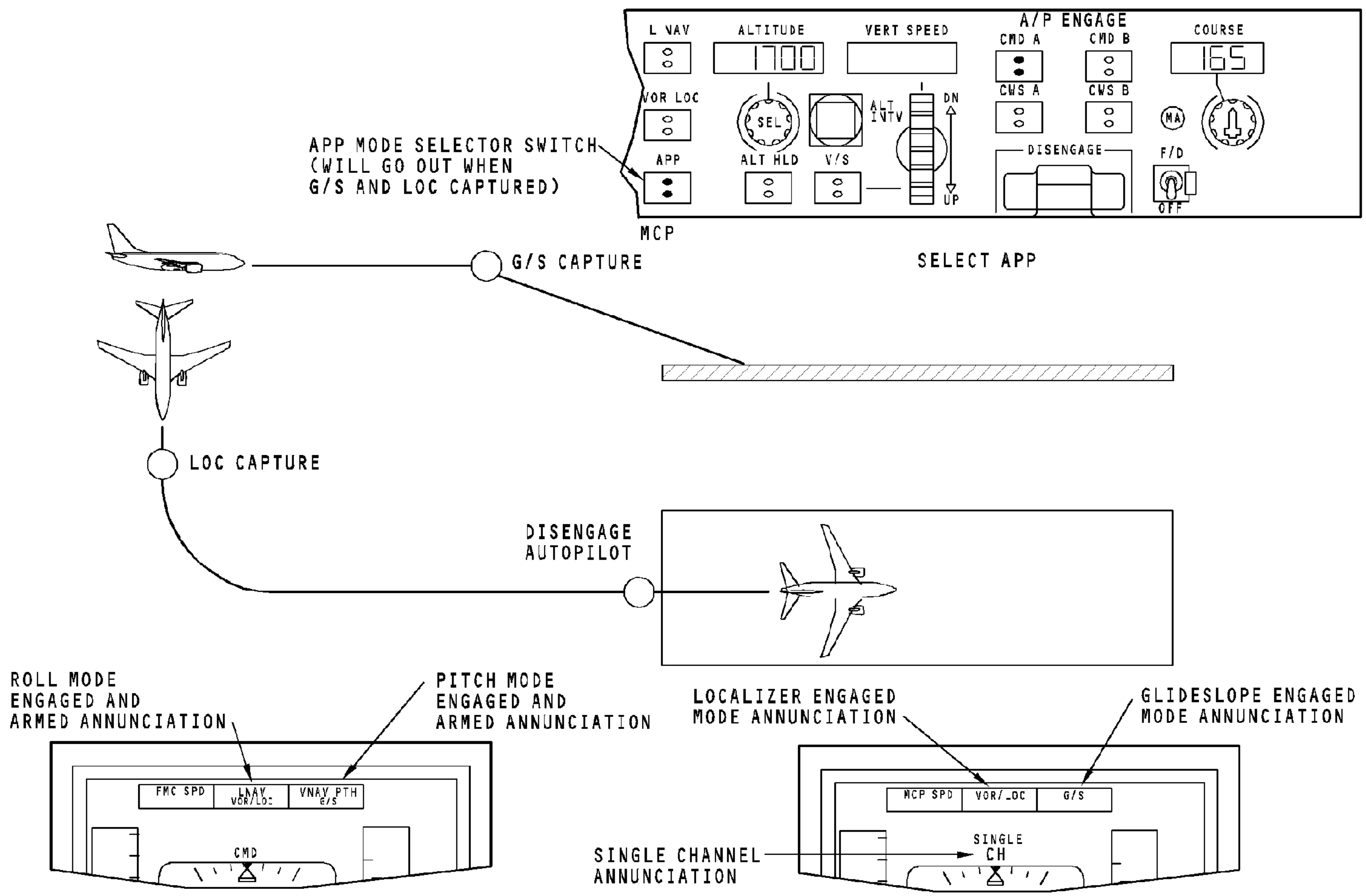
Approach On Course

The approach-on-course submode is the same as the localizer-on-course submode with these additions:

- The local radio altimeter must be valid
- The radio altitude is less than 1500 feet
- Glideslope is captured.

Single Channel Flare

Automatic flare is for dual channel approach, however, since it is part of the A/P design, it can function during single channel approaches. The flare mode does not annunciate on the FMA in a single channel approach. The autopilot should be disengaged manually when the airplane reaches the decision height.



DFCS - OPERATION - SINGLE CHANNEL APPROACH

DFCS - OPERATION - DUAL CHANNEL APPROACH

General

The crew can make a dual channel approach. They push the APP mode selector switch and then engage the second A/P in CMD. There can be one, two or no F/Ds on. This approach is similar to the single channel approach except A/P A and A/P B are engaged.

The FMA shows SINGLE CH in amber in the DFCS status area from localizer capture until the second A/P engages. This occurs 10 seconds after the approach-on-course submode is active. At this time, the FMA also shows FLARE in white letters in the pitch mode to show the crew that the DFCS is in the dual approach mode.

Dual Autopilots

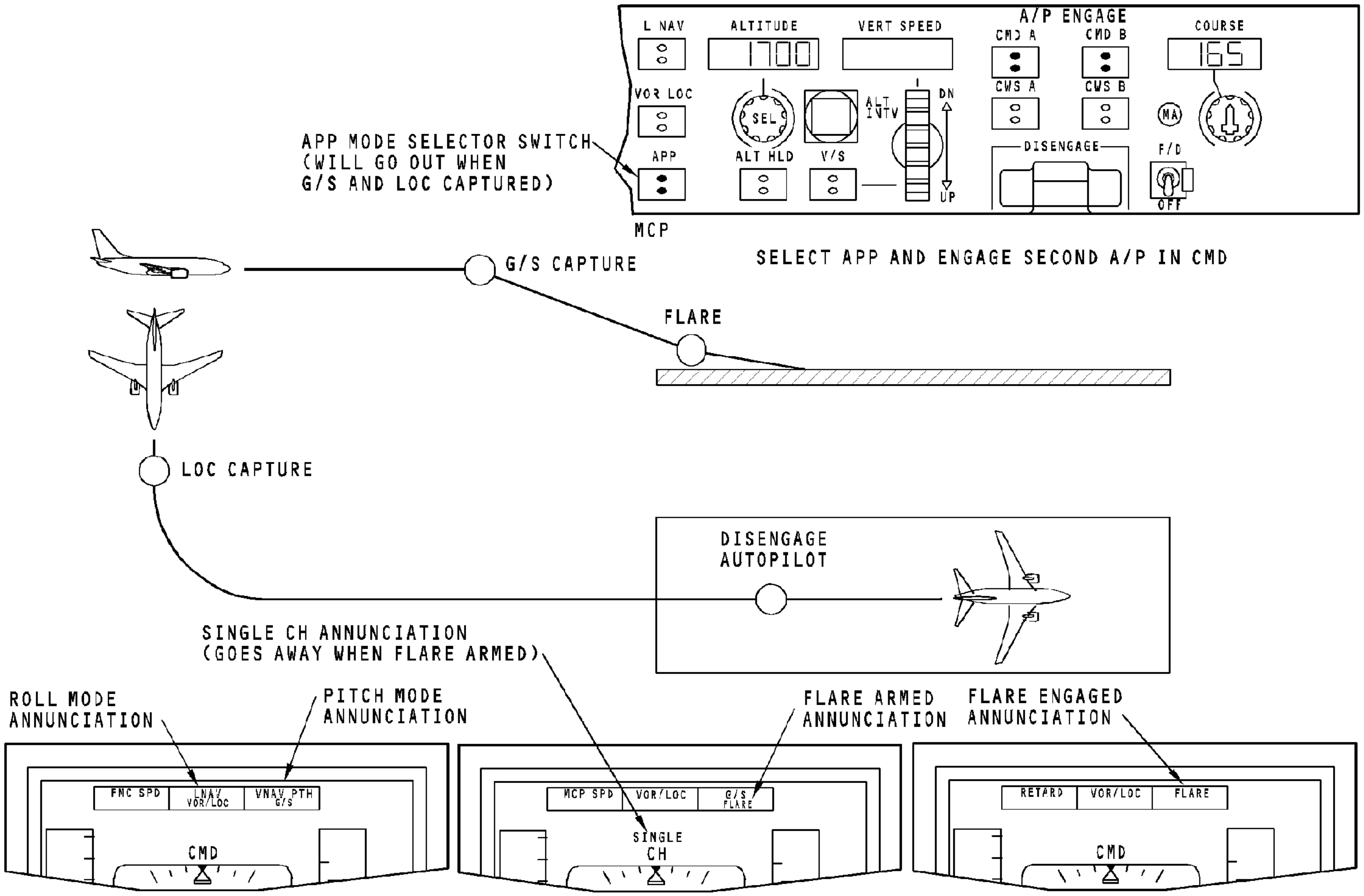
The second autopilot must be set to CMD before the airplane reaches a radio altitude of 800 feet. Below this altitude, the second autopilot cannot be engaged in CMD.

If FLARE does not show armed before the airplane reaches a radio altitude of 350 feet, the autopilots disengage.

Flare

The flare mode controls the airplane to a smooth touchdown at a point past the glideslope antenna. This is a computed command and is not part of the glideslope mode.

The autopilots start the flare at a radio altitude of 50 feet. The crew should disengage the autopilot at or after touchdown.



DFCS - OPERATION - DUAL CHANNEL APPROACH

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DFCS - OPERATION - AUTOPILOT GO-AROUND

General

The pilots can use the A/P go-around (G/A) mode to cancel an approach.

The A/P go-around mode consists of these conditions:

- A/P go-around arm
- A/P go-around reduced
- A/P go-around maximum
- A/P go-around exit.

A/P Go-Around Arm

A/P go-around arms when these conditions are true:

- The airplane is below 2000 feet radio altitude
- Both autopilots are engaged to CMD and the flare mode is armed or active.

The A/P G/A is available until touchdown (wheel spin up). If the crew pushes a TO/GA switch after touchdown, both A/Ps disengage, but the F/D and A/T G/A do not change.

The FMA and MCP continue to show the approach modes.

A/P Go-Around Reduced

The A/P go-around mode starts when the pilot pushes either TO/GA switch. TO/GA shows on the FMA as the active mode for the pitch mode. The roll mode annunciation is blank.

The pitch command is initially 15 degrees pitch up and then it changes to a speed control that is referenced to the flap settings. If an engine fails, the pitch command is a speed control that is referenced to the MCP speed.

The roll command holds the present magnetic track of the airplane over the ground.

The A/T command is a reduced thrust, but it still maintains a positive rate of climb.

A/P Go-Around Maximum

After the airplane reaches the reduced A/P go-around setting, the crew can push the TO/GA switch again. This increases the thrust setting.

See the authrottle system section for more information. (SECTION 22-31)

A/P Go-Around Exit

The pitch channel cannot exit from the A/P G/A mode if a single A/P cannot supply enough elevator control. When the trim conditions change so that the single A/P can supply enough elevator movement, pitch A/P G/A mode can be exited.

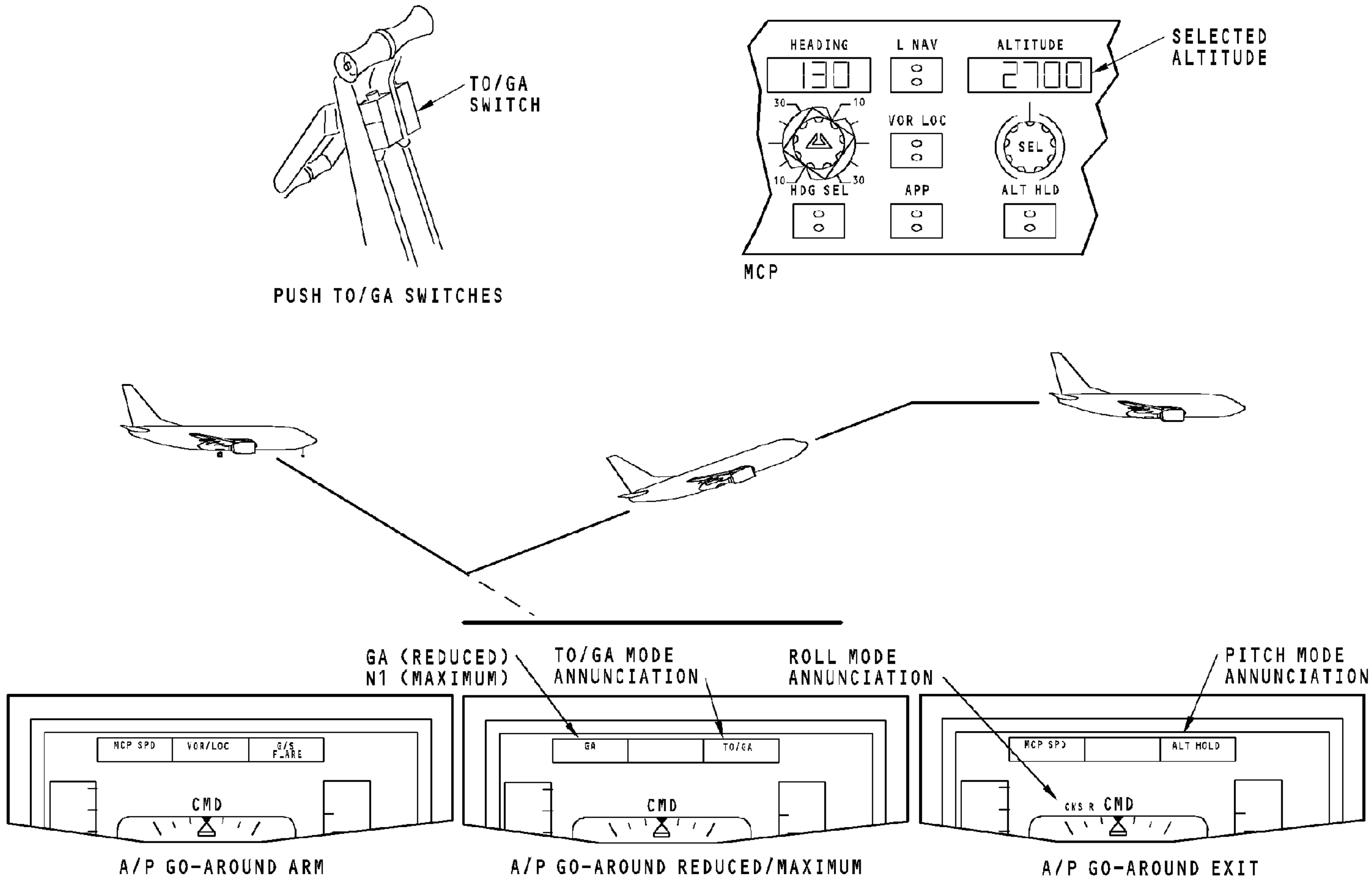
DFCS - OPERATION - AUTOPILOT GO-AROUND

The ALT ACQ mode is enabled for radio altitudes more than 800 feet. The airplane levels at the MCP altitude. If the single channel A/P does not have enough elevator control, the ALT ACQ mode is inhibited. The red A/P warning light on the autoflight status annunciator comes on steady red.

If the airplane levels off at the MCP altitude, the second A/P that was turned on disengages. The MCP IAS/MACH display shows the present speed. ALT HOLD and CWS R show on the FMA. The A/P stays in CWS R until the crew selects another roll mode.

Another way to exit the A/P G/A mode is to push the HDG SEL mode selector switch. The A/P exits the roll G/A to HDG SEL, but the pitch channels remain in A/P pitch G/A. Roll is now in single channel control, but pitch is still in dual channel control. The second A/P that was turned on disengages in the roll mode and turns off its aileron A/P actuator. Both A/Ps still show that they are in CMD.

When the crew selects a pitch cruise mode such as LVL CHG, the A/P exits the pitch G/A mode. The crew cannot use pitch CWS to exit A/P pitch G/A.



DFCS - OPERATION - AUTOPILOT GO-AROUND

22-11-00-099

DFCS - OPERATION - FLIGHT DIRECTOR GO-AROUND

General

The pilots can use the F/D go-around (G/A) mode if they want to cancel an approach or the airplane enters windshear conditions while landing.

The F/D go-around mode consists of these conditions:

- F/D go-around active
- F/D go-around exit.

F/D Go-Around Active

The F/D go-around mode starts when the pilot pushes either TO/GA switch and the airplane is below 2000 feet of radio altitude. TO/GA shows on the FMA as the active mode for the pitch mode. The roll mode annunciation is blank.

HAP 001-013, 015-026, 028-030; AIRPLANES WITH HONEYWELL FCC P/N 10-62038-7/-8 AND OPS SOFTWARE P/N 10-62038-708

The F/D go-around mode can be engage above 2000 feet of radio altitude if G/S(glide slope) is engaged or if the flaps are down.

HAP ALL

The pitch command is initially pitch up and then it changes to a speed control that is referenced to the flap settings. If an engine fails, the pitch command is a speed control that is referenced to the MCP speed.

The roll command holds the present magnetic track of the airplane over the ground.

In F/D go-around, the flight director display on the AIs automatically comes on even if the flight director switches are off. This is called the pop up mode. It occurs when all these conditions are true:

- A flight director switch is off
- The radio altitude is less than 2000 feet
- The pilot pushes a TO/GA switch.

F/D Go-Around Exit

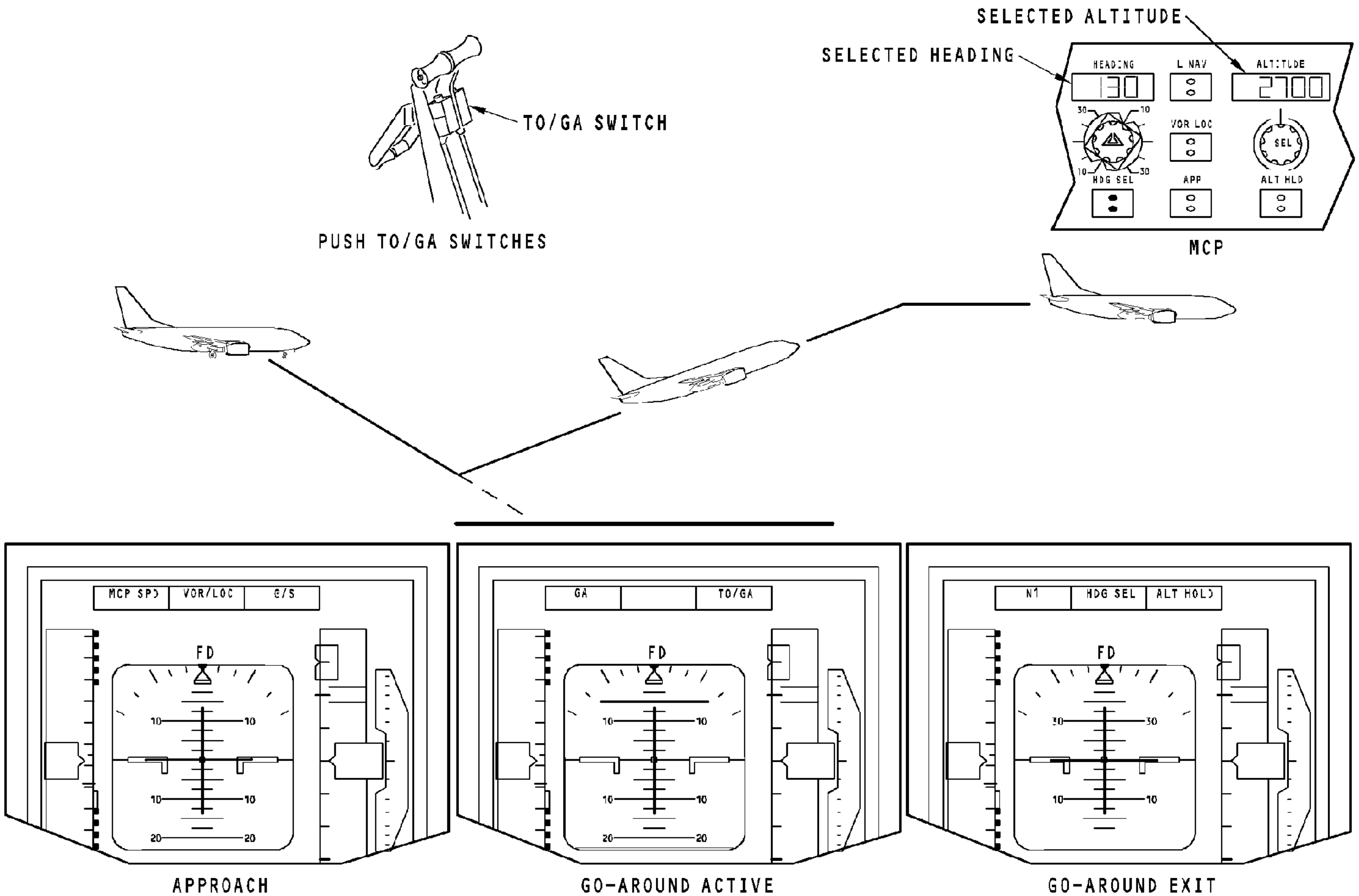
Below 400 feet, the DFCS stays in F/D go-around unless the pilot sets the flight director switches to off. Above 400 feet, the pilot can set another roll or pitch mode.

HAP 031-054, 101-999; AIRPLANES WITH COLLINS FCC SOFTWARE P/N 831-5854-130 AND ON

Below 400 feet, the DFCS stays in the F/D go-around and the pilot can switches to LNAV operation.

HAP ALL

If the pilot changes the pitch mode first, the roll mode will change to HDG SEL. If the pilot changes the roll mode first, the pitch mode remains in the pitch G/A mode. In the example the airplane changed from the pitch G/A mode to the altitude hold mode.



DFCS - OPERATION - FLIGHT DIRECTOR GO-AROUND

DFCS - OPERATION - AUTOFLIGHT GO-AROUND ROLL MODE - LNAV

General

The pilot can select LNAV as the active roll mode for go-around instead of track hold when a missed approach exists in the flight plan.

Normally when an approach is selected form the ARRIVALS page, it will include a missed approach. When a missed approach is in the flight plan and the FCCs are armed for go-around, LNAV ARM will be annuciated on the FMA.

The LNAV go-around mode consists of these conditions:

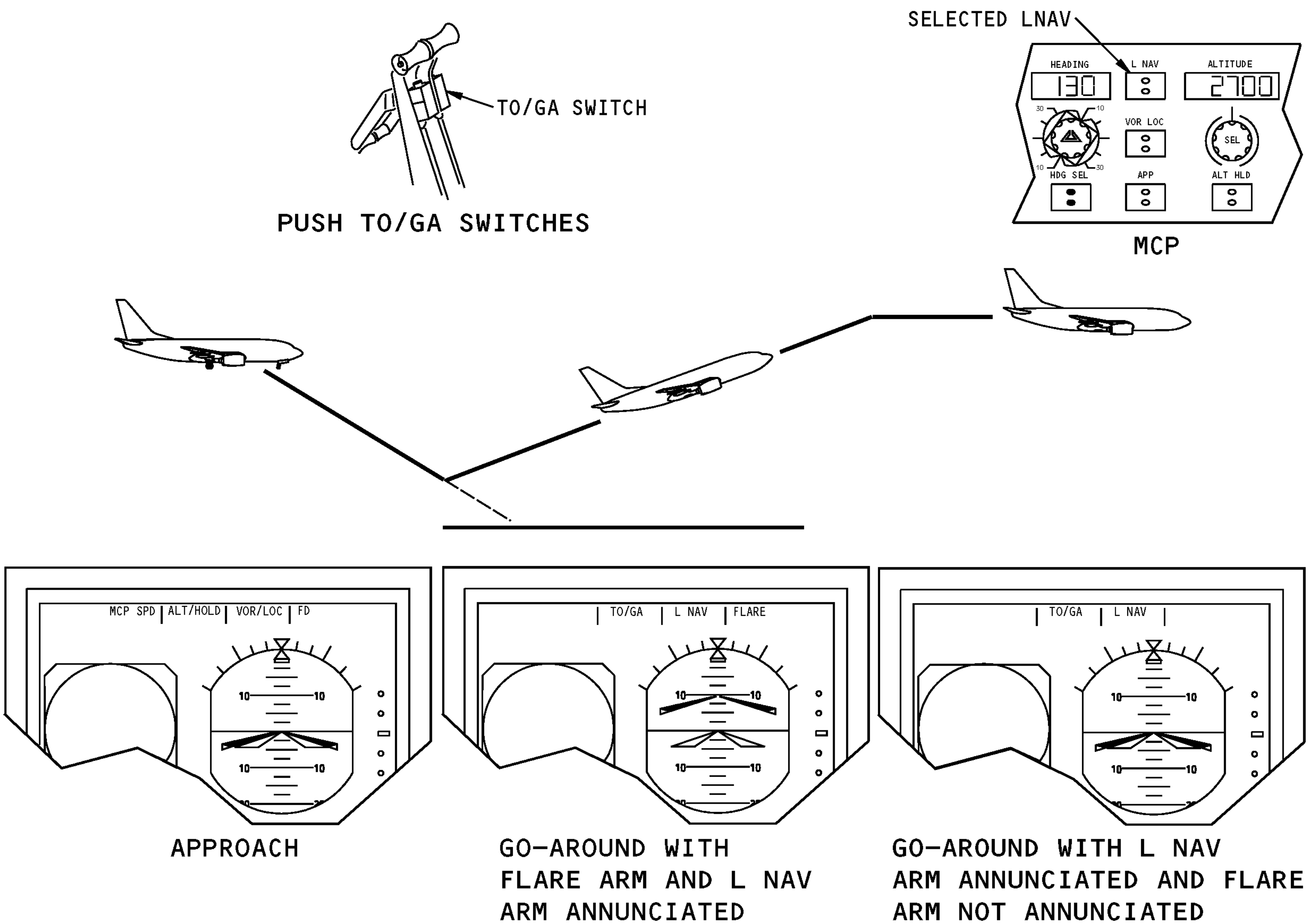
- TOGA is pressed with LNAV ARM and FLARE ARM annunciated.
- TOGA is pressed with LNAV ARM annunciated and FLARE ARM is not annunciated.

TOGA is pressed with LNAV ARM and FLARE ARM annunciated

If TOGA is pressed with FLARE ARM and LNAV ARM annunciated. LNAV will engage automatically upon reaching 400 feet (AGL). Prior to this condition, TOGA will be in altitude track hold.

TOGA is pressed with LNAV ARM annunciated and FLARE ARM is not annunciated

If TOGA is pressed with LNAV ARM annuciated and FLARE ARM is not annunciated, the flight director LNAV mode will engage when the airplane is above 50 feet (AGL). Prior to this condition, TOGA will be in altitude track hold.



DFCS - OPERATION - AUTOFLIGHT - GO AROUND ROLL MODE - LNAV

DFCS - OPERATION - GROUND OPERATIONS - TO/GA SWITCH

General

You can engage the autopilot in CMD or CWS and turn on the flight directors while on the ground. You can activate some of the modes while on the ground. You need hydraulic power to engage the autopilot.

When on the ground, the magnetic heading replaces the magnetic track so you can do several tests.

TO/GA and Flight Directors

The graphic shows what you see if you turn on the flight directors (F/D) and push the TO/GA switch on the ground.

When you turn on the captain F/D switch the master annunciator light above the switch turns on. The captain FMA shows FD. Turn on the first officer F/D switch. The first officer FMA shows FD.

When you push a TO/GA switch the first officer master annunciator turns on. Both FMAs show these annunciations:

- TO/GA
- HDG SEL
- FD.

The F/D commands show on the AI. The pitch command is set to -10 degrees and the roll command shows a command to turn to the selected heading.

TO/GA and Autopilot

Engage A/P A in CMD. The CMD A light comes on on the engage switch. The FMAs shows these annunciations:

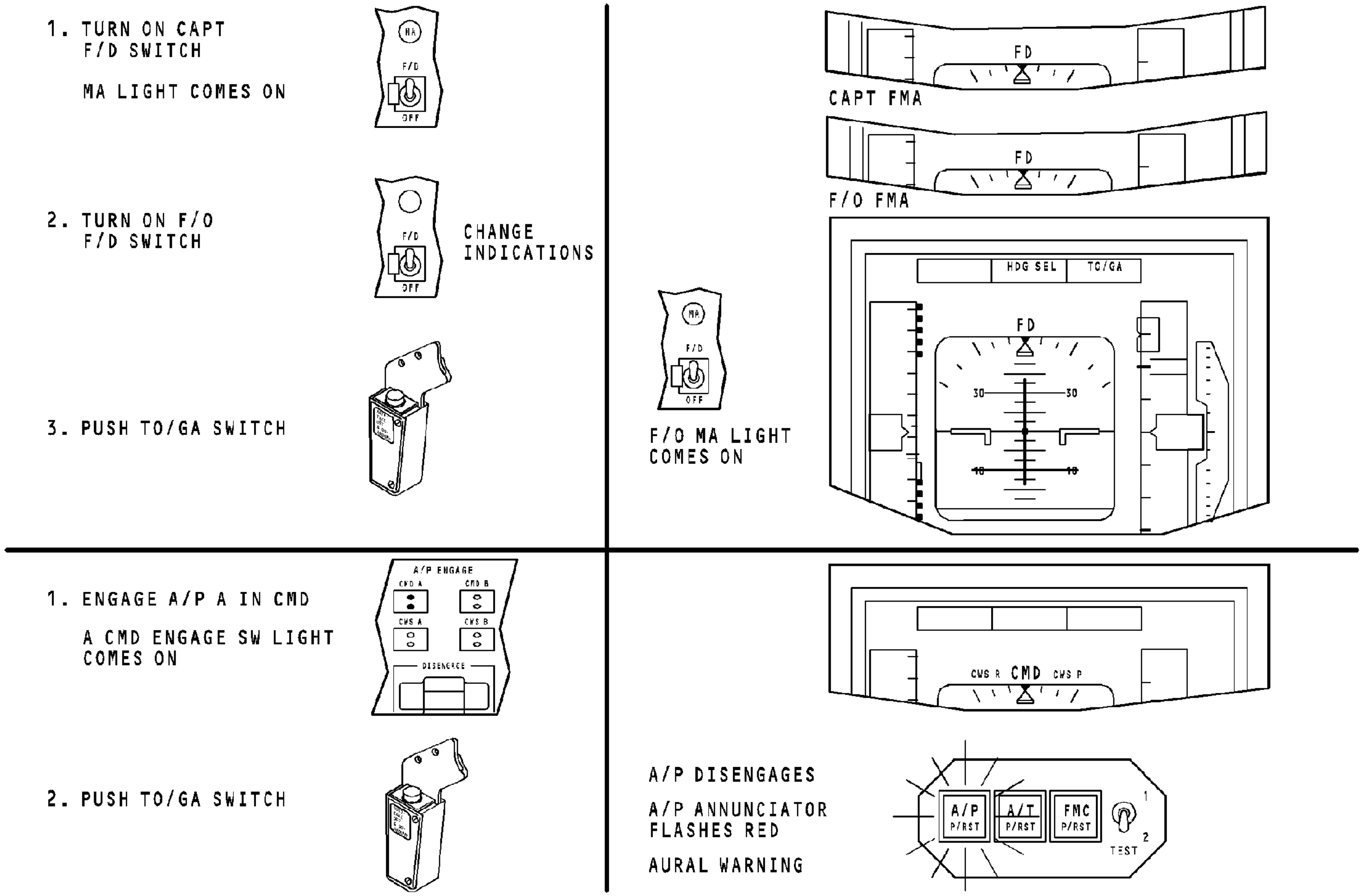
- CMD
- CWS P
- CWS R.

Push the TO/GA switch and the A/P disengages. The red A/P light on the ASAs flashes and the aural warning supplies a wailer sound.

Training Information Point

If you turn on the hydraulic power, observe the following warning.

WARNING: MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF ALL CONTROL SURFACES BEFORE YOU SUPPLY HYDRAULIC POWER. AILERONS, RUDDER, ELEVATORS, FLAPS, SPOILERS, LANDING GEAR, AND THRUST REVERSERS CAN MOVE QUICKLY WHEN YOU SUPPLY HYDRAULIC POWER. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.



DFCS - OPERATION - GROUND OPERATIONS - TO/GA SWITCH

DFCS - OPERATION - GROUND OPERATIONS - ROLL MODE - LNAV AND HDG SEL

General

You can push these roll mode selector switches on the MCP and activate these modes when the airplane is on the ground and the F/Ds are on:

- LNAV
- HDG SEL
- VOR LOC.

You can push the HDG SEL or VOR LOC mode selector switch when an A/P is engaged. You cannot activate LNAV on the ground when an A/P is engaged.

LNAV

When you push the LNAV mode selector switch, the mode selector switch light comes on. You can also see LNAV and FD on the FMA. You do not see any F/D commands on the AI.

HDG SEL and Flight Directors

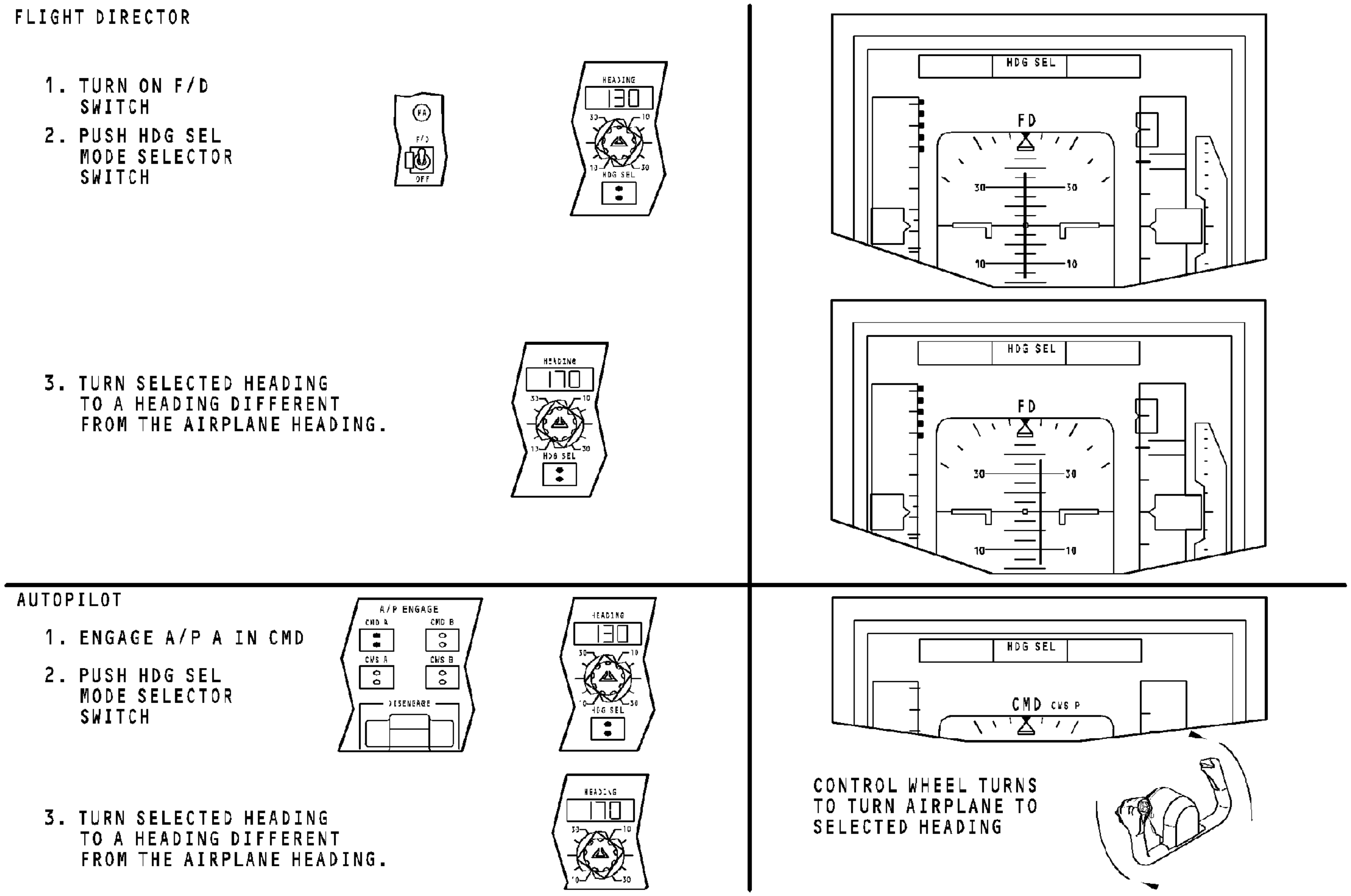
Turn on the F/Ds and push the HDG SEL mode selector switch. The FMA annunciator shows HDG SEL and FD. The F/D roll command bar shows on the AI. Turn the selected heading to a heading different from the airplane heading. The F/D roll command bar will move to command a turn to the selected heading.

HDG SEL and Autopilot

Engage A/P A in CMD and push the HDG SEL mode selector switch. These annunciations show on the FMA:

- HDG SEL
- CMD
- CWS P.

Turn the selected heading to a heading different from the airplane heading. The control wheel will turn to turn to the selected heading.



DFCS - OPERATION - GROUND OPERATIONS - ROLL MODE - LNAV AND HDG SEL

VOR LOC

Unless the VOR station is very close to the airport, you will not receive a valid VOR signal. However, you may be able to receive the localizer signal.

Flight Director

Turn on the F/Ds and push the VOR LOC mode selector switch. Tune the navigation control panel to the airport ILS frequency. The FMA shows VOR LOC and FD in green letters. The F/D roll command bar shows on the AI. This occurs if the ILS receiver receives a valid LOC signal. The F/D roll bar may move to command a turn to the localizer centerline.

Autopilot

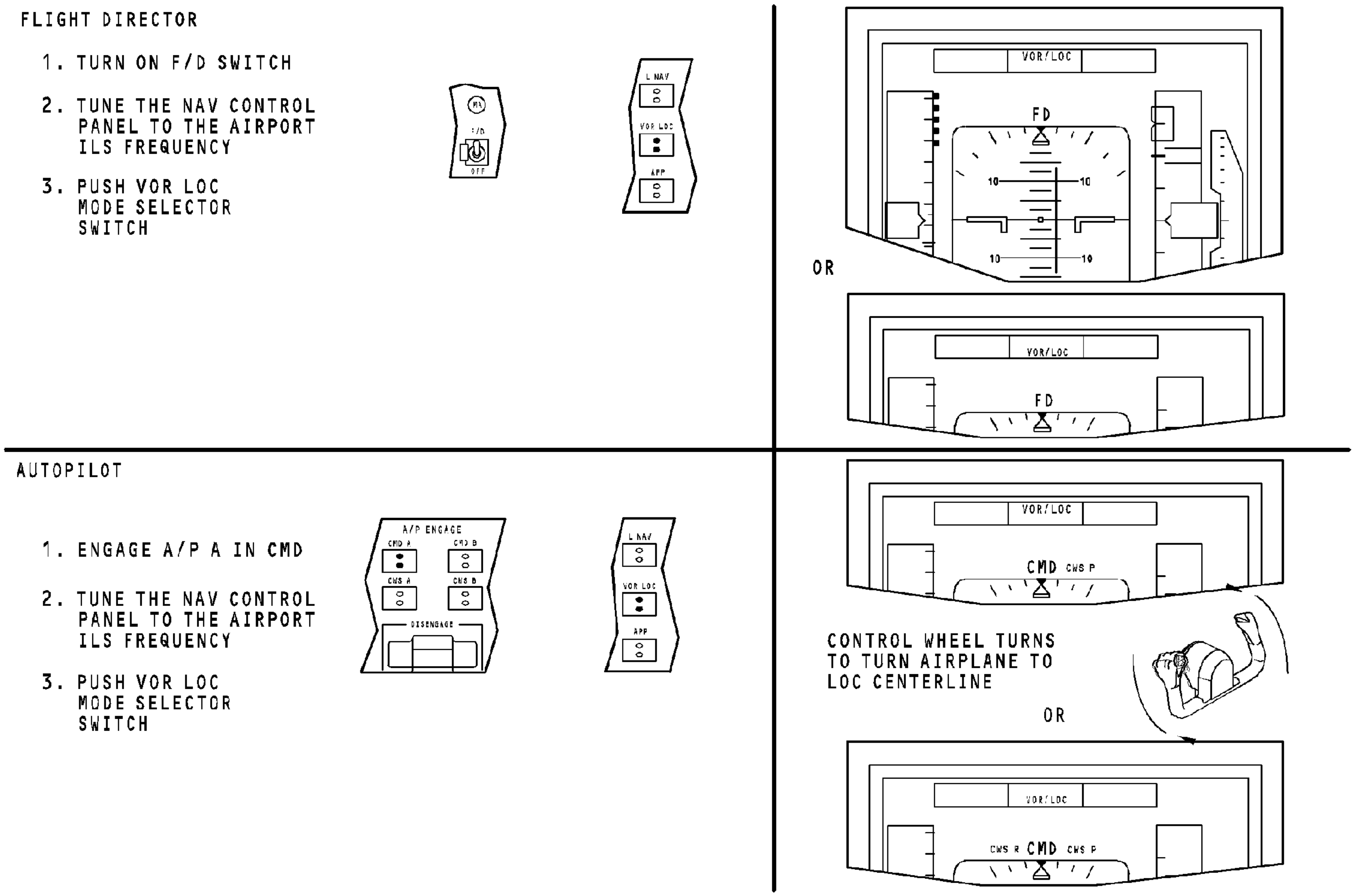
Engage A/P A in CMD and push the VOR LOC mode selector switch. These annunciations show on the FMA if the ILS receiver has a valid localizer signal:

- VOR LOC in green letters (active)
- CMD
- CWS P.

The control wheel may turn to turn the airplane to the localizer centerline.

If the ILS receiver does not have a valid localizer signal, these show on the FMA:

- VOR LOC in white letters (armed)
- CMD
- CWS P
- CWS R.



DFCS - OPERATION - GROUND OPERATIONS - ROLL MODE - VOR/LOC

22-11-00-108

DFCS - OPERATION - GROUND OPERATIONS - PITCH MODE - ALT HOLD

General

You can push these mode selector switches on the MCP and activate the modes when the airplane is on the ground:

- ALT HLD
- LVL CHG.

You cannot activate the VNAV mode when on the ground. You can push the V/S mode selector switch on the ground, however, the mode changes to LVL CHG.

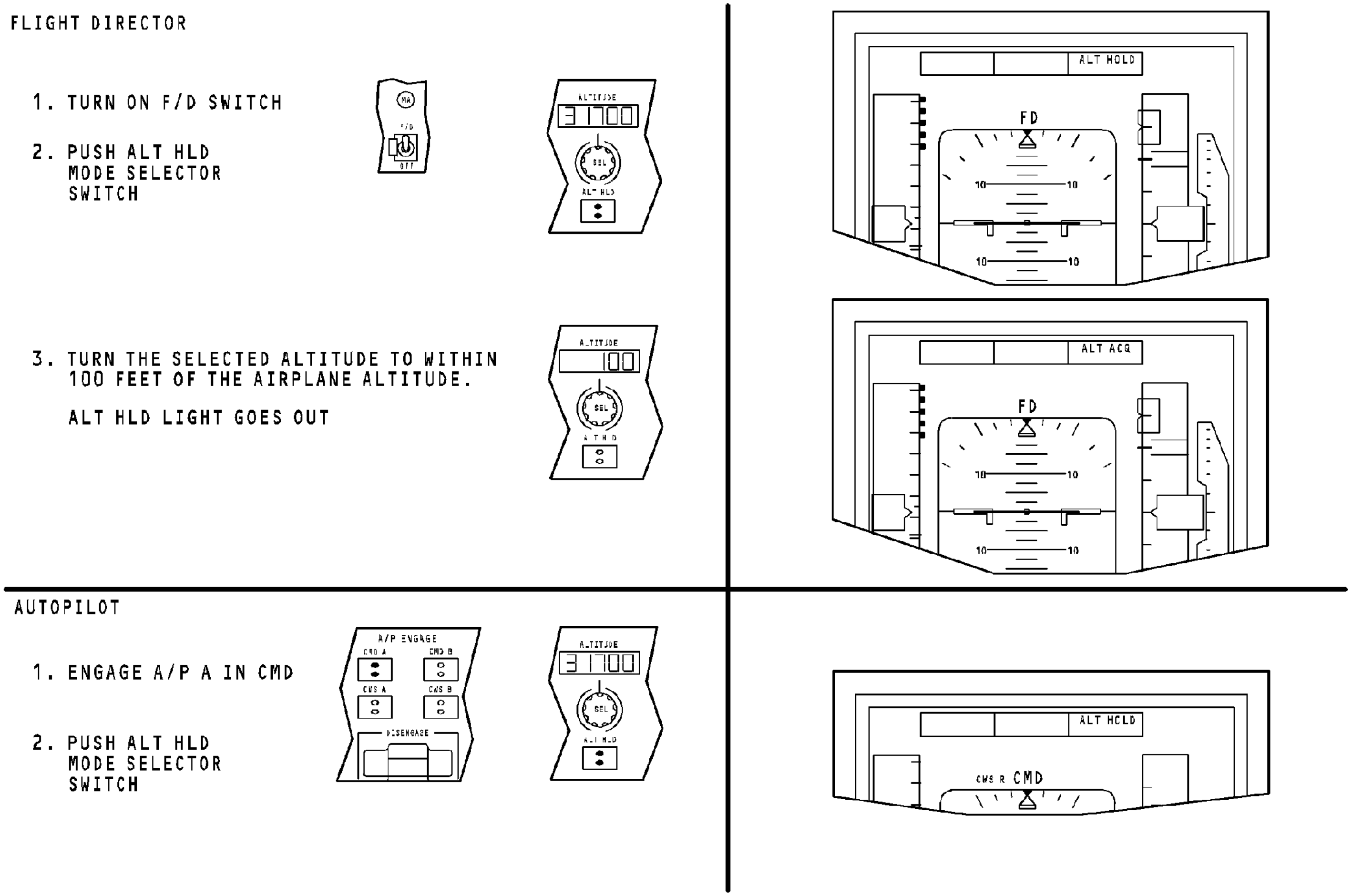
ALT HLD and Flight Directors

When you turn on the F/Ds and push the ALT HLD mode selector switch the FMA annunciator shows ALT HOLD and FD. The F/D pitch command bar shows on the AI. Turn the selected altitude to within 100 feet of the airplane altitude. The ALT HLD light on the mode selector switch goes out.

ALT HLD and Autopilot

When you engage A/P A in CMD and push the ALT HLD mode selector switch these annunciations show on the FMA:

- ALT HOLD
- CMD
- CWS R.



DFCS - OPERATION - GROUND OPERATIONS - PITCH MODE - ALT HOLD

22-11-00-103

DFCS - OPERATION - GROUND OPERATIONS - PITCH MODE - LVL CHG

LVL CHG and Flight Directors

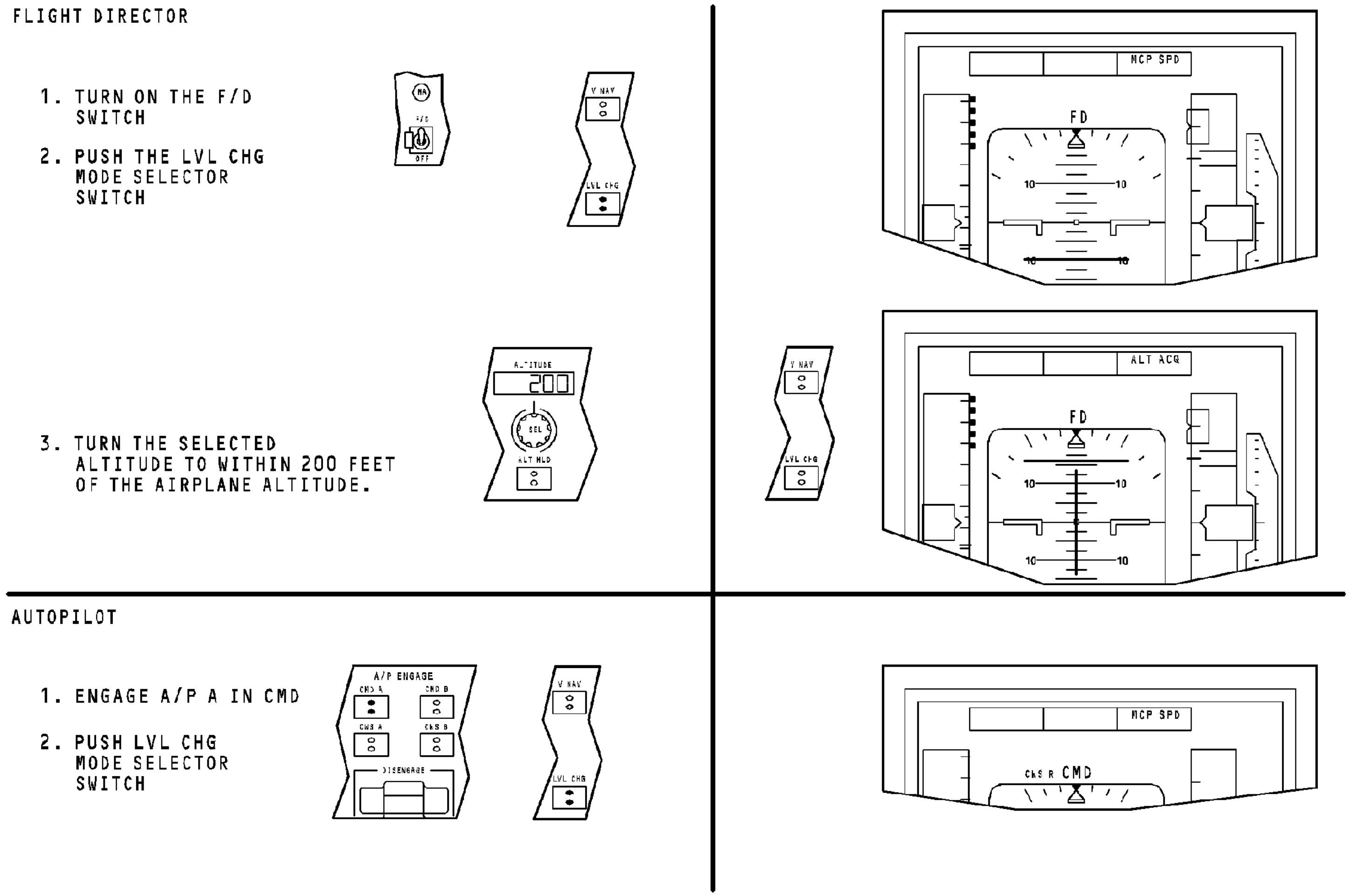
When you turn on the F/Ds and push the LVL CHG mode selector switch the FMA annunciator shows MCP SPD and FD. The F/D pitch command bar shows on the AI. Turn the selected altitude to within 200 feet of the airplane altitude and see these changes:

- LVL CHG light on the mode selector switch goes out
- FMA changes from MCP SPD to ALT ACQ
- F/D pitch bar moves to the top of AI.

LVL CHG and Autopilot

Engage A/P A in CMD and push the LVL CHG mode selector switch. These annunciations show on the FMA:

- MCP SPD
- CMD
- CWS R.



DFCS - OPERATION - GROUND OPERATIONS - PITCH MODE - LVL CHG

DFCS - OPERATION - GROUND OPERATIONS - APPROACH

General

You can activate the autopilot mode while on the ground.

APP and Flight Directors

Turn on the F/Ds and push the APP mode selector switch. The FMAs show these annunciations:

- G/S
- VOR/LOC
- FD.

HAP 001-013, 015-026, 028-036, 038-054, 101-999

The G/S annunciation will be in white letters to show the armed mode. The VOR/LOC may show in either green or white letters. It shows in green letters if the ILS receiver has a valid localizer signal. No F/D commands will show because there is no valid pitch mode.

HAP 037

The G/S annunciation will be in white letters to show the armed mode. The VOR/LOC may show in either green or white letters. It shows in green letters if the ILS receiver or the GLS receiver has a valid localizer signal. F/D pitch commands will show only for GLS because there is no valid pitch mode for ILS.

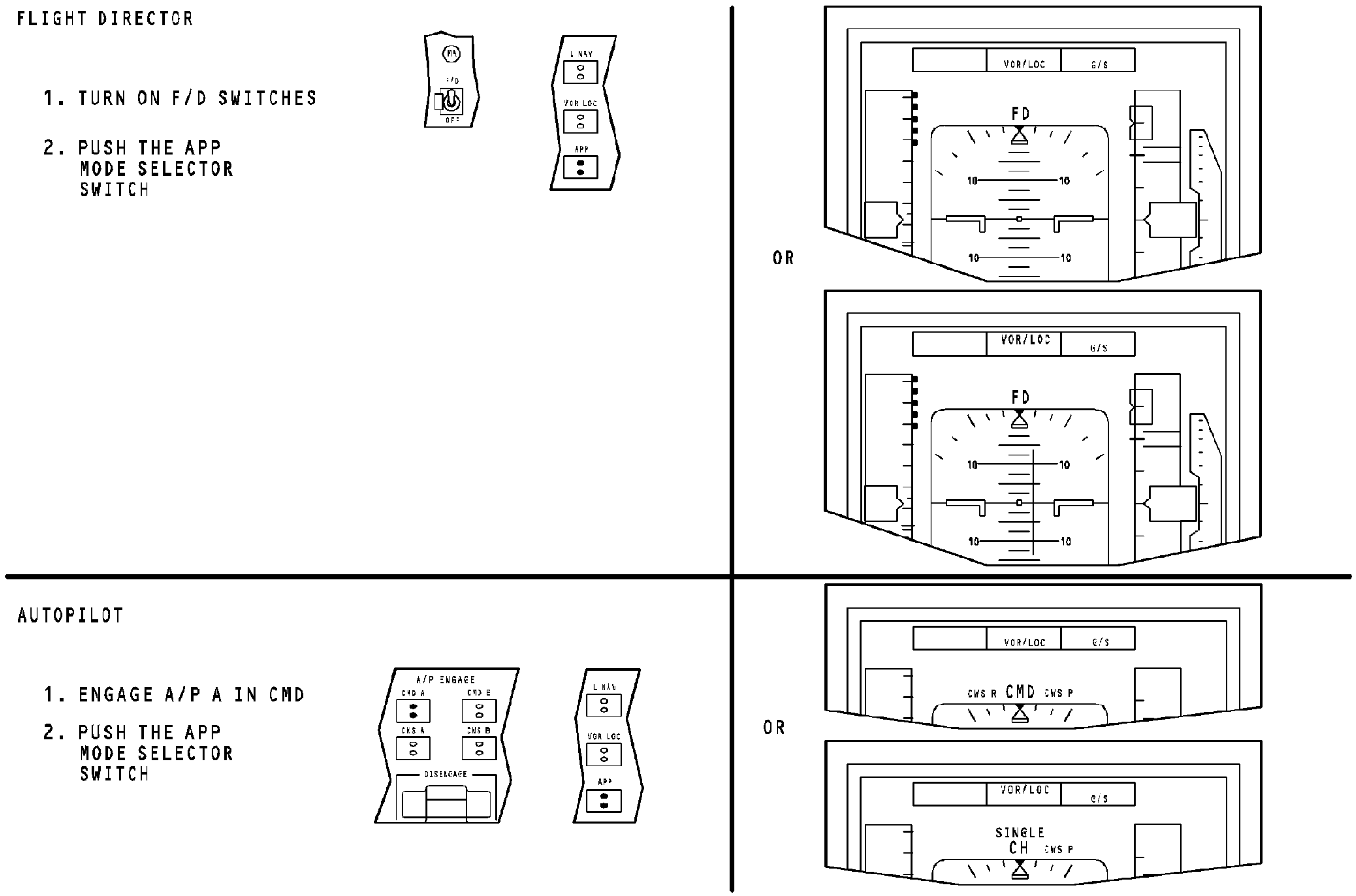
HAP ALL

APP and Autopilot

Engage A/P A in CMD and push the APP mode selector switch. Tune the navigation control panels to the airport ILS frequency. The FMAs show these annunciations:

- G/S
- VOR/LOC
- CMD.

The G/S annunciation shows in white letters. If the ILS receiver does not receive a valid localizer signal, VOR/LOC will show in white letters and CWS P and CWS R will show in amber letters on the FMAs. If the ILS receiver gets a valid localizer signal, VOR/LOC shows in green letters and CWS P and SINGLE CH show in amber letters.



DFCS - OPERATION - GROUND OPERATIONS - APPROACH

22-11-00-105

DFCS - OPERATION - GROUND OPERATIONS - CONTROL WHEEL STEERING

General

These are the three ways to engage an A/P in control wheel steering (CWS) on the ground:

- Push the CWS engage switch
- Push the CMD engage switch and do not select a roll and pitch mode
- When the A/P is engaged in CMD, apply force to the control column and control wheel.

You need hydraulic pressure to engage the autopilot in the CWS mode.

CWS Engage Switch

Push the CWS A engage switch. The light on the engage switch comes on. The FMAs show CWS P and CWS R in amber letters.

CMD Engage Switch and No Modes

Push the CMD A engage switch. The light on the engage switch comes on. The FMAs show these annunciations:

- CMD
- CWS P
- CWS R.

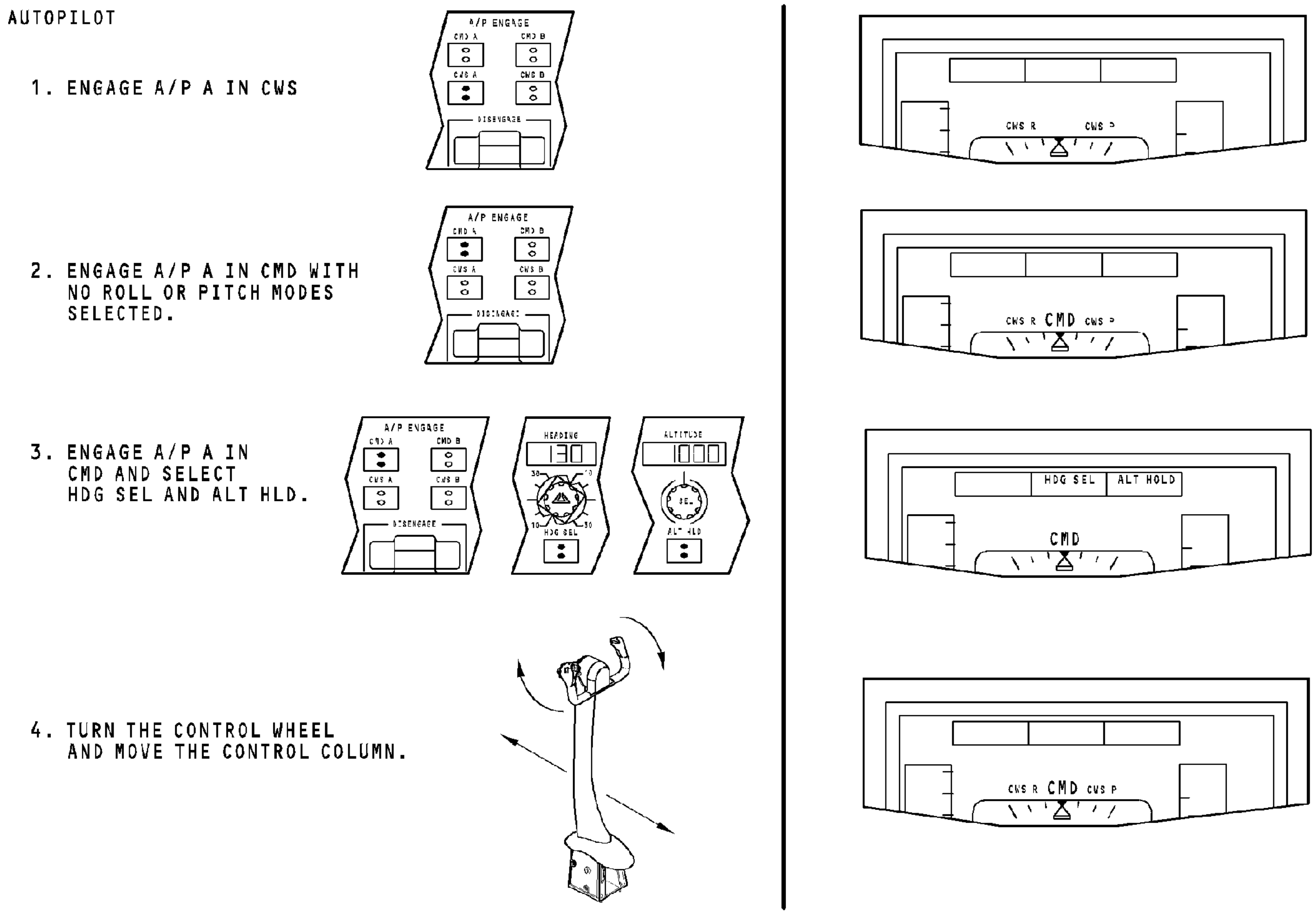
CWS Reversion From CMD

Engage A/P A in CMD and push the HDG SEL and ALT HLD mode selector switches. This engages the A/P in a roll and pitch mode. The FMAs show these annunciations:

- ALT HOLD
- HDG SEL
- CMD.

Apply force to the control wheel and the control column until the A/P reverts to the CWS modes. The FMAs show these annunciations:

- CMD
- CWS P
- CWS R.



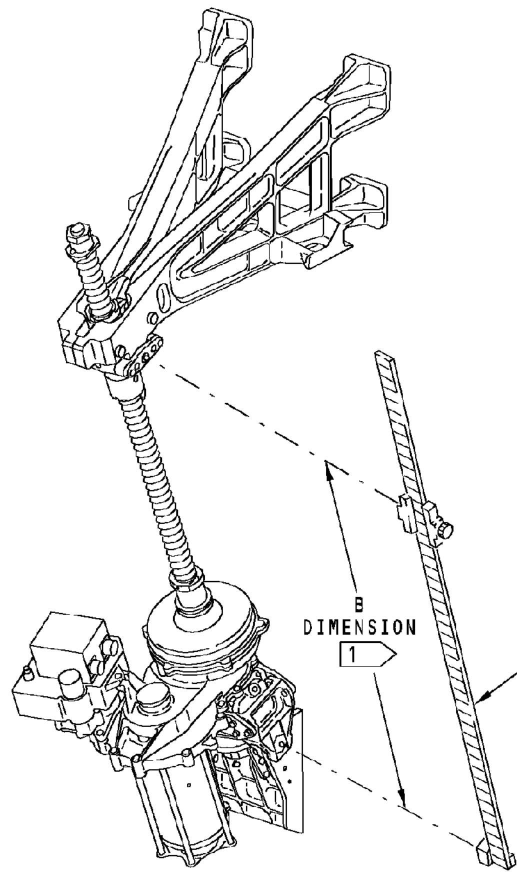
DFCS - OPERATION - GROUND OPERATIONS - CONTROL WHEEL STEERING

22-11-00-106

DFCS - TRAINING INFORMATION POINT - STABILIZER B DIMENSION

General

When you need to accurately measure the B dimension of the stabilizer, use the trammel bar or a steel measurement tape. Measure the distance between the center of the upper gimbal pin and the center of the lower gimbal pin.



1 THE B DIMENSION IS MEASURED BETWEEN THE CENTER OF THE UPPER AND LOWER GIMBAL PINS

DFCS - TRAINING INFORMATION POINT - STABILIZER B DIMENSION

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DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE LIBRARY

General

Maintenance action on the DFCS occurs only after the crew reports a problem in the flight log. The report occurs when a failure on the airplane causes a flight deck effect, such as autopilot A disengages. You use the built in test equipment (BITE) with the fault isolation manual (FIM) to find the problem.

BITE has these main properties:

- BITE uses the FMCS CDUs
- BITE shows all current failures and finds the line replaceable units (LRU) with the failures
- BITE lets you do a test of the LRU interfaces after you change an LRU
- BITE lets you do a rigging test of the system actuators and sensors
- BITE stores and shows failures for the last 40 flights.

When in BITE, all of the tests that the DFCS can do are in the DFCS ground maintenance BITE library.

BITE Library

The BITE library lists all of the DFCS tests. The library of tests has these five sections:

- Interface - LRU interfaces and signal data buses
- Surface - flight control surfaces and sensors
- MCP - mode control panel tests
- Annunciators - lights and warnings
- FCC (internal) - selftest and discrete inputs.

The graphic shows the different library tests, with their test numbers, in each section.

Groups

When the DFCS runs a test of a system, it groups all the tests from the library that it needs to do the system test. The group has a name and a number. The graphic gives two examples of groups. One is the current status test group (group 10) and the other is the autoflight test group (group 11).

When BITE does a test, it shows data about the test on the CDU. The group test data will show on the CDU as **Group name**Group number.library test number. For example, if BITE does the CDS test as part of the autopilot test group, the CDU will show **AUTOPILOT TEST**11.25.

The tests in the group may be divided into these three categories:

- Autotest
- Interactive
- Surface.

Autotest

Tests in this category do not need any inputs from the BITE operator and do not need hydraulic power. These tests can run very quickly.

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE LIBRARY

Interactive

Tests in this category need inputs from the BITE operator. They may need the operator to push a button or move a switch. The instruction shows on the CDU. These tests do not need hydraulic power. You can run these tests even if the autotests do not pass.

Surface

Tests in this category need hydraulic power. The tests may also need the operator to do specific tasks.

If the group test consists of tests in all three categories, the autotest occurs first, the interactive test occurs next and then the surface test.

DFCS GROUND MAINTENANCE BITE LIBRARY TESTS

INTERFACE
1. AIR DATA INERTIAL REFERENCE UNIT (ADIRU)
4. AUTOTHROTTLE (A/T)
5. DISTANCE MEASURING EQUIPMENT (DME)
7. LOW RANGE RADIO ALTIMETER (LRRA)
10. FLIGHT CONTROL COMPUTER (FCC)
11. LATERAL NAVIGATION (LNAV)
15. CROSS CHANNEL BUS
16. MODE CONTROL PANEL (MCP) INTERFACE
18. FLIGHT MANAGEMENT COMPUTER (FMC)
21. ANALOG SENSORS
22. STALL MANAGEMENT YAW DAMPER COMPUTER (SMYDC)
23. VHF OMNIDIRECTIONAL RANGE (VOR)
24. INSTRUMENT LANDING SYSTEM (ILS)
25. COMMON DISPLAY SYSTEM (CDS)
26. MICROWAVE LANDING SYSTEM (MLS)
27. GPS LANDING SYSTEM (GLS)

SURFACE
30. ELEVATOR
31. AILERON
32. SPEED/STABILIZER TRIM
33. MACH TRIM
34. FLAPS
35. DUAL/STAB

MCP
50. MCP PUSHBUTTONS
51. MCP FLIGHT DIRECTOR (F/D) SWITCH
52. MCP CHANGEOVER (C/O) SWITCH
53. MCP BANK ANGLE LIMIT SWITCH
54. MCP SPEED KNOB
55. MCP ALTITUDE SELECT
56. MCP VERTICAL SPEED
57. MCP DISPLAYS
58. INTERLOCKS
59. MCP COURSE/HEADING

ANNUNCIATOR
61. ALTITUDE ALERT
62. DISENGAGE WARNING

FCC (INTERNAL)
70. DISCRETE INPUTS
71. FCC SELFTEST

CURRENT STATUS - GROUP NUMBER 10

AUTOTEST	LIBRARY TEST NUMBER
DISCRETE INPUTS	70
ADIRU	1
DME	5
LRRA	7
LNAV	11
MCP INTERFACE	16
FMC	18
ANALOG SENSORS	21
SMYDC	22
VOR	23
ILS	24
CDS	25
MLS	26
GLS	27
MCP DISPLAYS	57

AUTOPILOT TEST - GROUP NUMBER 11

INTERACTIVE	LIBRARY TEST NUMBER
ADIRU	1
LNAV	11
VOR	23
ILS	24
CDS	25
MLS	26
GLS	27
MCP PUSHBUTTON	50
MCP C/O SW	52
MCP SPEED KNOB	54
MCP ALT SELECT	55
MCP V/S	56
MCP DISPLAYS	57
INTERLOCK	58
MCP CRS/HDG	59
ALT ALERT	61
DISENGAGE WARNING	62

SURFACE	LIBRARY TEST NUMBER
ELEVATOR	30
AILERON	31
SPEED/STAB TRIM	32
MACH TRIM	33
FLAPS	34
DUAL/STAB	35

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE LIBRARY

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT ISOLATION TESTS

General

You use BITE fault isolation tests with the FIM to find out what is wrong with the DFCS for troubleshooting the failures that the crew writes in their log. These are the DFCS BITE fault isolation tests:

- Current status (group 10)
- Fault history by flight leg (group 20)
- Fault history by flight deck effect (group 20)
- BITE library (group 60).

Current Status

These are the current status tests:

- Autotests of line repairable units (LRU)s
- Autopilot function interactive and surface tests (group 11)
- Flight director function interactive and surface tests (group 12)
- Mach trim function surface tests (group 13)
- Speed trim function interactive and surface tests (group 14)
- Altitude alert function interactive tests (group 15).

The current status tests let you quickly find the condition of the DFCS. It first runs a series of autotests without the need for inputs from the operator. The tests find steady state failures down to the LRU. You then choose one of the function tests, such as autopilot or flight director. These tests consist of interactive and surface tests.

You need to make inputs for the interactive tests. There are instructions on the CDU. After you do the interactive tests, you can do a surface test.

The surface tests needs hydraulic power to operate the control surfaces. When the surface test is complete, the current status is complete for that function.

Fault History by Flight Leg

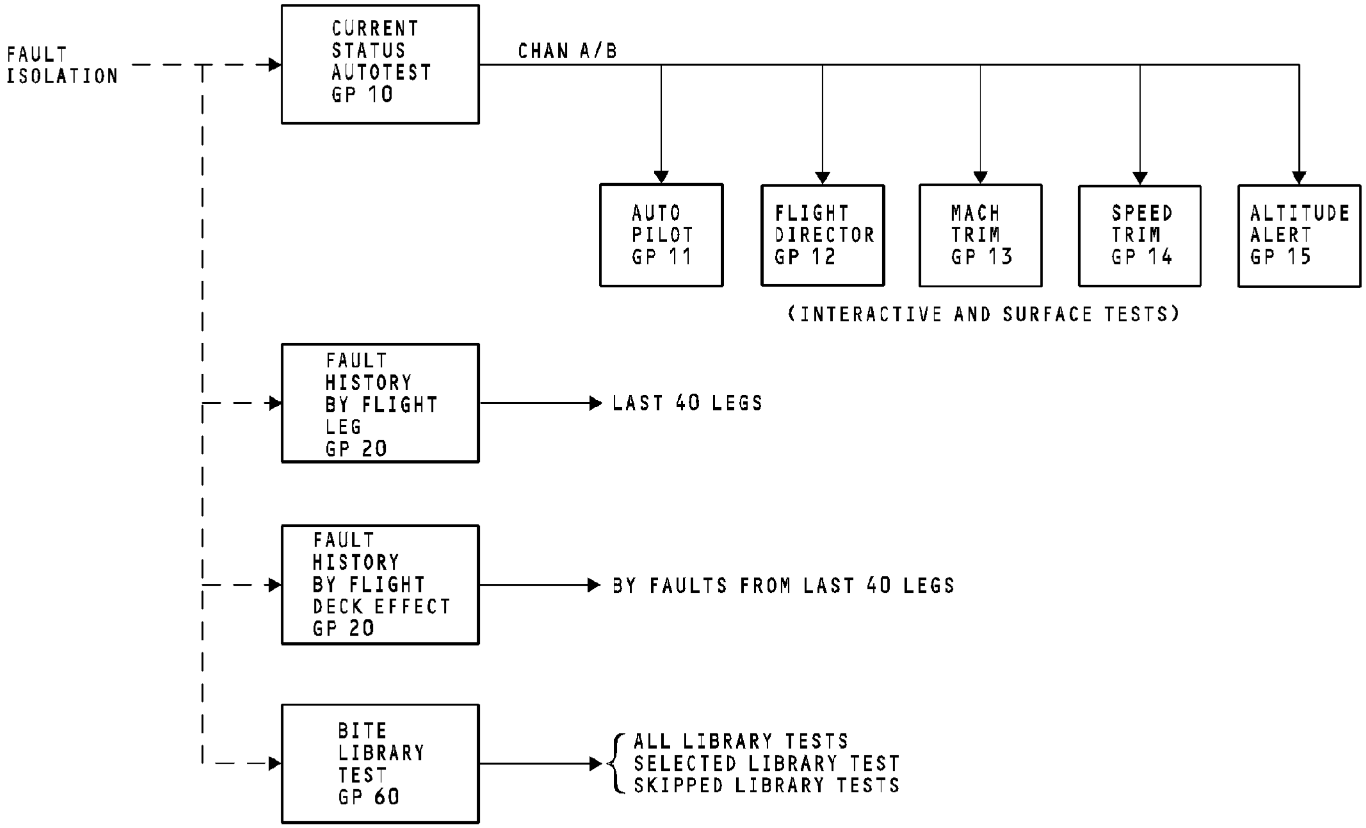
The maintenance monitor (MM) stores records of inflight failures for the last 40 flights in non-volatile memory. The BITE shows how many failures occured and what they were during each flight legs.

Fault History by Flight Deck Effect

The BITE also groups all of the failures during the last 40 flights by type of fault. The type of fault is a result of the effect it caused in the flight deck. An example of a flight deck effect is A/P DISC, autopilot disengaged.

BITE Library

You can do all of the library tests or you can select the tests that you want to do.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT ISOLATION TESTS

22-11-00-111

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - VERIFICATION TESTS

General

After you replace an LRU, you use the verification test to make sure it is valid. You use the verification tests to do a check of the control surface rigging. You also use the verification tests to measure the value of the sensors. These are the DFCS BITE verification tests:

- LRU replacement tests (group 30)
- Land verify test (group 49)
- MCP tests (group 70)
- Rigging tests (group 50)
- Sensor values.

LRU Replacement Tests

You use these tests to make sure that an LRU that you replaced is good. The test looks at the interface between the FCC and the LRU. All of the tests have an autotest part first. After the autotest is complete, you can do the interactive test. There are no surface tests. The graphic shows a list of the systems that have an LRU replacement test.

Land Verify Test

This is a test to do a check of as many autoland sensors and hardware as possible. This test also looks at the systems that the crew can use in a dual channel operation.

MCP Tests

This test does a check of the interface between the MCP and the FCC. It also does a check of the operation of the MCP switches and displays.

Rigging Tests

These tests let you read sensor data without the use of extra test equipment. The rigging tests verify the correct alignment of these components:

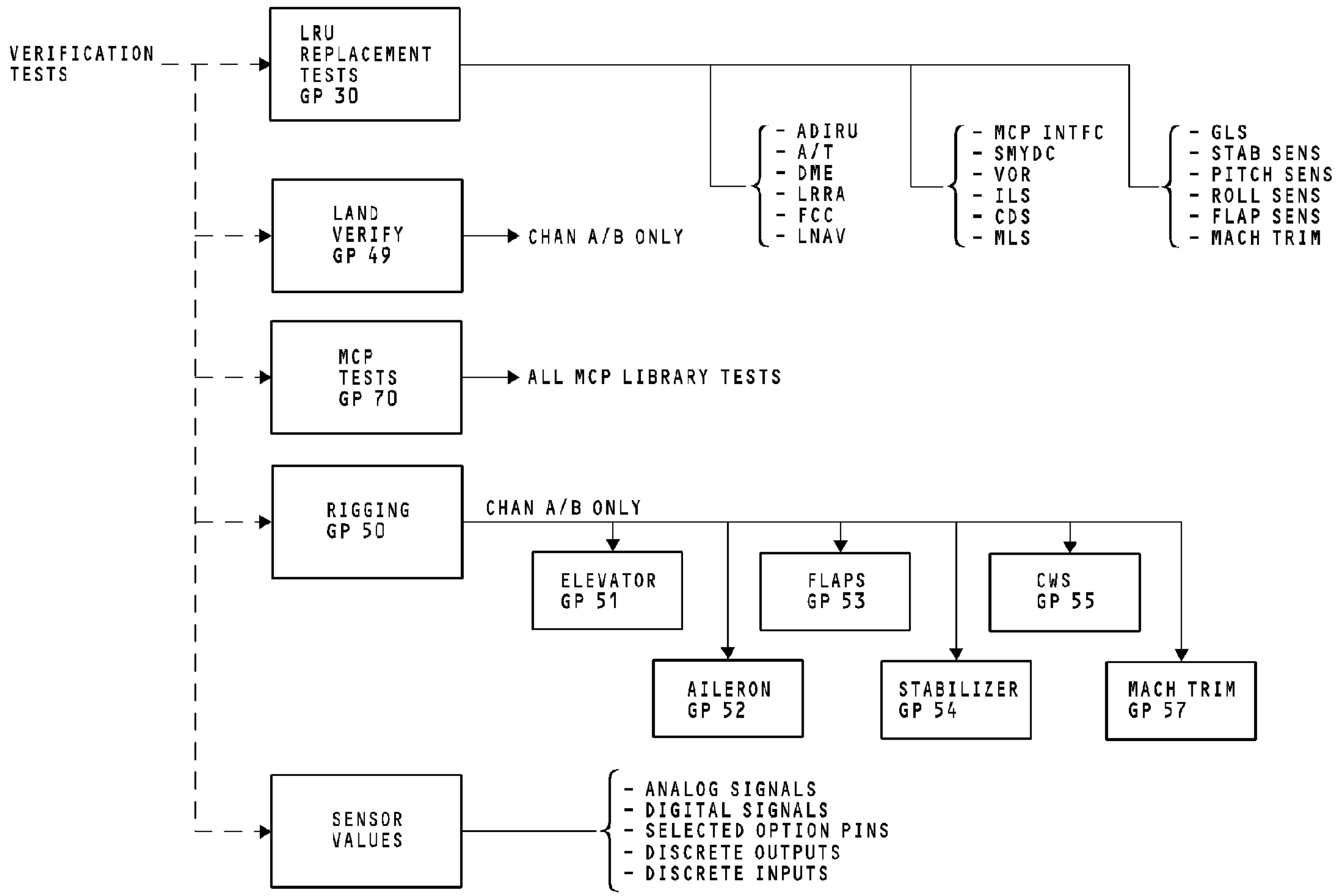
- Control surfaces
- Autopilot actuators
- Position sensors.

You can do rigging tests of the components for these functions:

- Elevator (group 51)
- Aileron (group 52)
- Flaps (group 53)
- Stabilizer (group 54)
- CWS (group 55)
- Mach trim (group 57).

Sensor Values

BITE allows you to see the analog position sensor values. You can measure some discrete signals and read some digital data words. You can also do a check of the option program pins.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - VERIFICATION TESTS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FCC BITE ENTRY FAILURE

General

To select the DFCS BITE test, push LSK 2L of the MAINT BITE INDEX page. When you push this key, FCC A and FCC B tries to go into the BITE mode. One FCC, usually FCC A becomes the master FCC and the other FCC becomes the slave FCC. If one FCC or both FCCs cannot get into BITE, a failure displays shows on the CDU.

Master FCC Cannot Enter BITE

If the master FCC cannot enter BITE, the lower left BITE page shows on the CDU. One of these messages shows on the CDU to tell the operator why it could not enter BITE:

- A/P-A ENGAGED (J4A-55)
- A/P-B ENGAGED (J2A-17)
- CAS ABOVE 60 KNOTS AND GND SPEED ABOVE 40 KNOTS FROM ADIRU#1/2
- AIR/GND SW INDICATES AIR MODE (J1A-42)
- NO FMC BITE REQUEST.

Pull the circuit breaker for the master FCC and push the INIT REF key on the CDU to try the test again.

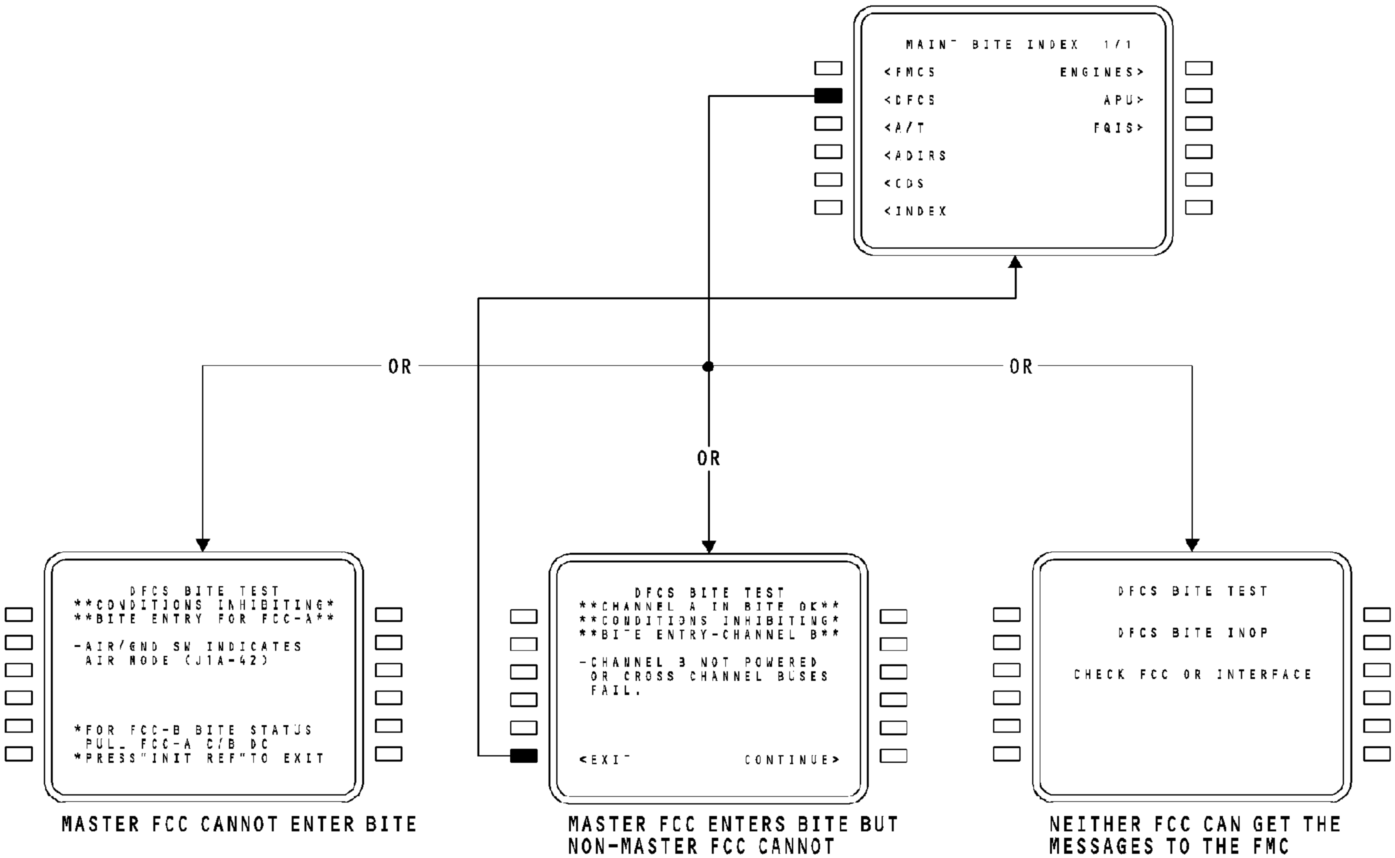
Master FCC Enters BITE, But Non-Master Does Not

If the master FCC goes into BITE and the non-master FCC does not, the lower center BITE page shows on the CDU. One of these messages also shows on the CDU:

- CHANNEL B NOT POWERED OR CROSS CHANNEL BUSES FAIL
- CAS ABOVE 60 KNOTS AND GND SPEED ABOVE 40 KNOTS FROM ADIRU#1/2
- AIR/GND SW INDICATES AIR MODE (J1A-42)
- NO FMC BITE REQUEST.
- FCC-A(B) TO MCP BUS FAILURE.

Neither FCC Can Send BITE Messages to the FMC

If neither FCC can send the BITE messages to the FMC, the lower right BITE page shows on the CDU. The DFCS BITE does not operate and the maintenance person needs to check the FCCs or the interface between the FCCs and the FMC.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FCC BITE ENTRY FAILURE

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - DFCS BITE TEST

General

If FCC A and FCC B can enter BITE, the CDU shows that the DFCS is in the selftest mode. The DFCS selftest has an FCC A selftest and an FCC B selftest. There is also a test of the cross channel buses. After the selftest, the CDU shows one of these pages:

- DFCS BITE TEST MAIN MENU
- FCC-A/B SELFTEST PASS, CROSS CHANNEL TEST FAIL
- FCC-A/B SELFTEST FAIL, CROSS CHANNEL TEST PASS.

DFCS BITE MAIN MENU Page

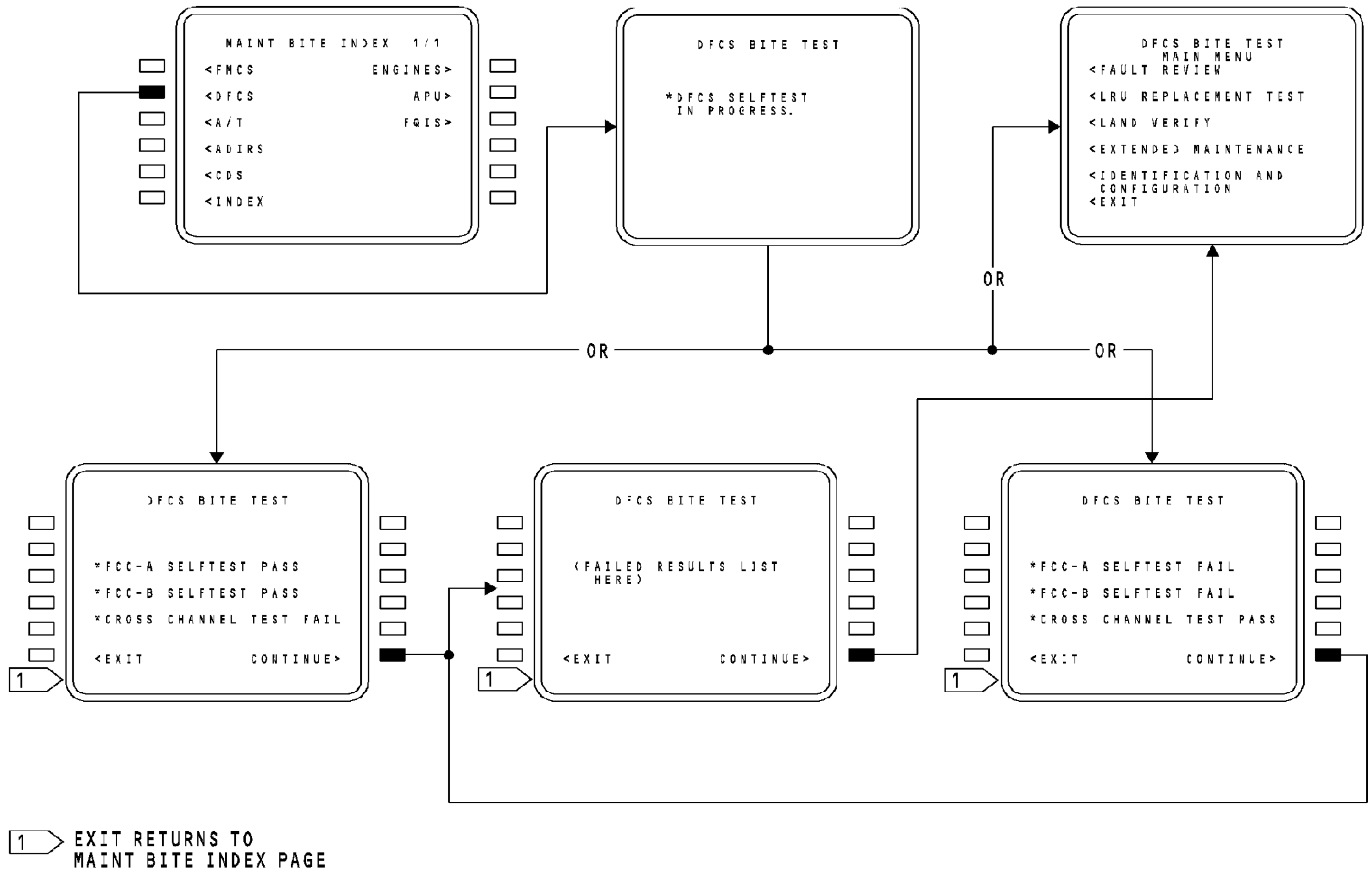
This page lets you choose a fault isolation or verification test.

FCC-A/B SELFTEST PASS, CROSS CHANNEL TEST FAIL Page

This page shows that the FCCs passed their selftests, but the cross channel test failed. You can go back to the MAINT BITE INDEX page or continue to show the failed results. After you see the failed results, you can go to the MAINT BITE INDEX or continue to the MAIN MENU.

FCC-A/B SELFTEST FAIL, CROSS CHANNEL TEST PASS Page

This page shows that the FCCs failed their selftests, but the cross channel test passed. You can go back to the MAINT BITE INDEX page or conitnue to show the failed results.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - DFCS BITE TEST

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE TEST EXIT

DFCS BITE MAIN MENU Page

If you want to get out of BITE from the MAIN MENU page, push LSK 6L, EXIT prompt. This shows the TEST COMPLETE page.

TEST COMPLETE Page

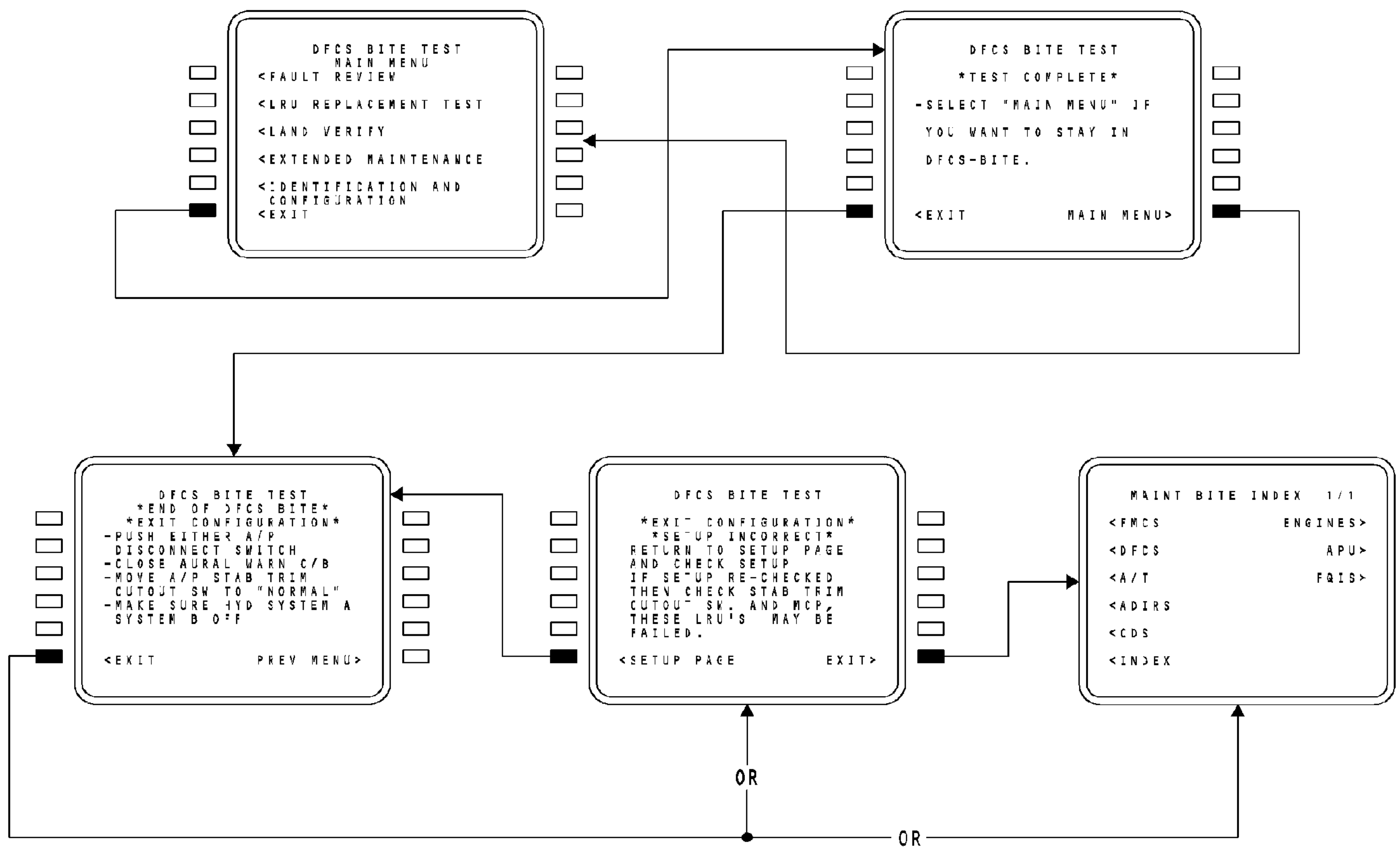
This page asks whether you want to stay in DFCS BITE or go out of the BITE. To stay in BITE, push the MAIN MENU prompt, LSK 6R and to go out of BITE, push the EXIT prompt, LSK 6L. When you push LSK 6R, you go back to the DFCS BITE MAIN MENU page. When you push LSK 6L, you go to the END OF DFCS BITE page.

END OF DFCS BITE Page

This page gives instructions on what you need to do before you can go out of BITE. To continue, push LSK 6L and you will go back to the MAINT BITE INDEX page or to the SETUP INCORRECT page.

SETUP INCORRECT Page

IF you go to this page, it means that you need to look at the instructions again before you can go out of BITE. Push the SETUP PAGE prompt, LSK 6l to go back to the END 0F DFCS BITE page. Push the EXIT prompt, LSK 6R to go to the MAINT BITE INDEX page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE TEST EXIT

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - IDENTIFICATION AND CONFIGURATION

DFCS BITE MAIN MENU Page

You select the identification and configuration pages when you push LSK 5L. This shows the CONFIGURATION page.

CONFIGURATION Page

From this page, you select the configuration for channel A (FCC A) or channel B (FCC B). Push LSK 2L to select Channel A. Push LSK 3L to select Channel B.

HAP 001-013, 015-026, 028-030

FCC-X CONFIGURATION Page

There are two configuration pages for each FCC. You use the NEXT PAGE and PREV PAGE function keys on the CDU to go between the two pages. The first page shows this data:

- Boeing part number for the FCC
- Honeywell part number for the FCC.

The second page shows CPU1 and CPU2 software part numbers.

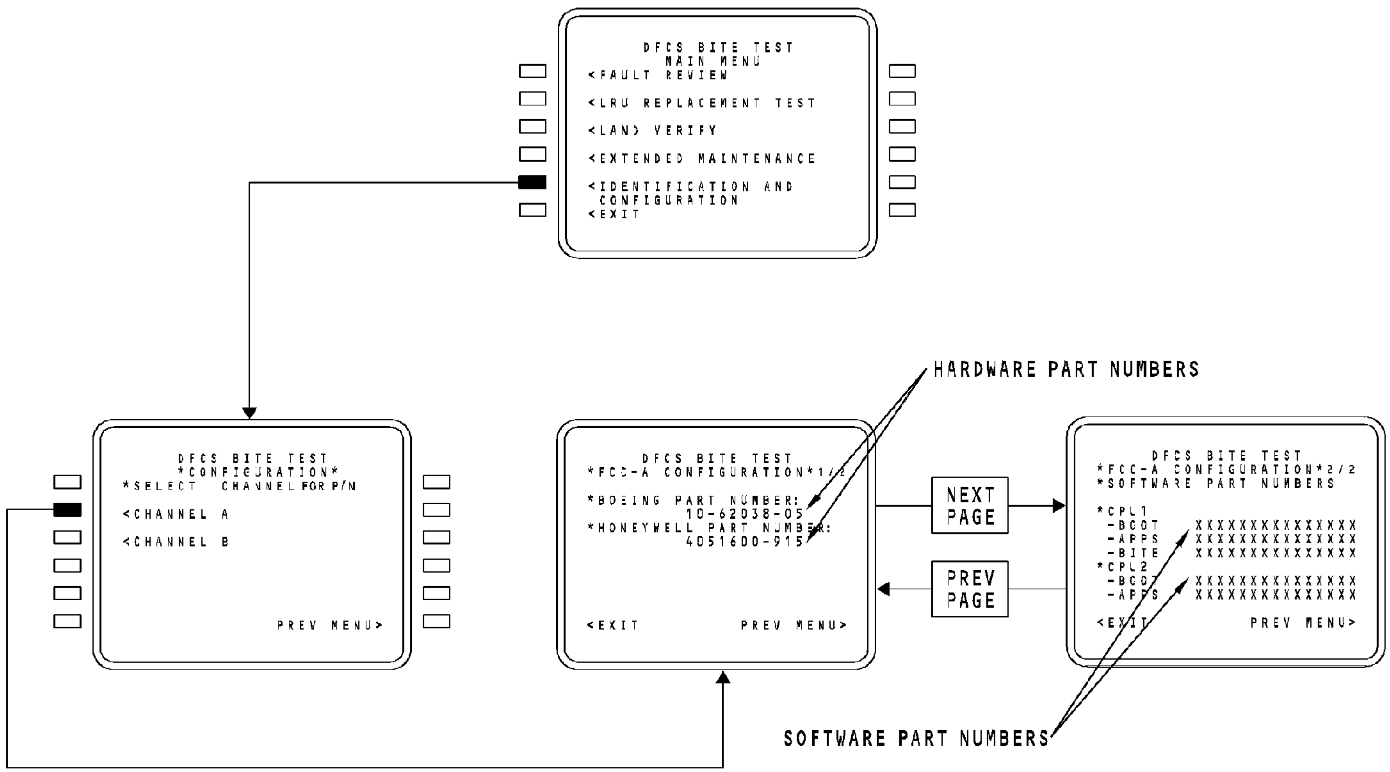
HAP 031-054, 101-999

FCC-X CONFIGURATION Page

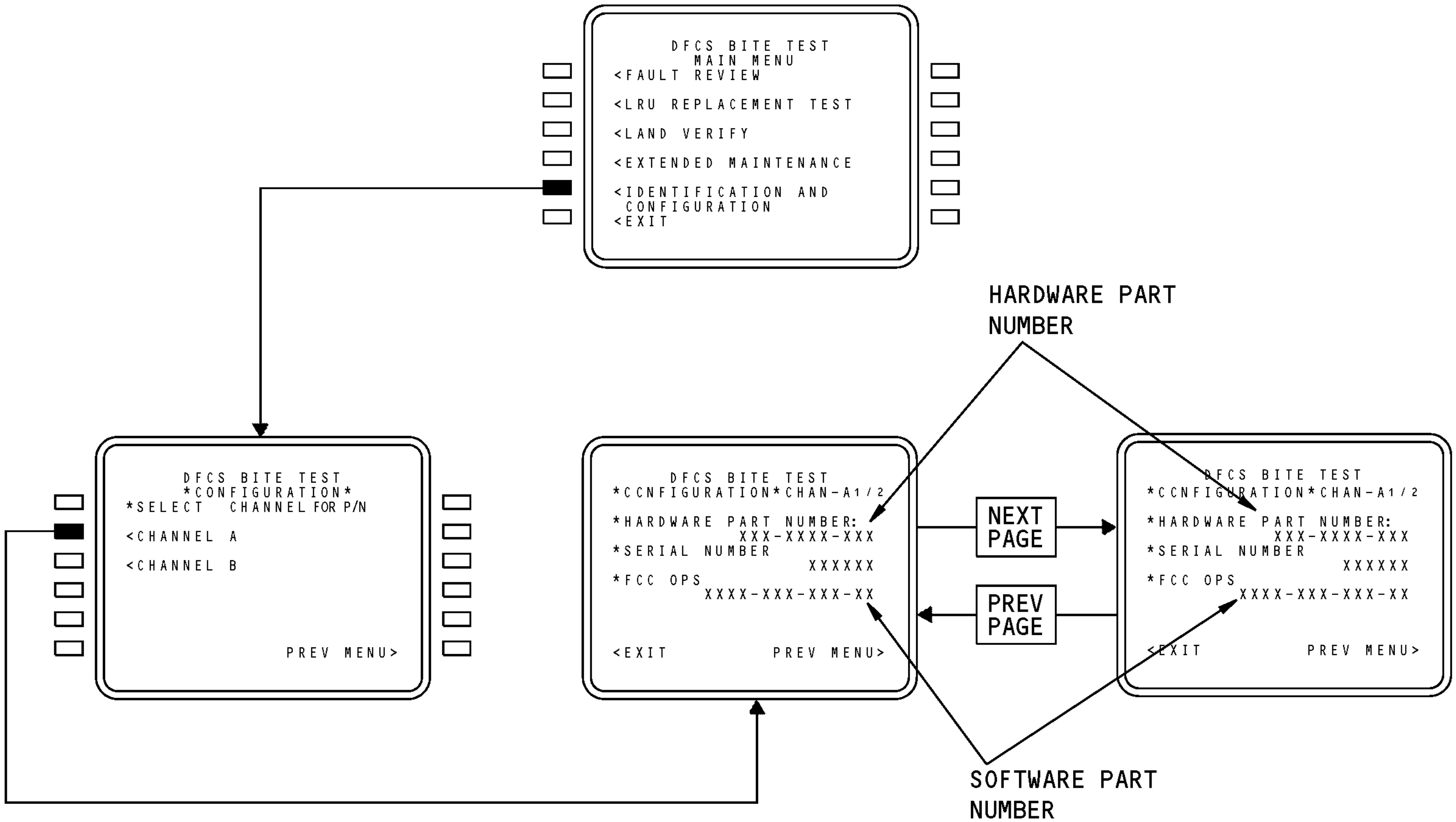
There is one configuration page for each FCC. You use the NEXT PAGE and PREV PAGE function keys on the CDU to go between channel A (FCC A) and channel B (FCC B). Each page shows this data:

- hardware part number for the FCC
- serial number of the FCC.
- software part number for the FCC.

HAP ALL



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - IDENTIFICATION AND CONFIGURATION



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - IDENTIFICATION AND CONFIGURATION

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DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - CURRENT STATUS

DFCS BITE MAIN MENU Page

To do a current status test, you select the FAULT REVIEW prompt on the DFCS BITE MAIN MENU page. When you push LSK 1L, you get the FAULT REVIEW page.

FAULT REVIEW Page

To select CURRENT STATUS, push the LSK 1L. This gets the AUTOTEST INITIALIZATION page for the current status test.

AUTOTEST INITIALIZATION Page

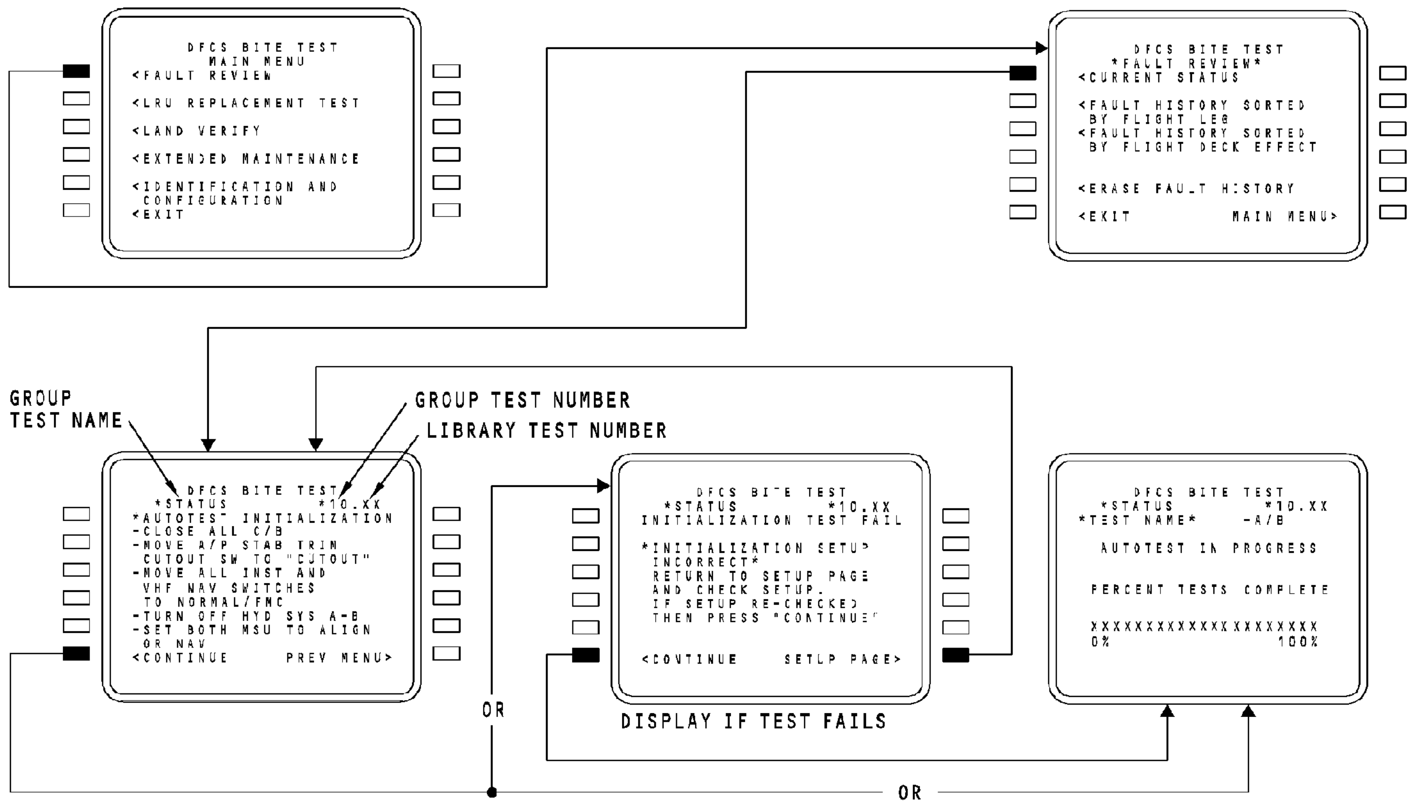
This page gives instructions to setup the current status test. After you have setup the test correctly, push LSK 6L to continue the test. If the setup is not correct, you get the INITIALIZATION SETUP INCORRECT page. If the setup is correct, you get the page that tells you the autotest is in progress.

INITIALIZATION SETUP INCORRECT Page

This page tells you that the initialization setup is not correct. To return to the setup page, push LSK 6R. If you made the correct changes, push the LSK 6L to continue.

Current Status Autotest

If the setup is correct, the autotests for all systems in group 10 starts. As the tests continue, the name of the system in test and its library number shows on the CDU page. For example, if the DME is now in autotest, you see *STATUS *10.05 on the second line and *DME *-A/B on the third line of the CDU. These displays change as different systems are in autotest. The page also shows the percentage of the tests that are completed.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - CURRENT STATUS

22-11-00-117

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - CURRENT STATUS AUTOTEST

General

If all of the autotests pass, the next page that shows on the CDU is the AUTOTEST PASSED page. You can then continue to the next page to select a channel to test.

If one or more of the autotests fail, you get the AUTOTEST FAILED page.

AUTOTEST FAILED Page

This page shows all of the systems that did not pass the autotest. You can get more data about the failure when you select the system. For the example, the operator selects the ADIRU, LSK 2L. This shows the STATUS SUSPECT LRU(S) page for the ADIRU autotest.

If you push LSK 6R, you go to the FAULT REVIEW page.

STATUS SUSPECT LRU(S) Page

This page shows the LRUs that could cause the failure of the ADIRU autotest. It also shows the connector pins of the FCC that were used to find this failure. You can use the NEXT PAGE and PREV PAGE function keys on the CDU to look at all of the suspect LRUs.

If you want to look at more detail about the failure, select LSK 6L for test data.

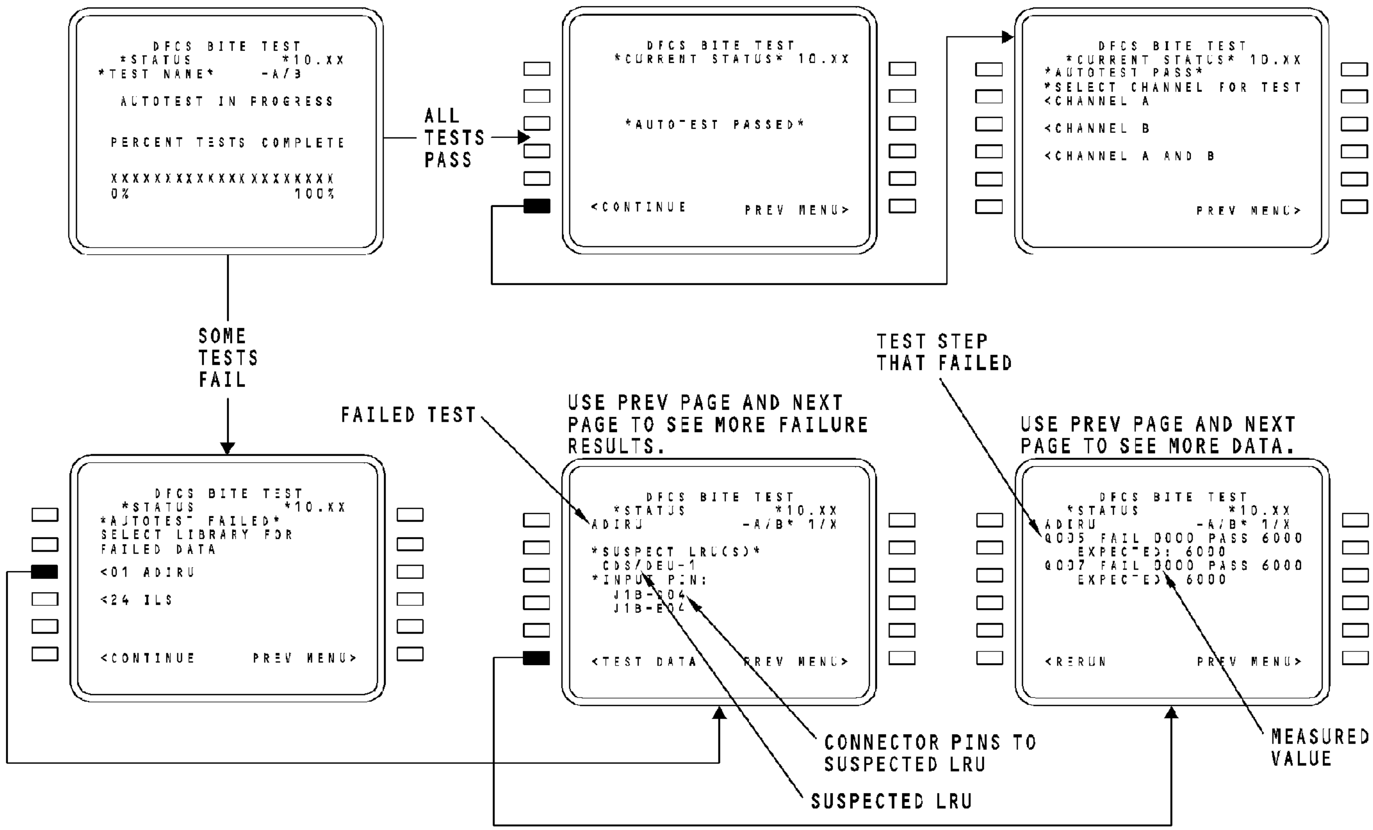
Test Data Page

This page shows the test step where the failure was found and the results of the test. For the example, in the graphic, the first failure occurs in the 5th step (Q005) of the test. The expected data should be a hex word 6000. FCC A failed since it shows a hex word of 0000, but FCC B passes. There was also a failure in step 7 (Q007). Again, FCC A failed and FCC B passed.

The Q before 005 and 007 means the failures occurred during the autotest. Q stands for quick test which is what the autotest used to be called.

You can use the NEXT PAGE and PREV PAGE function keys on the CDU to look at all of the detail test data.

If you want to rerun the test, you push LSK 6L. If you push LSK 6R, PREV MENU prompt, you go to the AUTOTEST FAILED page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - CURRENT STATUS AUTOTEST

22-11-00-118

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT INTERACTIVE TEST 1

AUTOTEST PASSES Page

If all of the autotests pass, you need to select the channel for the test. You can choose one of these:

- Channel A
- Channel B
- Channel A and B.

For this example, channels A and B were selected.

SELECT ADDITIONAL TEST Page

After you select a channel, you need to choose one of these tests:

- Autopilot
- Flight director
- Mach trim
- Speed trim
- Altitude alert.

For this example, the autopilot test was selected. You select AUTOPILOT when you push LSK 2L.

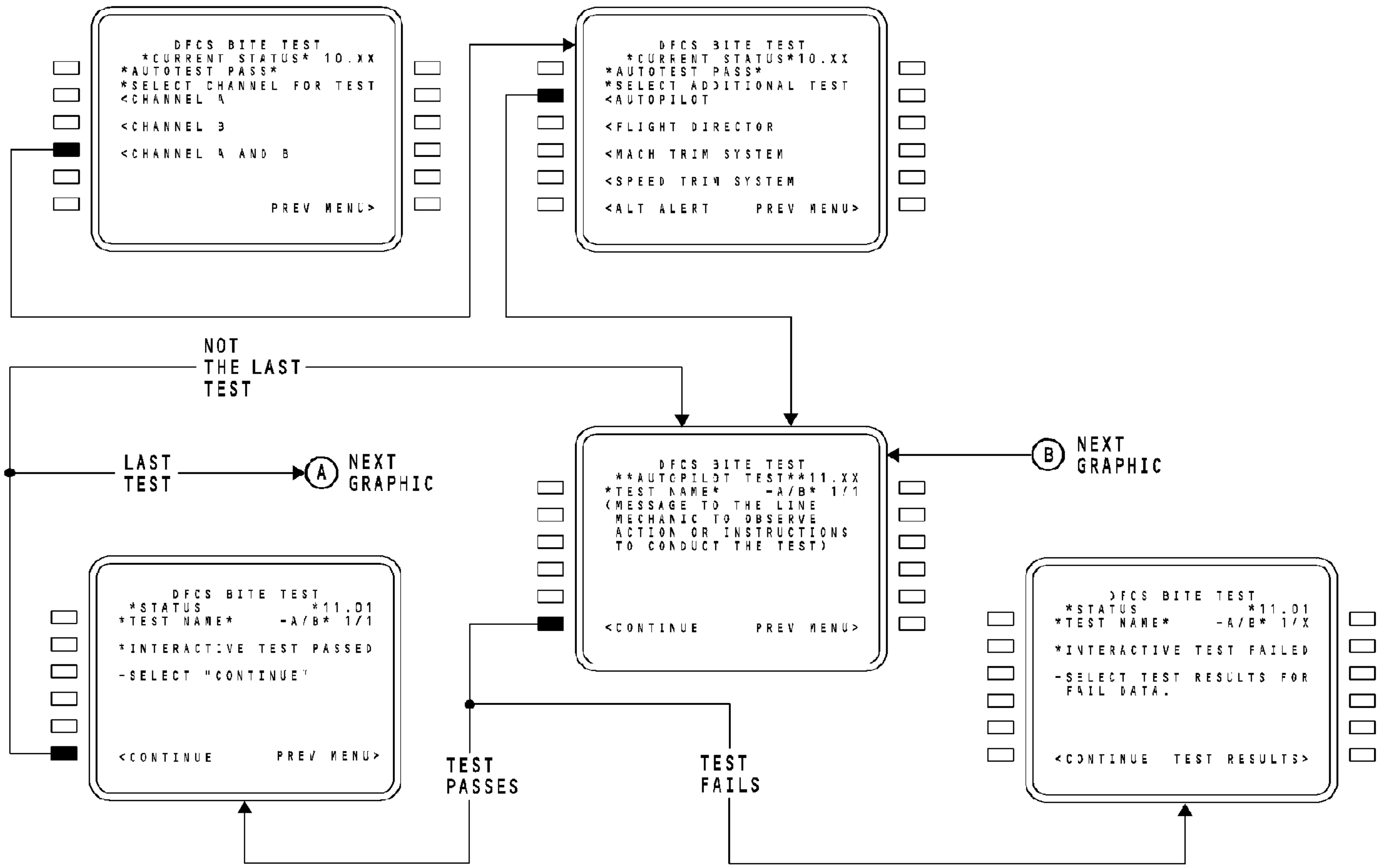
INTERACTIVE TEST Page

This page gives YOU instructions as the test continues. After you follow the instructions, push the LSK 6L to continue the test. When the test is complete and it passes, the next page is the INTERACTIVE TEST PASSED page. If the test fails, the next page is the INTERACTIVE TEST FAILED page.

INTERACTIVE TEST PASSED Page

This shows that the last interactive test passed. When you push LSK 6L to continue, the next interactive test starts. The page that shows is the INTERACTIVE TEST page.

If there are no more interactive tests, the next page will be the AUTOPILOT TEST SUMMARY page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT INTERACTIVE TEST 1

22-11-00-119

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT INTERACTIVE TEST 2

INTERACTIVE TEST FAILED Page

This pages shows an interactive test that failed. If you do not want to see the test results, push LSK 6L to continue. If this is the last interactive test, the next page will be one of the autopilot summary pages. If it is not the last test, the next page will be the INTERACTIVE TEST page. If you want to see the test results, push LSK 6R. This shows the AUTOPILOT TEST SUSPECT LRU(S) page.

AUTOPILOT TEST SUSPECT LRU(S) Page

This page shows the suspect LRU for the autopilot test like the STATUS SUSPECT LRU(S) page did for the current status test. To see the test data, push LSK 6R. If you push the LSK 6L, you continue or go back to the INTERACTIVE TEST page.

Test Data Page

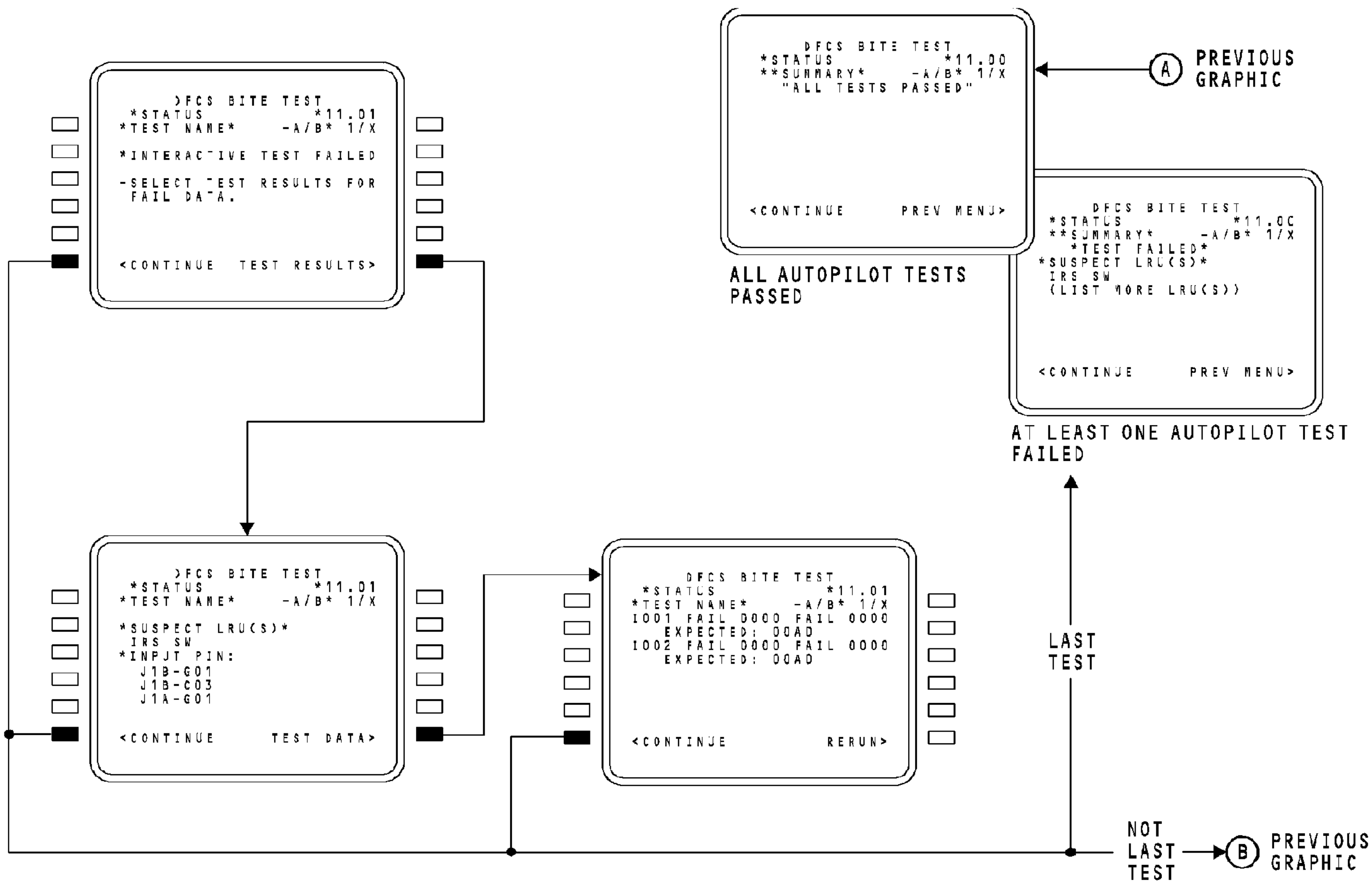
This page shows the step where the failure occurred and the FCC failed data. The I in I001 means this is an interactive test. If you push LSK 6L, you continue to an autopilot summary page or go back to the INTERACTIVE TEST page. You can rerun the test if you push LSK 6R.

AUTOPILOT SUMMARY ALL TESTS PASSED Page

This pages shows that all of the interactive tests passed BITE. Push LSK 6L to continue to the surface tests.

AUTOPILOT SUMMARY TEST FAILED Page

This page shows that at least one of the interactive tests failed. It lists all of the suspect LRU that may have caused the failed interactive tests. Push LSK 6L to continue to the surface tests.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT INTERACTIVE TEST 2

22-11-00-120

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT SURFACE TEST

AUTOPILOT SUMMARY ALL TESTS PASSED Page

This pages shows that all of the interactive tests passed BITE. You push LSK 6L to continue to the surface tests. The next page is the AUTOPILOT TEST WARNING page.

AUTOPILOT TEST WARNING Page

This pages shows a warning that the hydraulics are on and control surfaces and the control columns may move. To continue, push LSK 6L. This next page is the AUTOPILOT SURFACE TEST INIT page.

AUTOPILOT SURFACE TEST INIT Page

This page gives you some instructions. After you follow the instructions, push LSK 6L to continue. This starts the first surface test from the test library for the autopilot test group.

SURFACE TEST Page

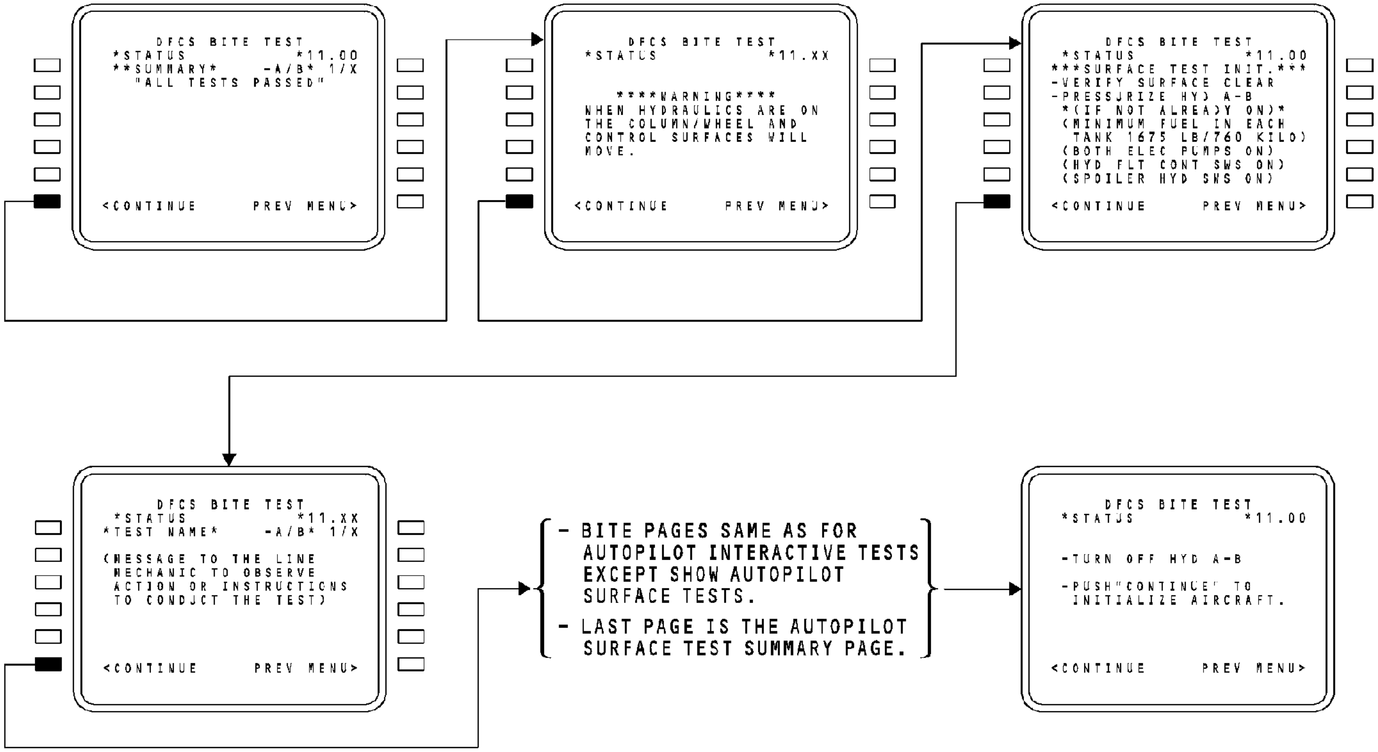
This page gives instructions to the operator as the test continues. After you follow the instructions, push LSK 6L to continue the test. The remaining steps of the surface test follows the same order as the interactive tests. The pages are the same except they will show SURFACE instead of INTERACTIVE.

When the summary pages show that all surface tests passed or show the suspect LRUs for the failed tests, push LSK 6L to continue. The next page is the final autopilot test page.

Final Autopilot Test Page

This page tells the operator to turn off the hydraulic power for system A and B. It also tells the operator to push LSK 6L to continue to initialize the airplane. The next page is the TEST COMPLETE page.

If you push LSK 6R, the next page is the AUTOTEST PASSED page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - AUTOPILOT SURFACE TEST

22-11-00-121

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DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT HISTORY SORTED BY FLIGHT LEG

FAULT REVIEW Page

From the FAULT REVIEW page, you can select these tests:

- Current status
- Fault history sorted by flight legs
- Fault history sorted by flight deck effect.

This example shows the steps you go through to see the fault history sorted by flight legs. To do this, push LSK 2L. This shows the SELECT CHANNEL FOR FAULT HISTORY page.

SELECT CHANNEL FOR FAULT HISTORY Page

You select channel A fault history or channel B fault history. After you select the channel, you see the FAULT HISTORY BY LEGS page.

FAULT HISTORY BY LEGS Page

The page shows these data for legs 1 through 5:

- Flight leg
- Number of faults for that leg
- Time the flight leg started
- Date of the flight leg.

To see more data about the faults on a flight leg, push the LSK next to the flight leg. If there are no faults for that leg, you see the page that shows ** NO FAULT **. If there are faults, you go to a FAULT FOR EACH LEG page.

To see the faults for the other legs, use the NEXT PAGE function key on the CDU.

FAULT FOR EACH LEG Page

This page shows these data for each leg:

- Flight leg
- DFCS fault
- Channel that had the fault
- Roll and pitch modes that were active when the fault occurred
- Monitor that found the fault
- Suspect LRUs
- Flight number
- Time of fault
- Date of flight
- Altitude when fault occurred
- Airspeed when fault occurred.

To see all of the faults for that leg, you can use the NEXT PAGE and PREV PAGE function keys on the CDU.

If you push LSK 6R, you will go back to the FAULT HISTORY BY LEGS page. If you want to do an LRU interface test on the suspect LRU, push LSK 6L. You will go through these LRU tests:

- Autotest
- Interactive
- Surface.

If the tests passes, you get the FAULT HISTORY TEST PASSED page. If the test does not pass, you get the FAULT HISTORY TEST FAILED page.

FAULT HISTORY TEST PASSED Page (Not Shown)

This page shows these data:

- LRU that was tested
- Which channel was tested
- Group number
- Library test number.

If you push LSK 6R, you will go to the NEXT PAGE OF LEG FAULTS.

FAULT HISTORY TEST FAILED Page

This page shows these data:

- LRU that was tested
- Which channel was tested
- Group number
- Library test number.

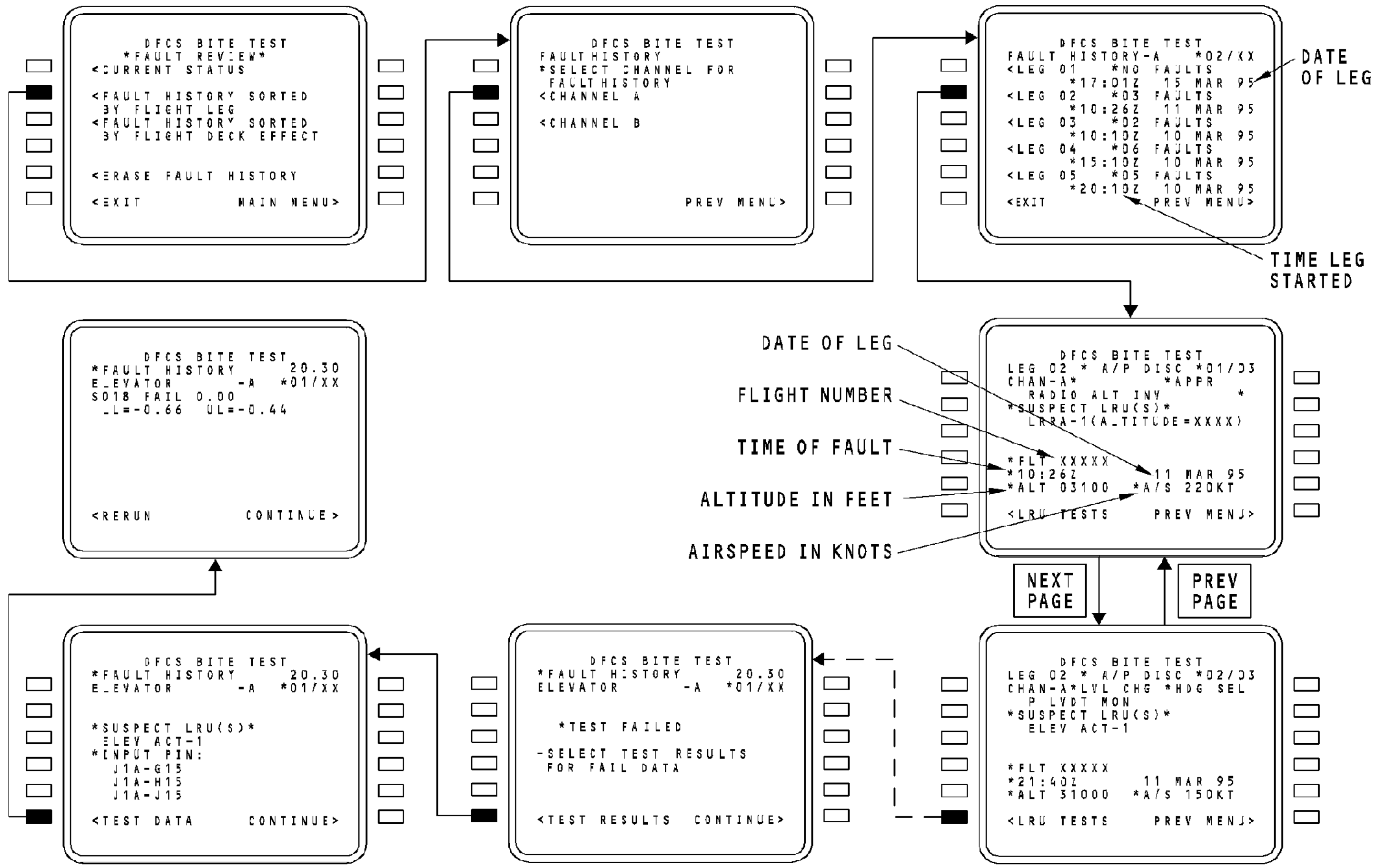
If you push LSK 6L, you will go to the FAULT HISTORY SUSPECT LRU(S) page.

FAULT HISTORY SUSPECT LRU(S) Page

This page is similar to the other suspect LRU pages that were shown. To see test data about the failures, push LSK 6L. This shows the test data page.

Test Data Page

This is the same as the other test data pages. It shows what step the test was on when it recorded the failure. It also shows the value of the failed data. To rerun the test, push LSK 6L. To return to the FAULT FOR EACH LEG page, push LSK 6R.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT HISTORY SORTED BY FLIGHT LEG

22-11-00-122

EFFECTIVITY
HAP ALL

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT HISTORY SORT BY FLIGHT DECK EFFECT

FAULT REVIEW Page

To see fault history sorted by flight deck effect, select LSK 3L. This shows the SELECT CHANNEL FOR FAULT HISTORY page. After you select the channel, you will see the FAULT HISTORY BY FLIGHT DECK EFFECT page.

FAULT HISTORY BY FLIGHT DECK EFFECT Page

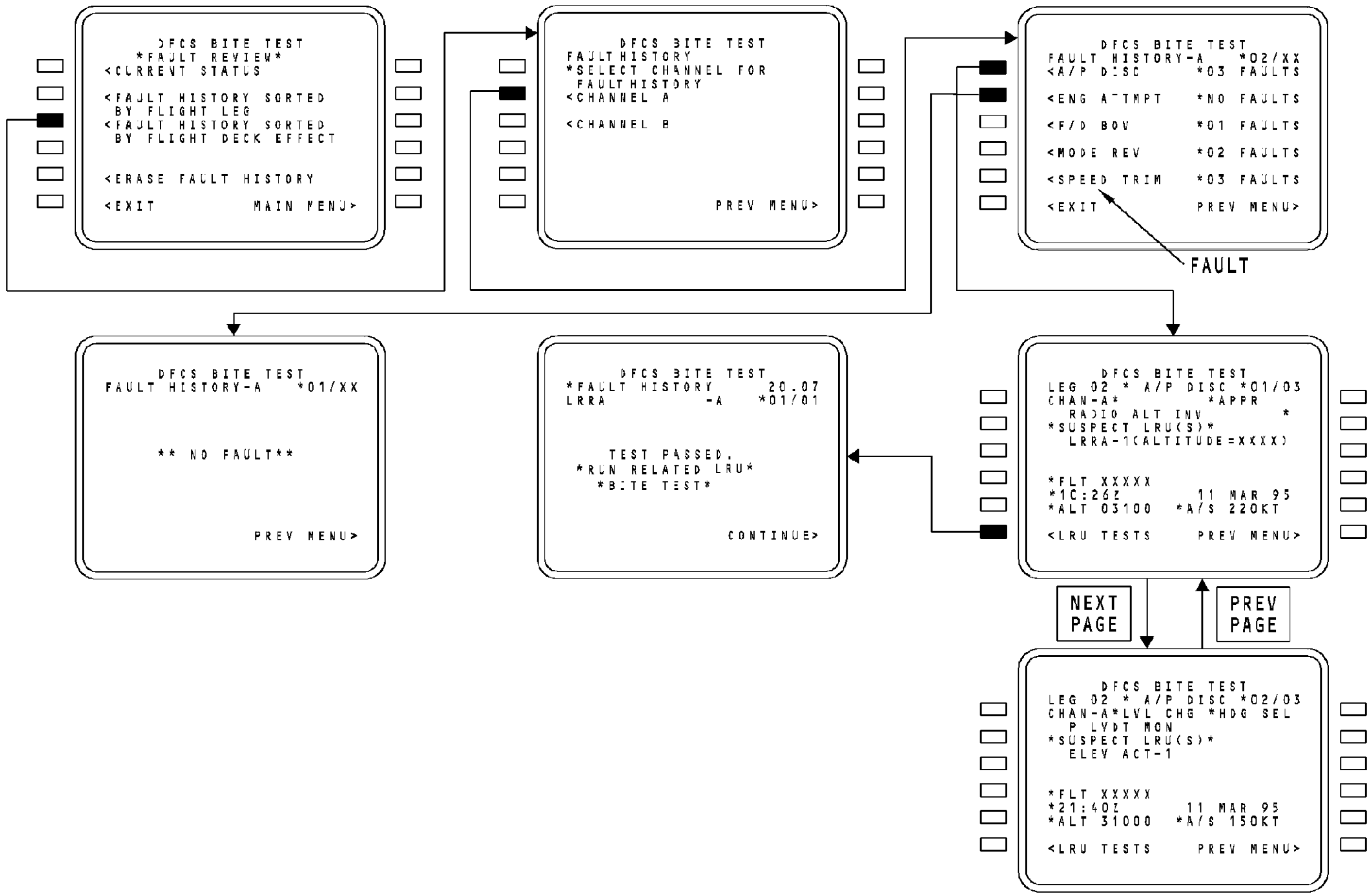
The page shows these data:

- Flight deck effect
- Number of times the flight deck effect occurred.

To see more flight deck effects, use the NEXT PAGE function key on the CDU.

To see more data about the flight deck effect, push the LSK next to the effect. If that flight deck effect did not occur within the last 40 flights, you see the page that shows ** NO FAULT **. If there are faults, you go to a FAULT FOR EACH LEG page.

The rest of the pages that show the faults are the same pages that the previous graphic shows.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - FAULT HISTORY SORT BY FLIGHT DECK EFFECT

22-11-00-123

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - ERASE FAULT HISTORY

General

You can erase all the fault history data in the FCC. This should only occur if you install a new FCC in the airplane or if you permanently swap the FCC from another airplane. You need to be on the FAULT REVIEW page to start the erase procedure.

FAULT REVIEW Page

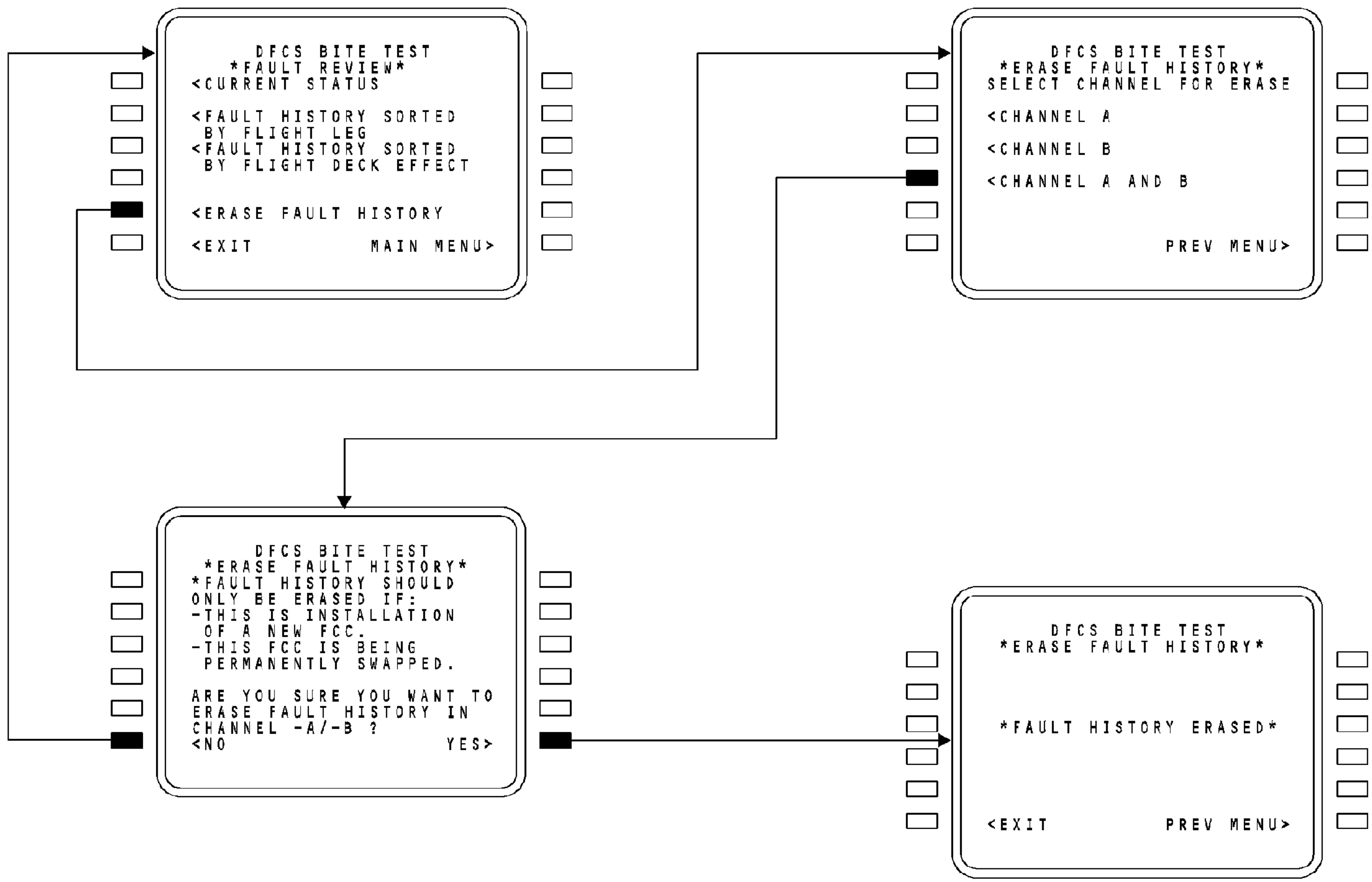
To erase the fault history, push LSK 5L. This shows the ERASE FAULT HISTORY page.

ERASE FAULT HISTORY Page

Select whether you want to erase the fault history in FCC A and/ or FCC B. To do this, push LSK 2L, 3L, or 4L. This shows the ERASE FAULT HISTORY VERIFICATION page.

ERASE FAULT HISTORY VERIFICATION Page

This shows a page that verifies that you want to erase the fault history. If you do not want to erase the fault history, push LSK 6L to go back to the FAULT REVIEW page. If you want to erase the fault history, push LSK 6R to continue to the FAULT HISTORY ERASED page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - ERASE FAULT HISTORY

22-11-00-124

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - LRU REPLACEMENT TESTS

General

The LRU replacement test makes sure that the replacement LRU operates correctly. The test can have these tests:

- Autotests
- Interactive tests.

You can start an LRU replacement test from the DFCS BITE MAIN MENU page.

DFCS BITE MAIN MENU Page

To do an LRU replacement test, push LSK 2L. This shows the LRU REPLACEMENT SELECT CHANNEL page.

LRU REPLACEMENT SELECT CHANNEL Page

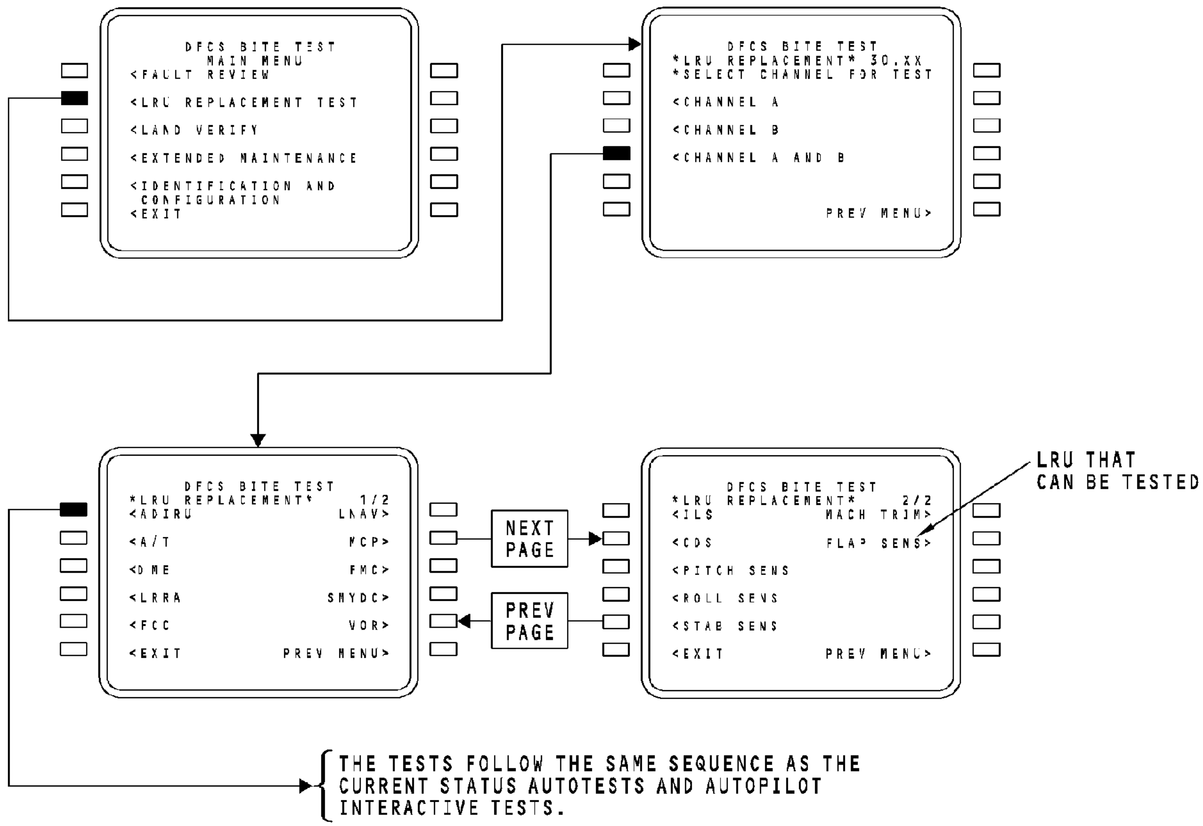
You select if you want to do an LRU replacement test for FCC A and/or FCC B. To do this, push LSK 2L, 3L, or 4L. This shows the LRU REPLACEMENT page.

LRU REPLACEMENT Page

This page lists the LRUs that you can use for the test. Push the LSK next to the LRU to start the test. To see all of the LRUs that you can test, push the NEXT PAGE and PREV PAGE function keys on the CDU.

Continue the Test

When you push one of the LSKs, you start the LRU replacement test. The test sequence is the same as when you select CURRENT STATUS and AUTOPILOT tests. The pages look very similar except the title has LRU REPLACEMENT in it instead of CURRENT STATUS and AUTOPILOT.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - LRU REPLACEMENT TESTS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - LAND VERIFY

General

The land verify tests do a check of many of the autoland sensors and hardware. It also does a check of the systems that the crew can use in a dual channel operation.

You can start a land verify test from the DFCS BITE MAIN MENU page.

DFCS BITE MAIN MENU Page

To do a land verify test, push LSK 3L. This shows the LAND VERIFY AUTOTEST INITIALIZATION page.

LAND VERIFY AUTOTEST INITIALIZATION Page

This page gives instructions to setup the land verify test. After you have setup the test correctly, push LSK 6L to continue the test. If the setup is not correct, you get the INITIALIZATION SETUP INCORRECT page. If the setup is correct, you get the page that tells you the autotest is in progress.

INITIALIZATION SETUP INCORRECT Page

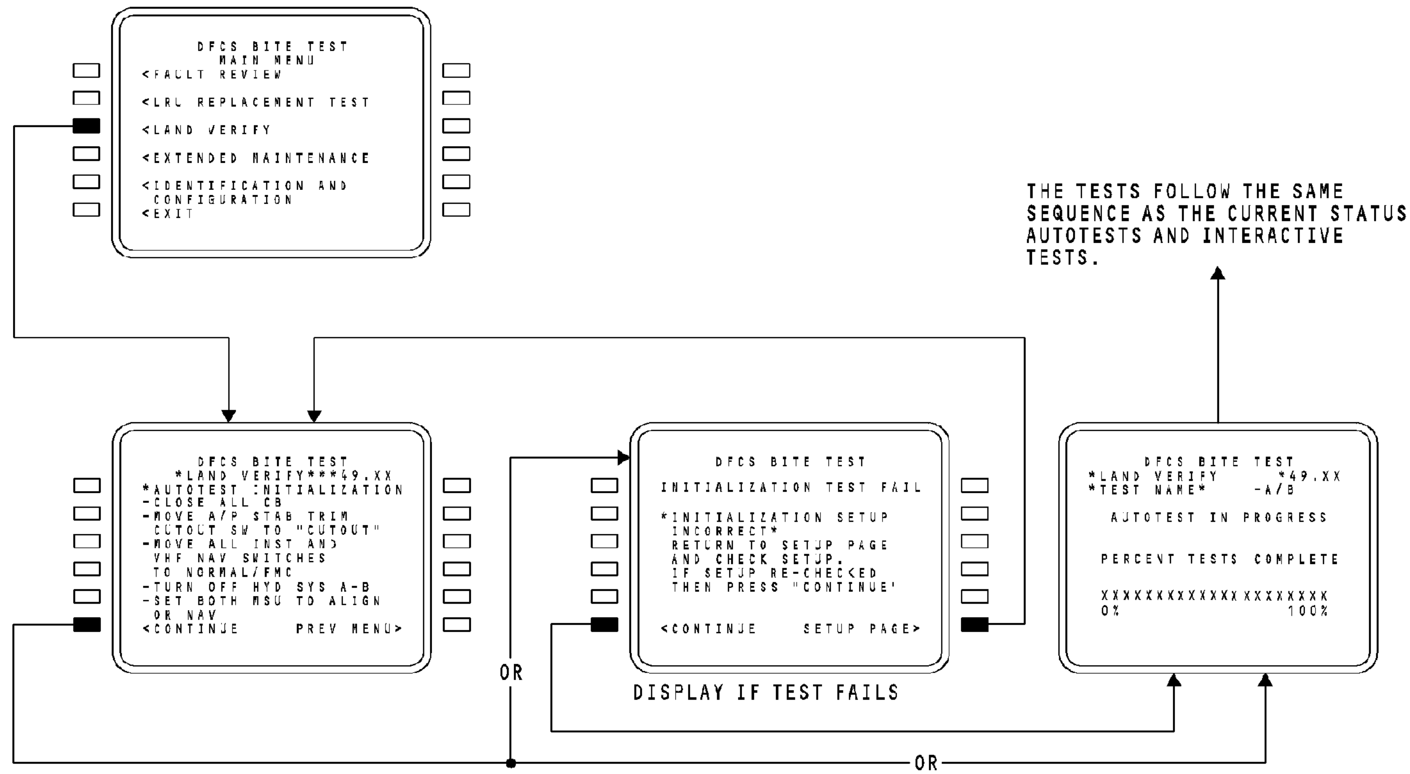
This page tells you that the initialization setup is not correct. To return to the setup page, push LSK 6R. If you made the correct changes, push LSK 6L to continue.

Land Verify Autotest

If the setup is correct, the autotests for all systems in group 49 start. As the tests continue, the name of the system in test and its library number show on the CDU page. The page also shows the percentage of the tests completed.

Continue the Test

When the autotests complete, the next tests are the interactive tests. The test sequence is the same as when you select AUTOPILOT tests. The pages look very similar except the title has LAND VERIFY in it instead of AUTOPILOT.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - LAND VERIFY

22-11-00-126

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE LIBRARY TESTS

General

There are more tests in addition the one that shows on the DFCS BITE MAIN MENU page. These tests show on the EXTENDED MAINTENANCE page. To get to this page, push LSK 4L.

EXTENDED MAINTENANCE Page

These are the additional tests that you can do from this page:

- BITE library tests
- Rigging
- MCP tests
- Sensor values.

To do the BITE library tests, push LSK 1L.

BITE LIBRARY TEST SELECT CHANNEL Page

You select if you want to do a BITE library test for FCC A and/or FCC B. To do this, push LSK 2L, 3L, or 4L. This shows the BITE LIBRARY TEST page.

BITE LIBRARY TEST Page

You can select one of these options:

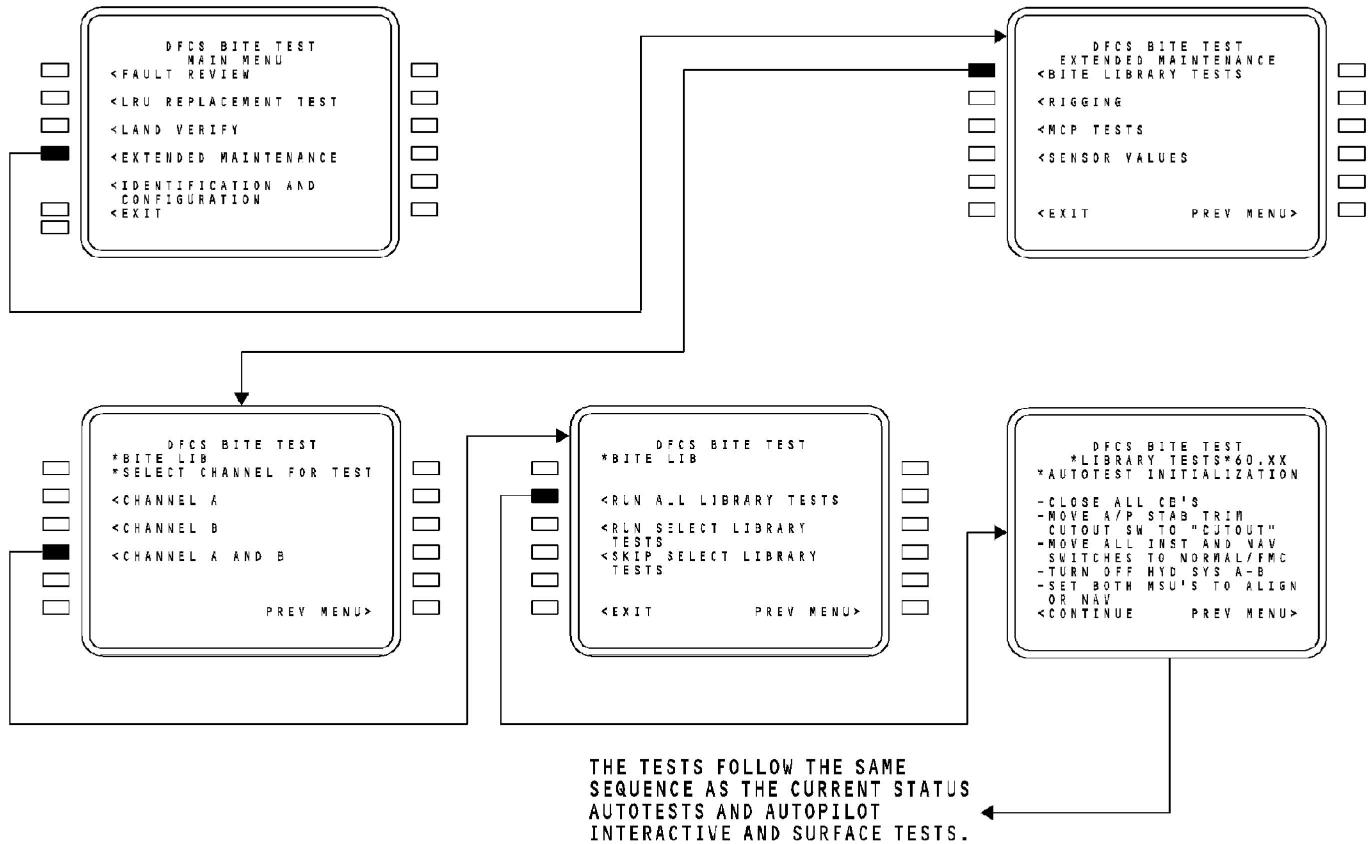
- Run all library tests
- Run select library tests
- Skip select library tests.

If you select RUN ALL LIBRARY TEST, you do all of the tests in the library. If you select RUN SELECT LIBRARY TEST, you only do the tests that you select. If you select SKIP SELECT LIBRARY TESTS, you do all the tests in the library except for the ones you select.

To run all library tests, push LSK 2L. The next page is the LIBRARY TEST AUTOTEST INITIALIZATION page.

LIBRARY TEST AUTOTEST INITIALIZATION Page

Like all the other initialization pages, this page gives instructions to setup the autotests. The test sequence is the same as when you select CURRENT STATUS and AUTOPILOT tests. The pages look very similar except the title has LIBRARY TEST in it instead of CURRENT STATUS and AUTOPILOT.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - BITE LIBRARY TESTS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RUN/SKIP SELECT LIBRARY TESTS

BITE LIBRARY TEST Page

To run select library tests, push LSK 3L. This shows the LIBRARY TEST LIST page.

LIBRARY TEST LIST Page

This page lists some of the library tests. To see all of the library tests, use the NEXT PAGE and PREV PAGE function keys on the CDU.

To select a test, push LSK next to the LRU name. When you push the LSK, a * shows just below the LRU prompt symbol. This means that this library test runs when you start the tests. You can select as many tests as you want.

To start the tests, push the EXECUTE prompt, LSK 6L. The next page is the LIBRARY TEST AUTOTEST INITIALIZATION page which is like all the other initialization pages.

BITE LIBRARY TEST Page

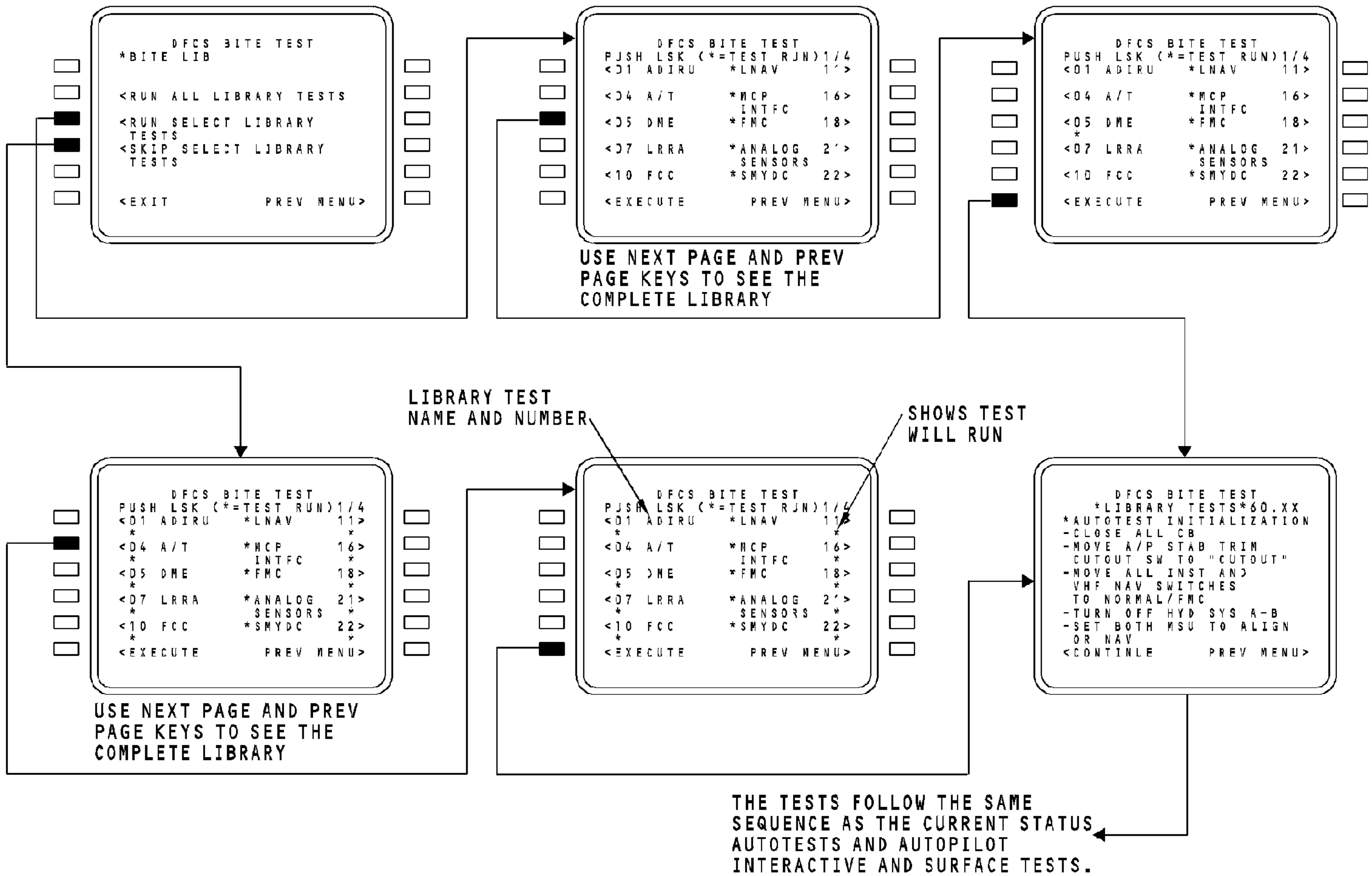
To skip some library tests, push LSK 4L. This shows the LIBRARY TEST LIST page.

LIBRARY TEST LIST Page

This page lists some of the library tests. To see all of the library tests, use the NEXT PAGE and PREV PAGE function keys on the CDU.

There is an * below all of the LRU prompts. To skip a test, push the LSK next to the LRU name. When you push the LSK, the * just below the LRU prompt symbol goes out of view. This means that this library test does not run when you start the tests. You can skip as many tests as you want.

To start the tests, push the EXECUTE prompt, LSK 6L. The next page is the LIBRARY TEST AUTOTEST INITIALIZATION page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RUN/SKIP SELECT LIBRARY TESTS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - MCP TESTS

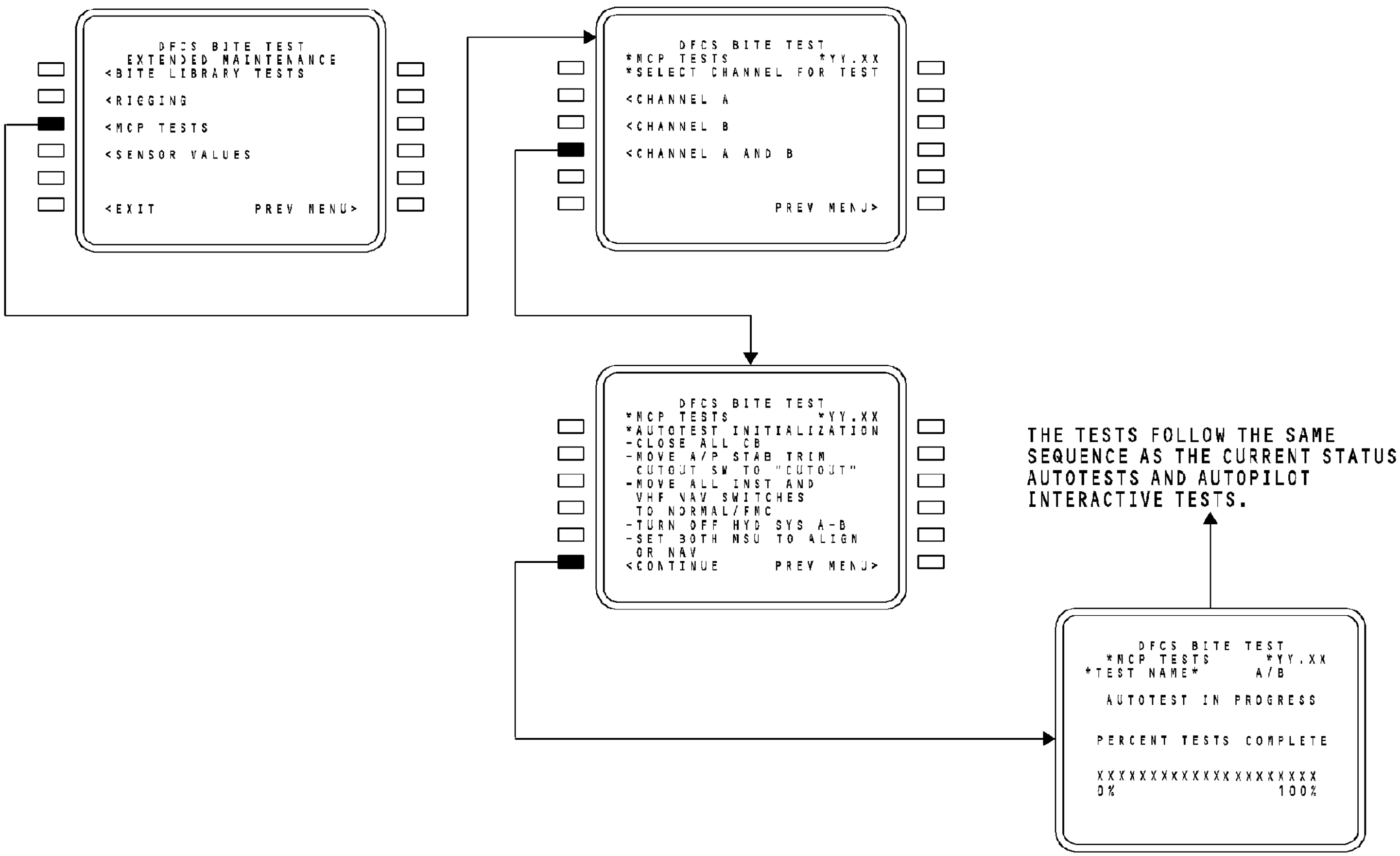
General

The MCP tests lets you do several tests of the mode control panel. In the tests you do a check of the function of the switches and the displays. You also do a test of all of the mode selector switches.

To do these tests, push LSK 3L on the EXTENDED MAINTENANCE page. The next page is the SELECT CHANNEL FOR TEST page. After you select the channel, you will see the MCP TEST AUTOTEST INITIALIZATION page.

MCP TEST AUTOTEST INITIALIZATION Page

Like all the other initialization pages, this page gives instructions to setup the autotests. The test sequence is the same as when you select CURRENT STATUS and AUTOPILOT tests. The pages look very similar except the title has MCP COMPLETE TEST in it instead of CURRENT STATUS and AUTOPILOT.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - MCP TESTS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - ANALOG SIGNALS

General

When you select the SENSOR VALUES prompt on the EXTENDED MAINTENANCE page, you can then see one of these signals on the SENSOR VALUES page:

- Analog signals
- Digital signals
- Option/program pins
- Discrete outputs
- Discrete inputs.

This lets you see the values for these signals without the need for extra test equipment.

To select analog signals, push LSK 1L. This shows the ANALOG SIGNALS LIST page.

ANALOG SIGNALS LIST Page

This pages lists some of the analog sensors that you can measure. To see all of the analog sensors, push the NEXT PAGE and PREV PAGE function keys on the CDU.

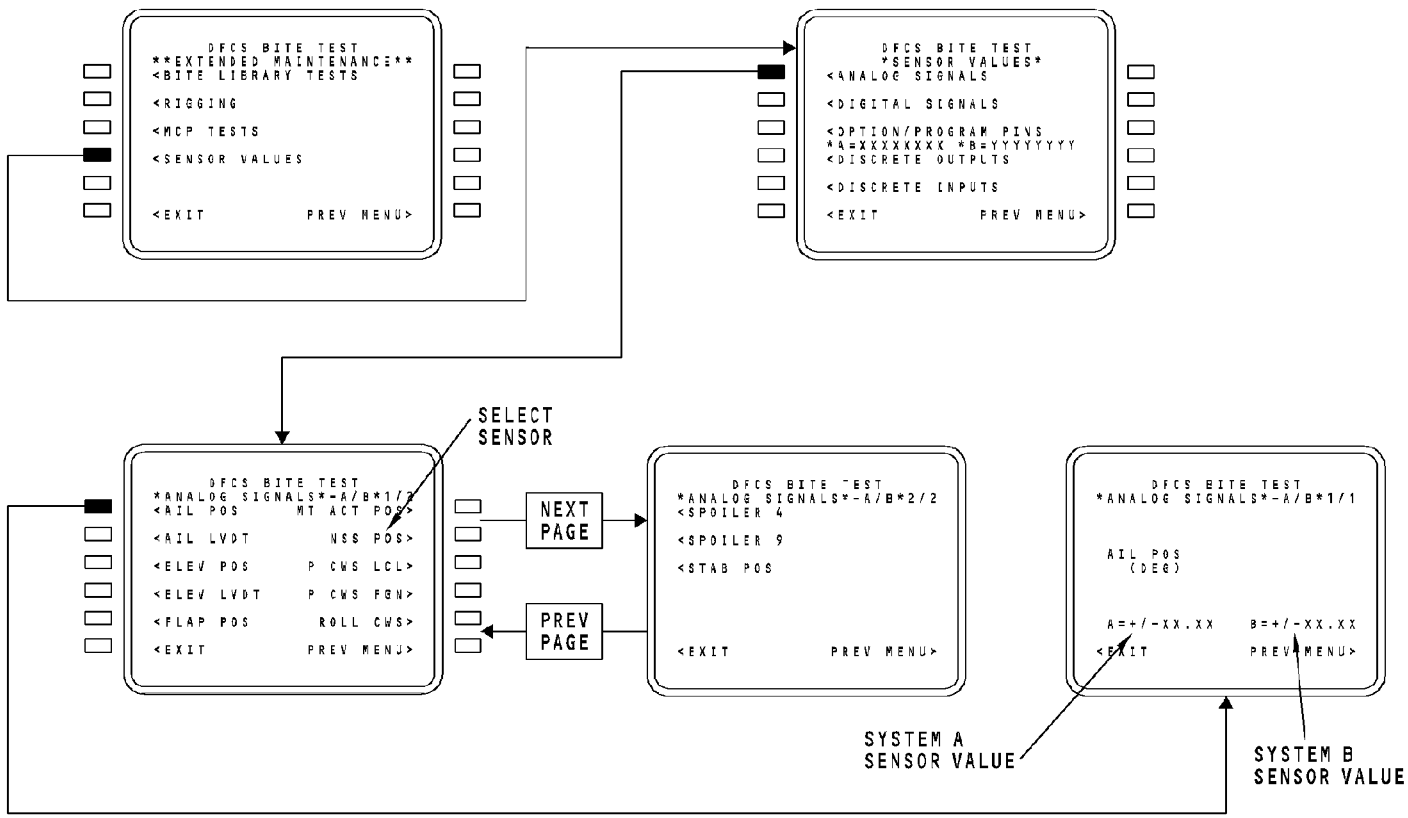
To select an analog sensor, push LSK next to the sensor name. This shows the ANALOG SIGNAL page.

ANALOG SENSOR Page

This page lists these data:

- Analog sensor
- Units that the analog data is in
- Sensor value for A and B system.

The LSK 6R will take you back to the SENSOR VALUES page.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - ANALOG SIGNALS

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - DIGITAL SIGNALS

General

You can see the digital signals from LRUs that send data to the DFCS. Some of the digital signals are digital sensor values and some are discrete words.

To select digital signals, push LSK 2L. This shows the DIGITAL SIGNALS LRU LIST page.

DIGITAL SIGNALS LRU LIST Page

This pages lists some of the LRUs that send digital signals to the DFCS. To see all of the LRUs, push the NEXT PAGE and PREV PAGE function keys on the CDU.

To select an LRU to list the digital signals, push the LSK next to the LRU name. This shows the DIGITAL SIGNALS LIST page.

DIGITAL SIGNALS LIST Page

This page lists the digital signals that you can select. To see all of the digital signals, push the NEXT PAGE and PREV PAGE function keys on the CDU. To select a signal, push the LSK next to the signal name. This shows the DIGITAL SIGNAL page.

DIGITAL SIGNAL Page

The digital signal can be a value from a digital sensor. These are the data that shows on this page:

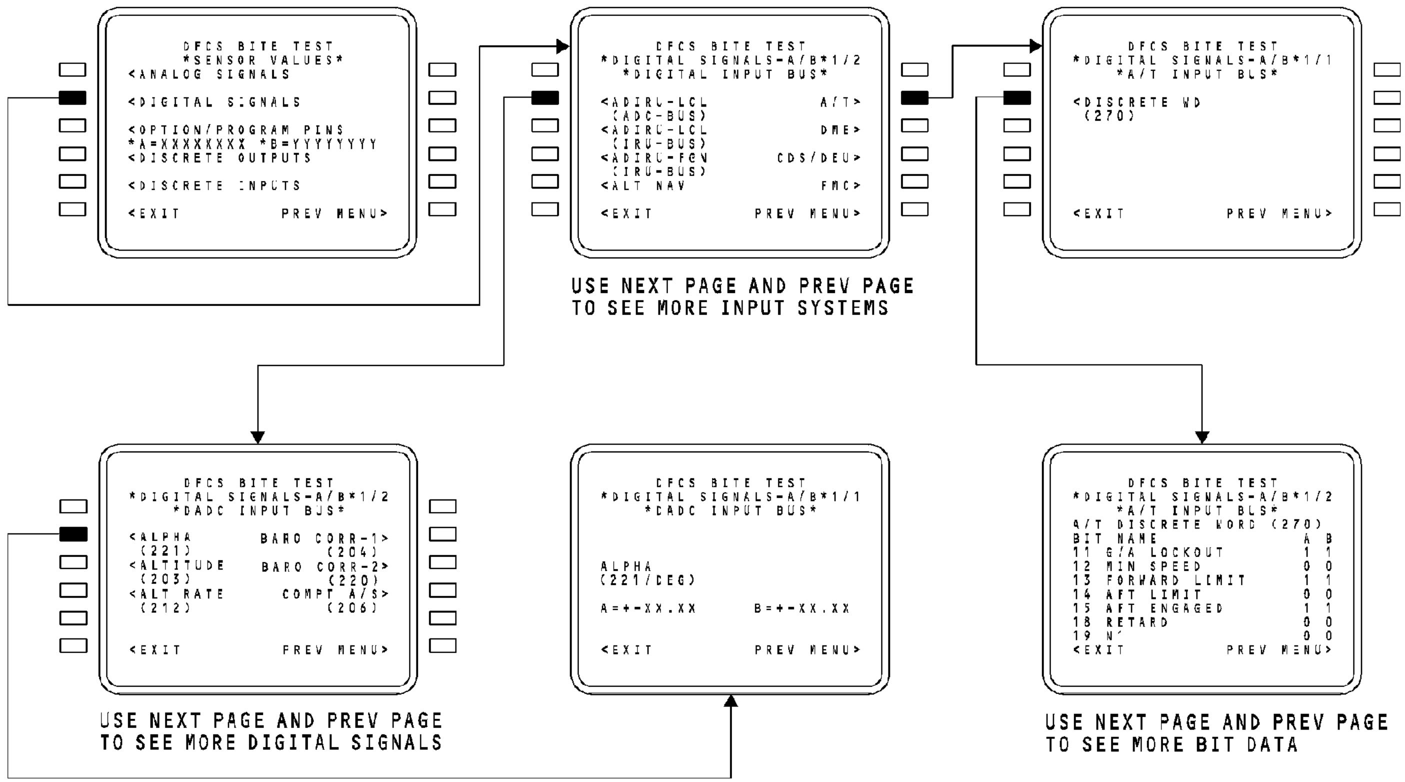
- LRU that the digital signal is from
- Sensor name
- Units the data is in
- Sensor value for A and B system.

The example shows the altitude data output from the local ADIRU.

The digital signal can also be the bit data from a digital word. These are the data that shows on this page:

- LRU that the discrete word is from
- Discrete word label
- Word bits and name
- Bit values for systems A and B.

The example shows the discrete word 270 from the autothrottle (A/T).



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - DIGITAL SIGNALS

22-11-00-131

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SELECTED OPTION PINS/DISCRETE INPUTS

General

From the SENSOR VALUES page, you can select pages to see the configuration of the option program pins. You can also see the discrete values on the connector pins.

If you want to see the option program pins, push LSK 3L. This shows the OPTION/PROG page. If you want to see the discrete values of the connector pins, push LSK 5L. This shows the DISCRETE INPUTS page.

OPTION/PROG Page

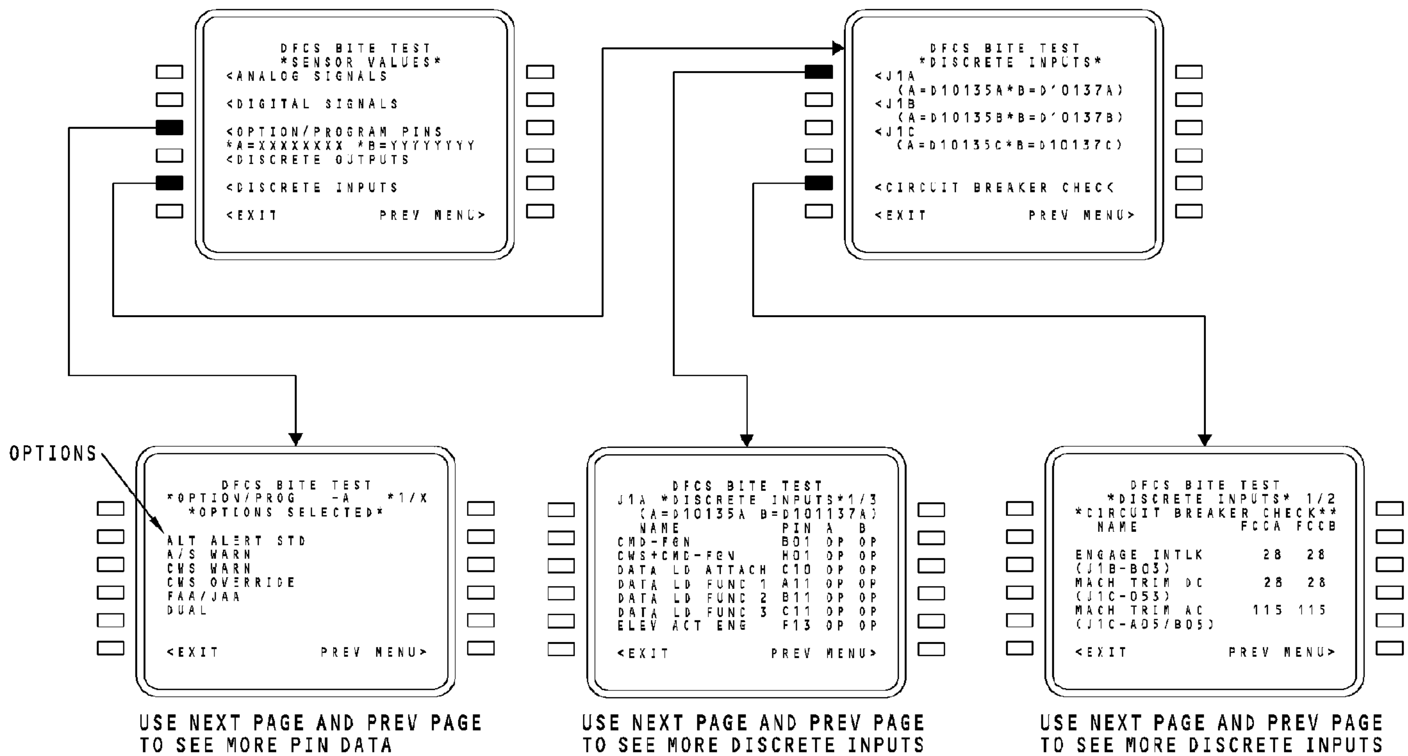
This page shows the names of the options for the airplane. To see all of the options, push the NEXT PAGE and PREV PAGE function keys on the CDU.

DISCRETE INPUTS Page

This page shows these data about the discrete inputs:

- Connector number for FCC A and FCC B
- Pin name and number
- Pin configuration for FCC A and B.

To see all of the discrete inputs. push the NEXT PAGE and PREV PAGE function keys on the CDU.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SELECTED OPTION PINS/DISCRETE INPUTS

22-11-00-132

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - DISCRETE OUTPUTS

General

There are radio altimeter trip points and DC bus isolation discrete outputs from each FCC. To see these outputs, select DISCRETE OUTPUTS, LSK 4L, from the SENSOR VALUES page. This shows the DISCRETE OUTPUTS page.

DISCRETE OUTPUTS Page

This page list the two possible discrete outputs that the FCCs send out. They are radio altimeter trip points and the DC bus isolation signal. To select the radio altimeter trip point outputs, push LSK 2L. This shows the R/A TRIP POINT OUTPUTS pages. To select the DC bus isolation output, push LSK 3L. This shows the DC BUS ISOLATION OUTPUT pages.

R/A TRIP POINT OUTPUT Pages

This first page lets you select either channel A or channel B. When you push a LSK to select the channel, you will get a second page that lists these data:

- Channel that you selected
- Altitude of the trip point
- Connector name and pin number
- State of the discrete, on or off.

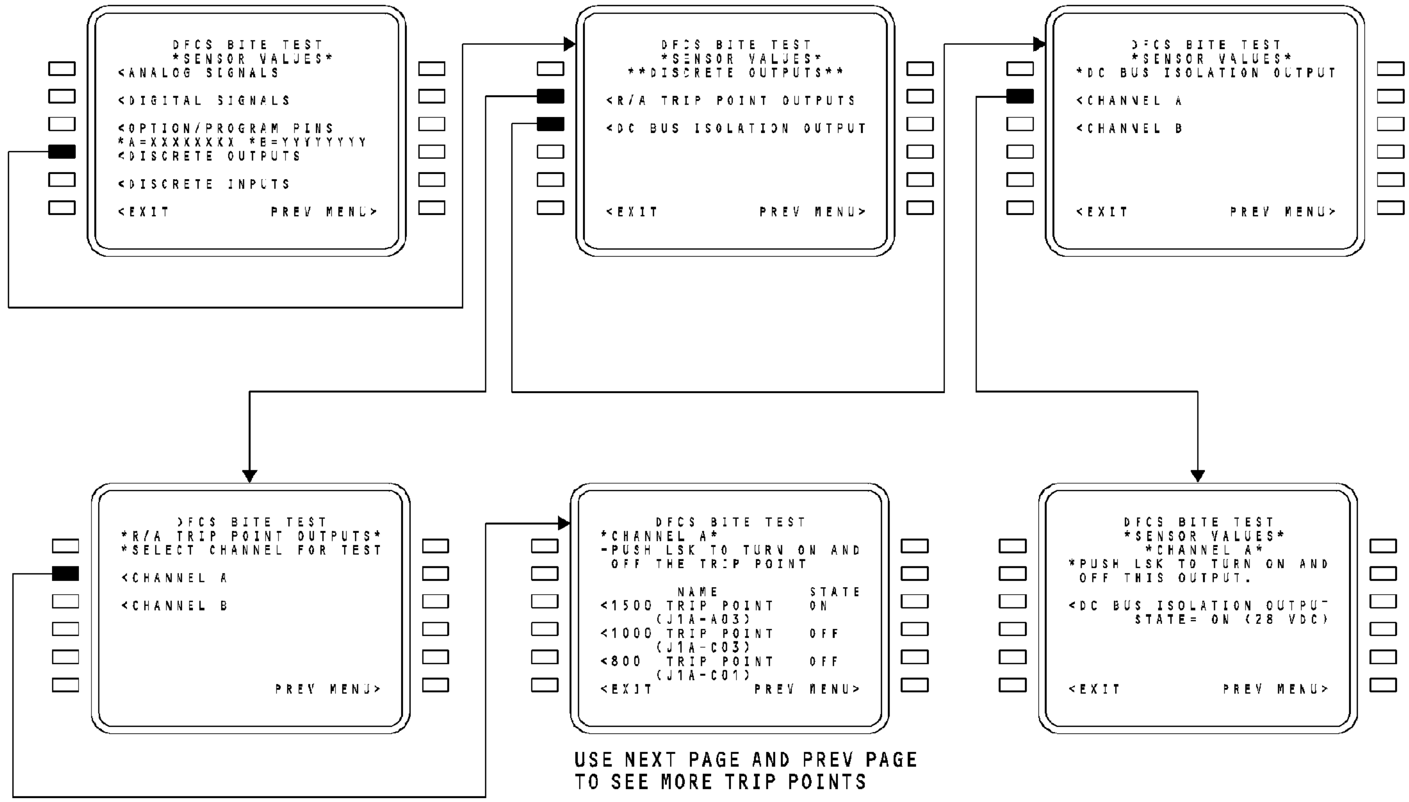
You can change the state of the altitude discrete output if you push the LSK next to the altitude value. To see all of the altitude trip points, push the NEXT PAGE and PREV PAGE function keys on the CDU.

DC BUS ISOLATION OUTPUT Pages

This first page lets you select either channel A or channel B. When you push a LSK to select the channel, you will get a second page that lists these data:

- Channel that you selected
- State of the discrete, on or off.

You can change the state of the DC bus isolation discrete output if you push the LSK next to the prompt.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - SENSOR VALUES - DISCRETE OUTPUTS

22-11-00-133

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RIGGING

General

The BITE rigging lets you make sure that the control surface actuators and sensors are aligned correctly. The rigging procedure follows the procedure in the part 2 of the maintenance manual. It lets you get position sensor data without extra test equipment. In order to do the rigging tests, FCC A and B must be installed.

To do the rigging test, push LSK 2L on the EXTENDED MAINTENANCE page. This shows the RIGGING INDEX page.

RIGGING INDEX Page

Rigging covers sensors and actuators for these functions as well as setting set command outputs:

- Elevator
- Aileron
- Flaps
- Stabilizer
- CWS
- Mach trim.

To select one of the rigging tests, push the LSK next to the function name. This shows the RIGGING TEST WARNING page.

If you do not want to do any more rigging tests, push LSK 6L to continue to the END OF BITE RIGGING page.

END OF BITE RIGGING Page

This page tells you to turn off the hydraulic power and to push LSK 6L to leave BITE or return to the DFCS BITE MAIN MENU.

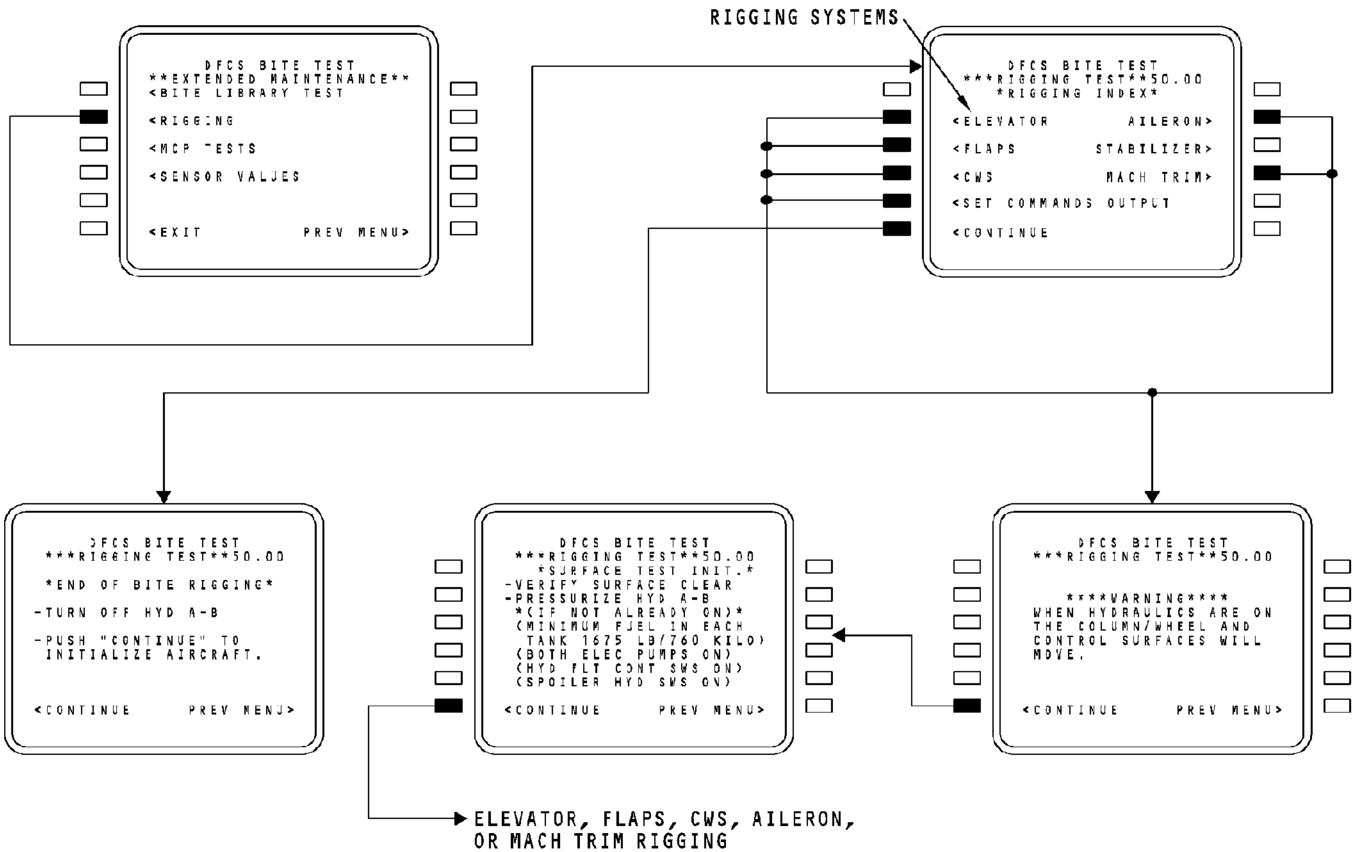
RIGGING TEST WARNING Page

This page warns the operator that hydraulic power is on and the control surfaces and the control columns may move. If you want to continue, push LSK 6L to go to the RIGGING SURFACE TEST INITIALIZATION page.

RIGGING SURFACE TEST INITIALIZATION Page

This page gives you some instructions. After you follow the instructions, push LSK 6L to continue. This starts the first surface test from the test library for the rigging test group.

Some of the rigging tests are complex and take many steps to complete.

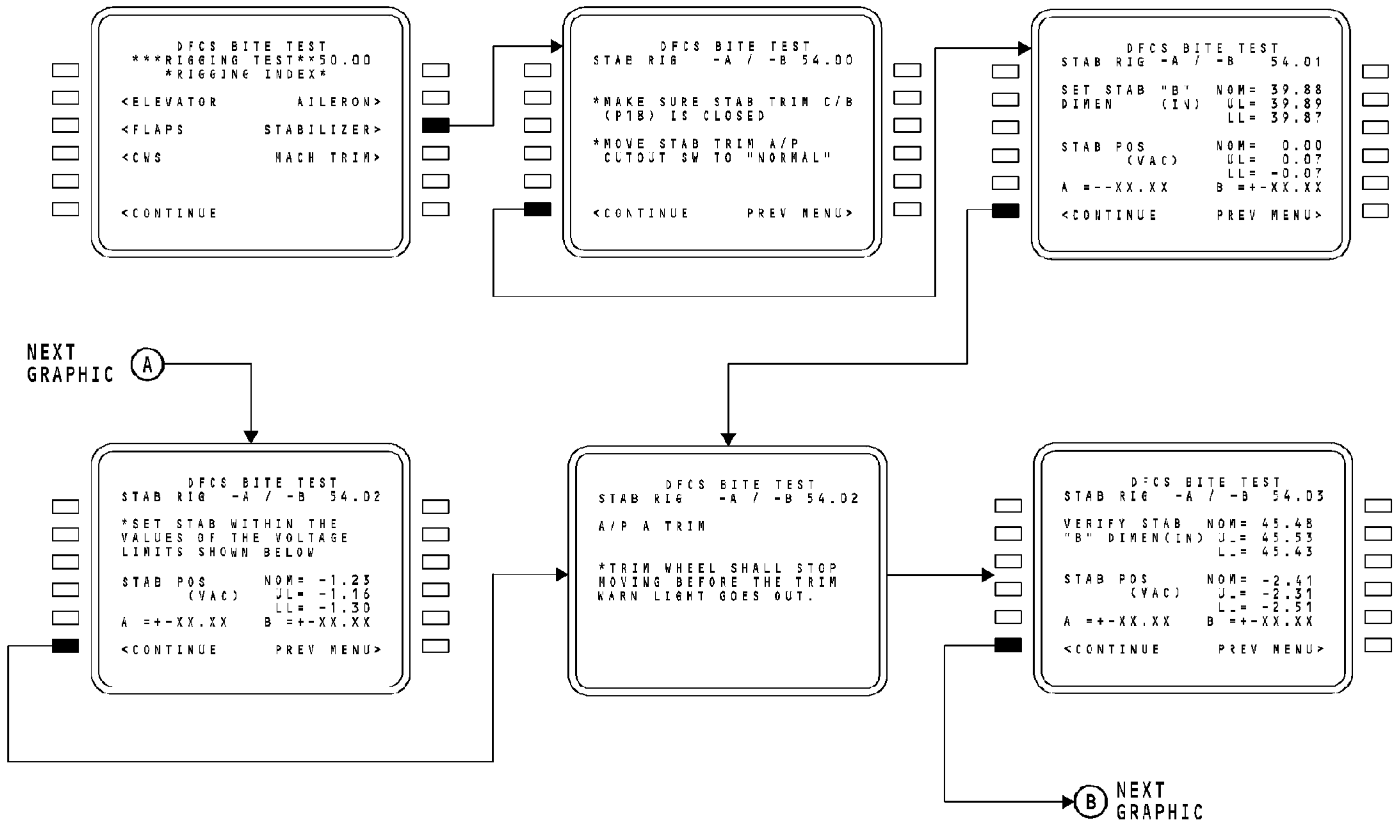


DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RIGGING

DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RIGGING - STABILIZER 1

General

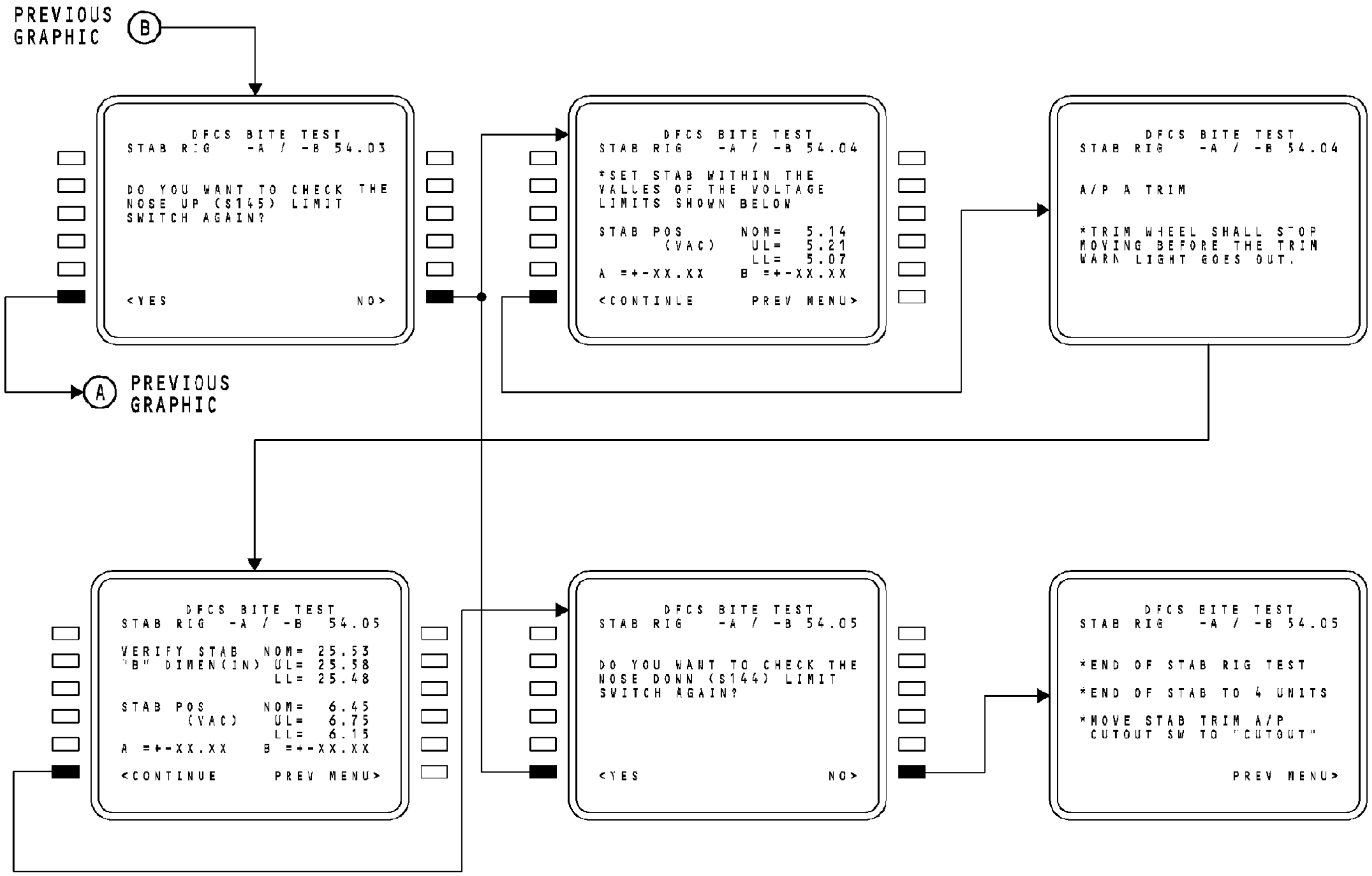
This shows an example of one of the rigging tests, the stabilizer rigging. You can follow the test through each of the stabilizer rigging pages. You can always go back to the RIGGING INDEX page if you push LSK 6R when it says PREV MENU.



DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RIGGING - STABILIZER 1

Stabilizer Rigging Continue

This shows more pages of the stabilizer rigging test.



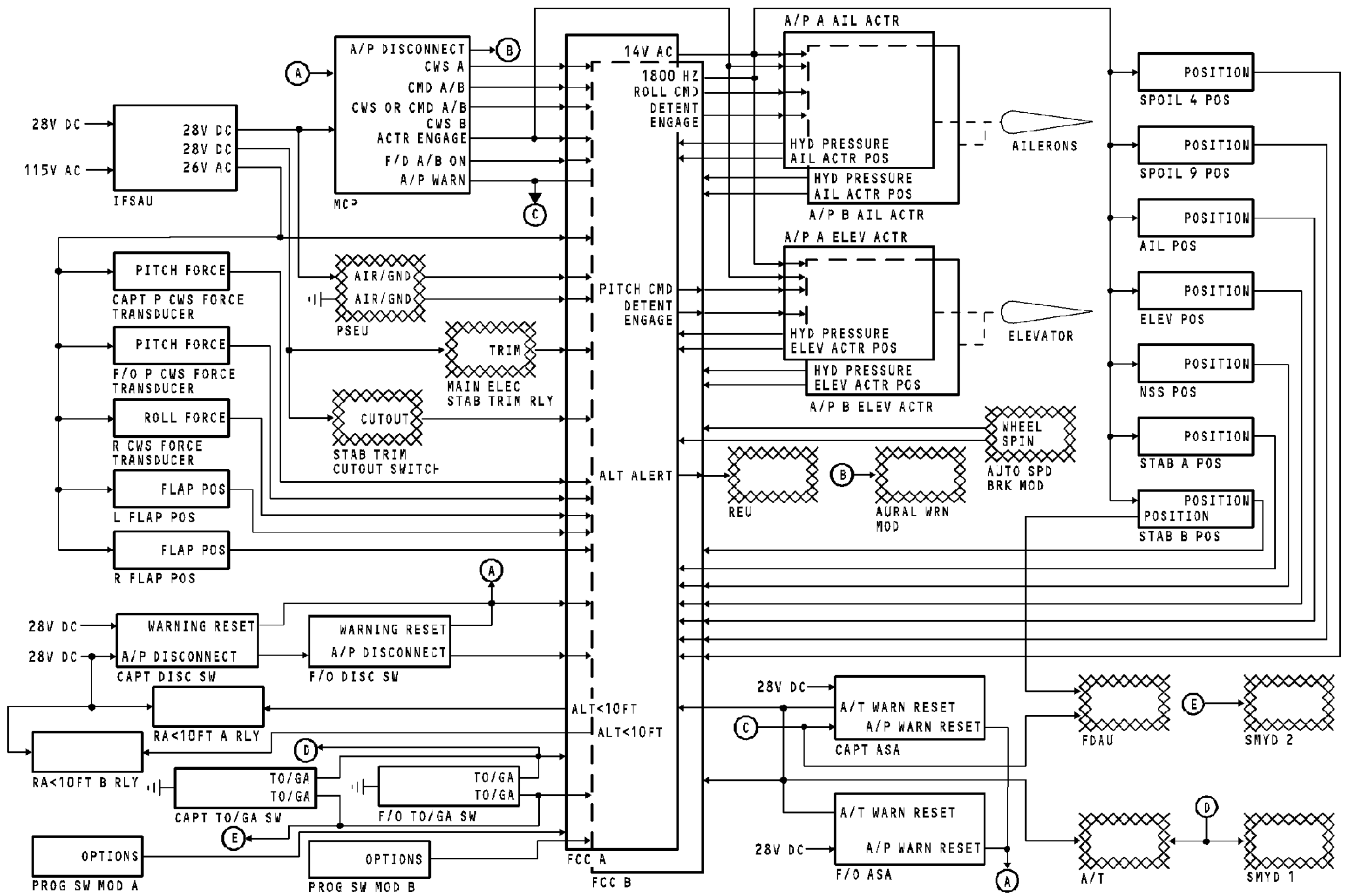
DFCS - TRAINING INFORMATION POINT - DFCS BITE PAGES - RIGGING - STABILIZER 2

22-11-00-136

DFCS - SYSTEM SUMMARY 1

General

This graphic is for reference.

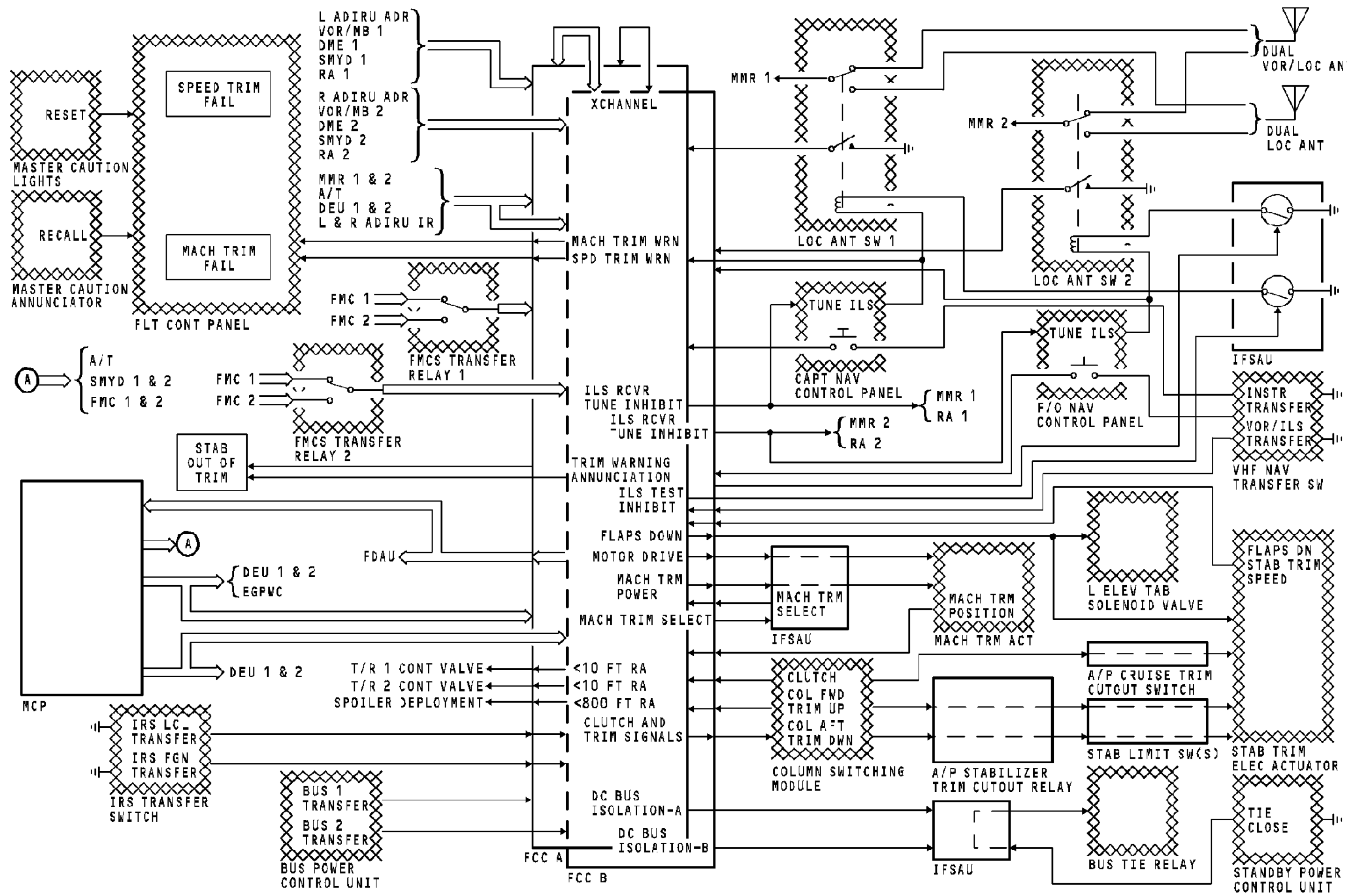


DFCS - SYSTEM SUMMARY 1

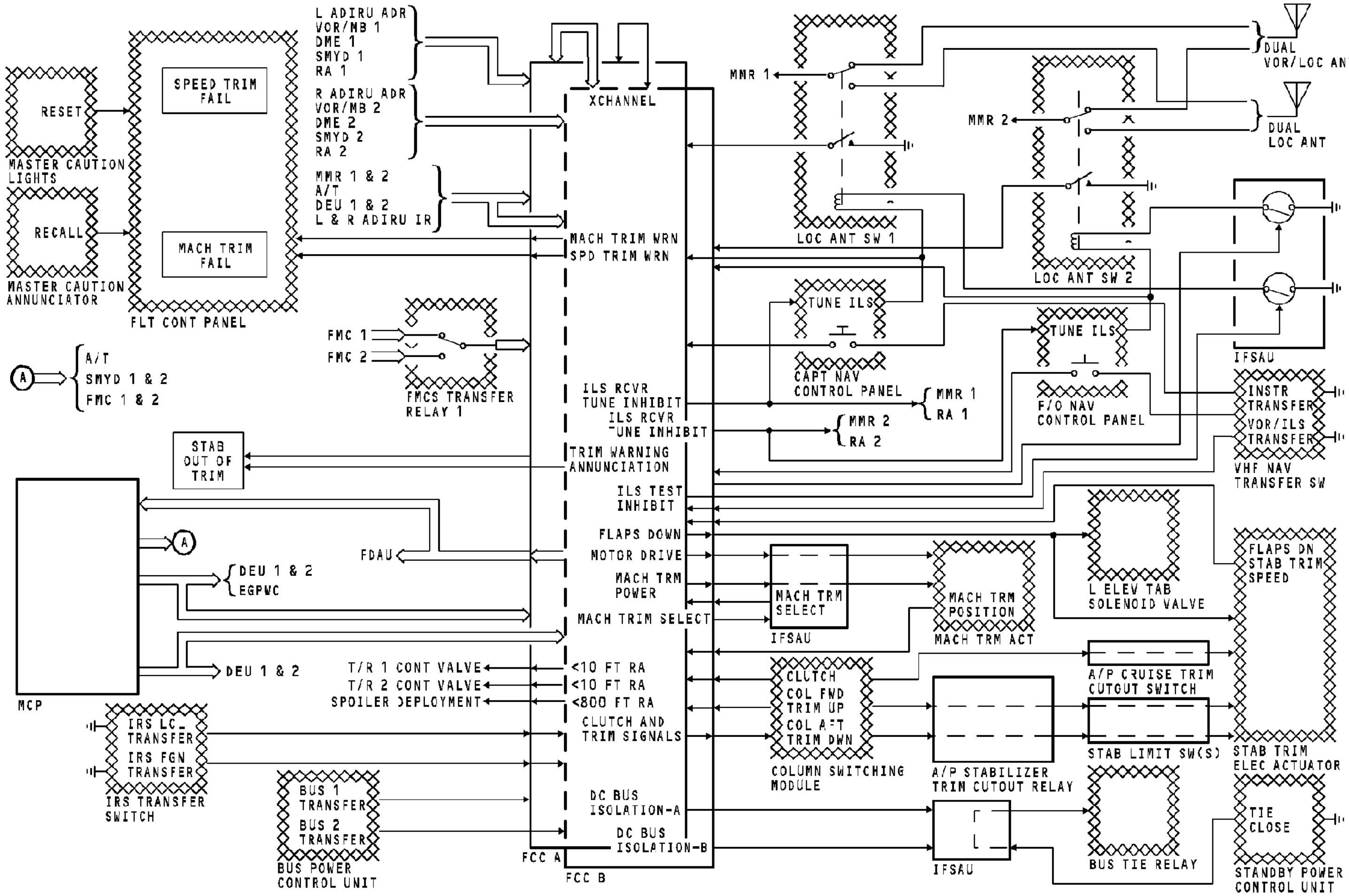
DFCS - SYSTEM SUMMARY 2

General

This graphic is for reference.



DFCS - SYSTEM SUMMARY 2



DFCS - SYSTEM SUMMARY 2

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YAW DAMPER SYSTEM - INTRODUCTION

Purpose

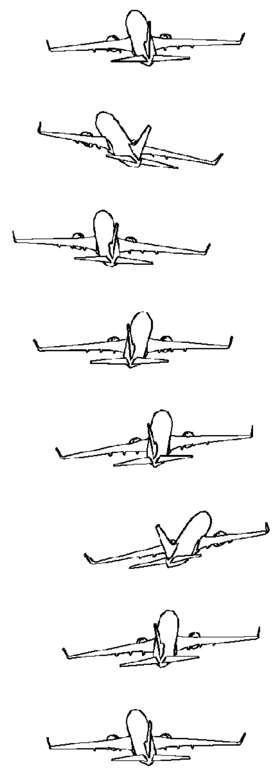
The yaw damper system keeps the airplane stable around the airplane yaw (vertical) axis. During flight, the yaw damper commands rudder movement in proportion to and opposite to the airplane yaw moment. This keeps unwanted yaw motion to a minimum and makes the flight smoother. The yaw damper is an autoflight system.

Unwanted airplane yaw motion is caused by either of the following conditions:

- Dutch roll
- Air turbulence.

Abbreviations and Acronyms

- ac - alternating current
- ADR - air data reference
- ADIRU - air data inertial reference unit
- AOA - angle of attack
- ARINC - Aeronautical Radio Incorporated
- ATR - Austin Trumbull Radio
- BITE - built in test equipment
- CAA - Civil Aviation Authority
- CDS - common display system
- CDU - control display unit (FMC)
- CPC - cabin pressure controller
- CPU - central processing unit
- dc - direct current
- DEU - display electronic unit
- DFCS - digital flight control system
- EHSV - electro-hydraulic servo valve
- FAA - Federal Aviation Administration
- FMC - flight management computer
- FMCS - flight management computer system
- FMS - flight management system
- IR - inertial reference
- I/O - input/output
- LRU - line replaceable unit
- LVDT - linear variable differential transformer
- MCP - mode control panel
- N1 - engine low pressure rotor (fan) speed
- N2 - engine high pressure rotor speed
- NN - a number from 01 to 99
- PCU - power control unit
- PLI - pitch limit indicator
- SMYD - stall management yaw damper
- SWS - stall warning system
- V - volts
- Vmin - minimum safe airspeed
- Vmax - maximum safe design airspeed
- WTRIS - wheel to rudder interconnect system
- YDS - yaw damper system



UNWANTED YAW MOTION DUE TO DUTCH ROLL OR TURBULENCE

YAW DAMPER SYSTEM - INTRODUCTION

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YDS - GENERAL DESCRIPTION

General

The yaw damper system is an autoflight system which moves the rudder to decrease airplane yaw motion caused by dutch roll or turbulence. The system operates for all phases of flight and is normally engaged on the ground before takeoff.

These are the components for primary yaw damping:

- SMYD 1
- Yaw damper engage switch
- Yaw damper disengage light
- Yaw damper indicator
- Yaw damper components on the main rudder PCU.

Yaw Damper Engage Switch and Disengage Light

You engage the yaw damper system with a switch on the flight control panel. For primary yaw damping, system B hydraulic pressure is necessary and the FLT CTRL B switch must be ON. The yaw damper disengage warning light is above the engage switch. For normal yaw damper operation, the light is OFF. The light is ON to show the yaw damper is not engaged while power is on the airplane.

Yaw Damper Indicator

The yaw damper indicator shows rudder movement due to SMYD 1 primary yaw damping commands. It does not show rudder movement due to rudder pedal inputs. The indicator is connected only to SMYD 1.

Main Rudder PCU

There are two rudder PCUs, a main and a standby, in the vertical stabilizer. These PCUs are hydraulic actuators that move the rudder in response to pilot rudder pedal inputs. The main rudder PCU is used only during normal operations. The standby rudder PCU is used only during standby operations.

The primary yaw damper uses the main rudder PCU to move the rudder to reduce yaw. For yaw damping, these are the four components on the main rudder PCU:

- Yaw damper solenoid valve
- Yaw damper electro-hydraulic servo valve (EHSV)
- Yaw damper LVDT
- Yaw damper actuator.

ADIRU

The air data inertial reference units (ADIRUs) send inertial and air data to the SMYDs. The data includes airspeed, attitude, yaw and roll rates, and accelerations. SMYD 1 uses this data for detection of yaw motion to calculate a command to move the rudder in the opposite direction to decrease unwanted yaw motion of the airplane.

FMC

The FMC provides airplane gross weight to the SMYDs for use in yaw damping calculations.

YDS - GENERAL DESCRIPTION

Trailing Edge Flaps Up Limit Switch

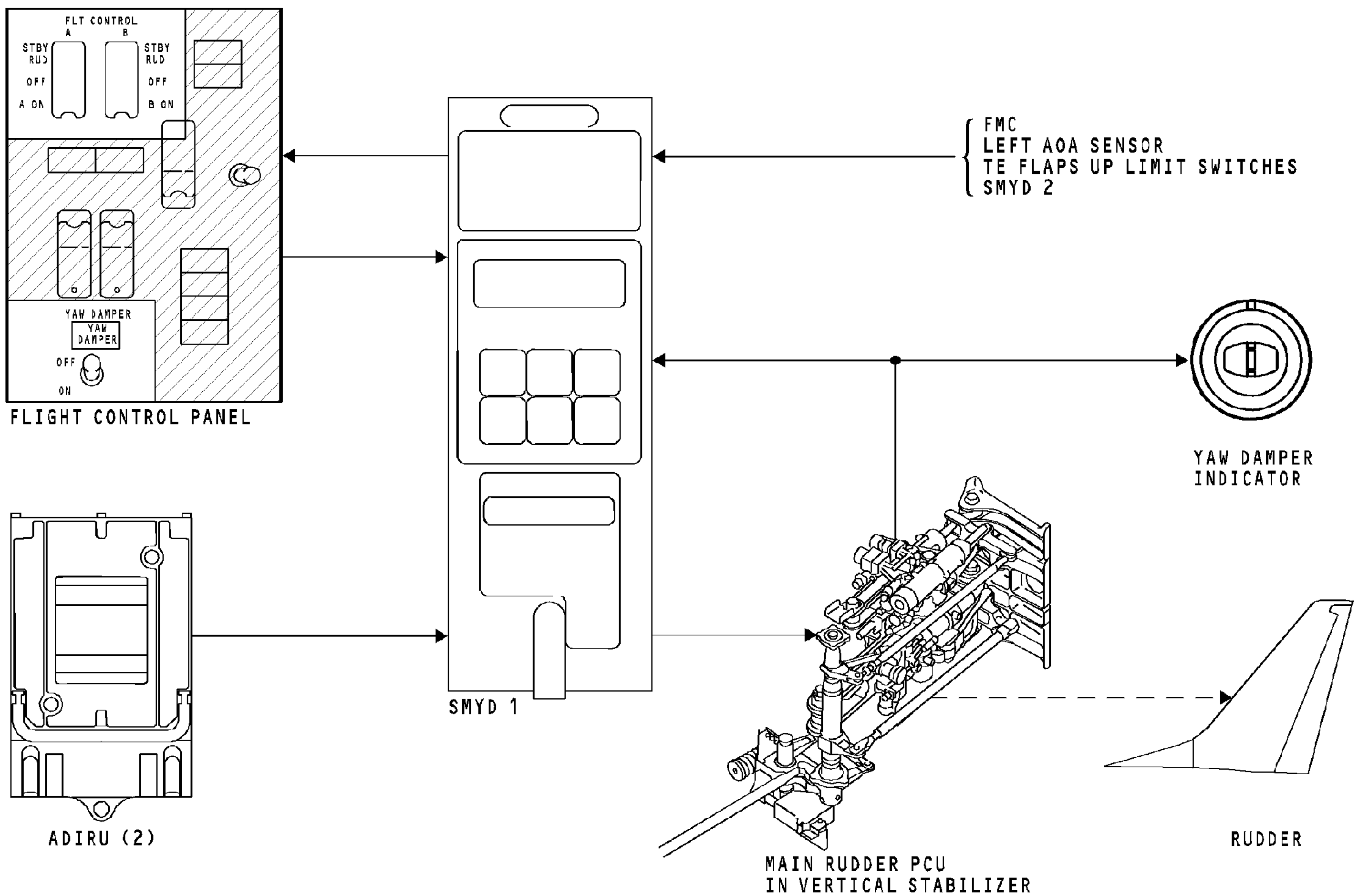
The trailing edge flaps up limit switches send data to the SMYDs to limit rudder travel for yaw damping when the flaps are up.

SMYD

The two SMYDs are the same. When a SMYD LRU is put in position 1, it does the primary yaw damper function during normal operations.

For primary yaw damping, both SMYDs must be operational because SMYD 1 compares its yaw damping calculations with SMYD 2 before it commands rudder movement.

For operation of the WTRIS and standby yaw damping systems, see the wheel-to-rudder section. (SECTION 27-24)



YDS - GENERAL DESCRIPTION

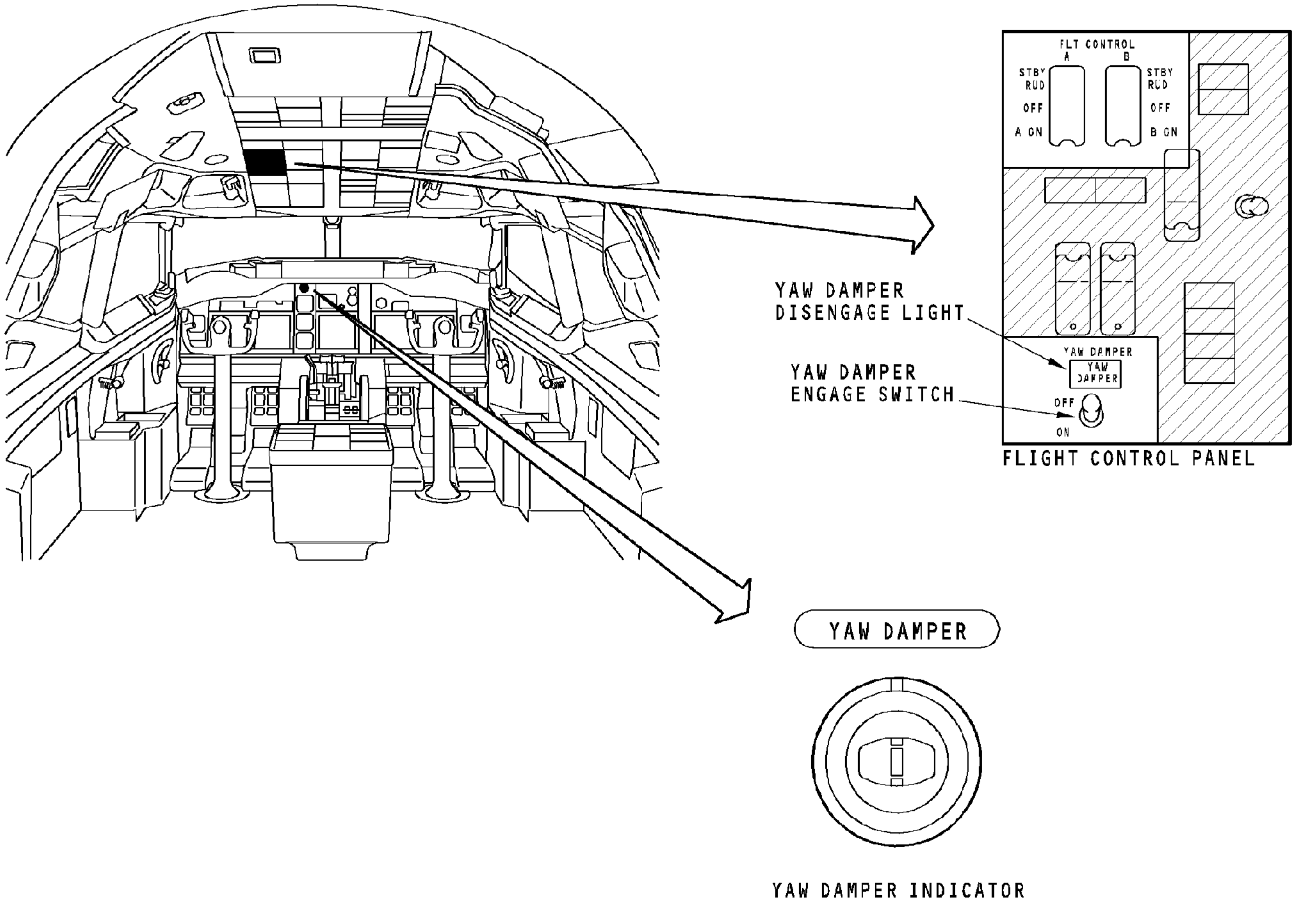
YDS - FLIGHT COMPARTMENT COMPONENT LOCATION

Engage Switch and Disengage Light

The yaw damper engage switch and the disengage light are on the flight control panel (P5 forward overhead).

Yaw Damper Indicator

The yaw damper indicator is on the P2 panel.

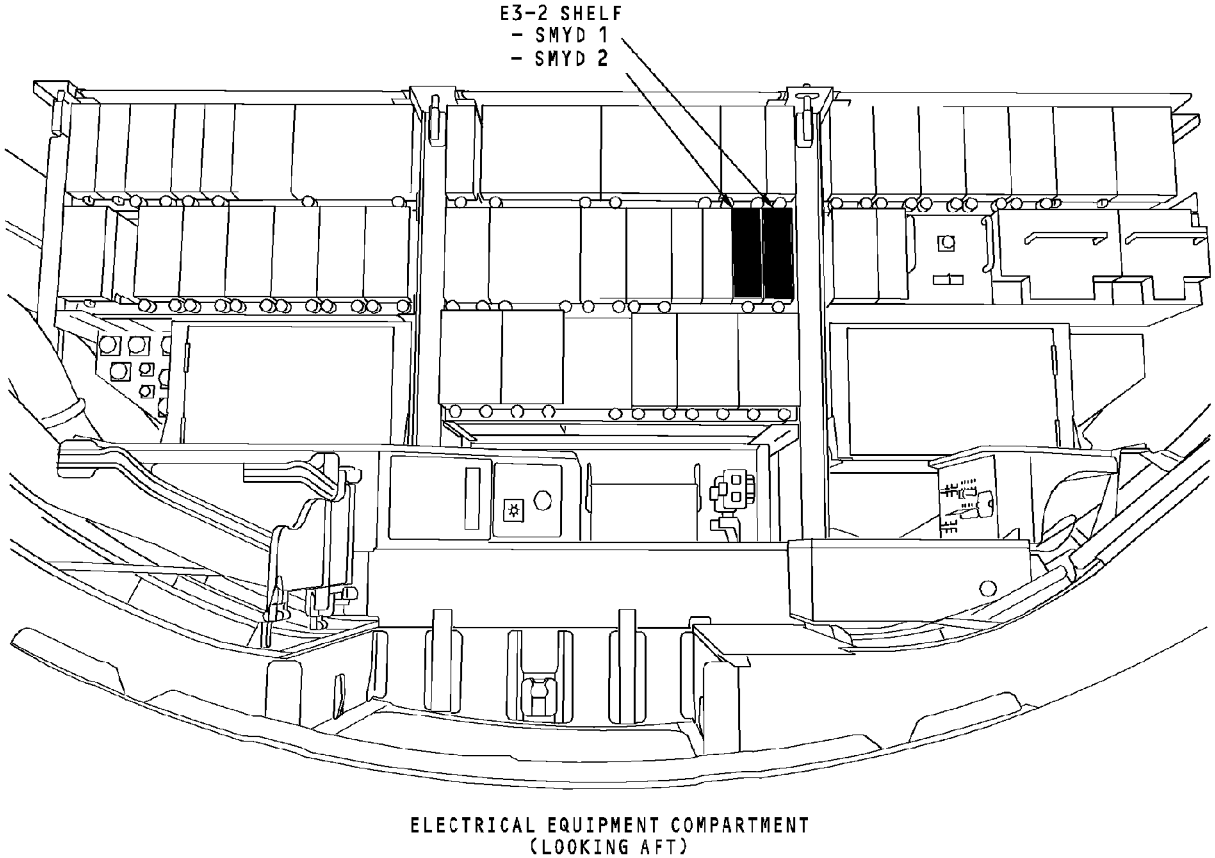


YDS - FLIGHT COMPARTMENT COMPONENT LOCATION

YDS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

Stall Management Yaw Damper

SMYD 1 and 2 are on the E3-2 shelf in the electronic equipment compartment.



YDS - ELECTRONIC EQUIPMENT COMPARTMENT COMPONENT LOCATION

YDS - VERTICAL STABILIZER COMPONENT LOCATION

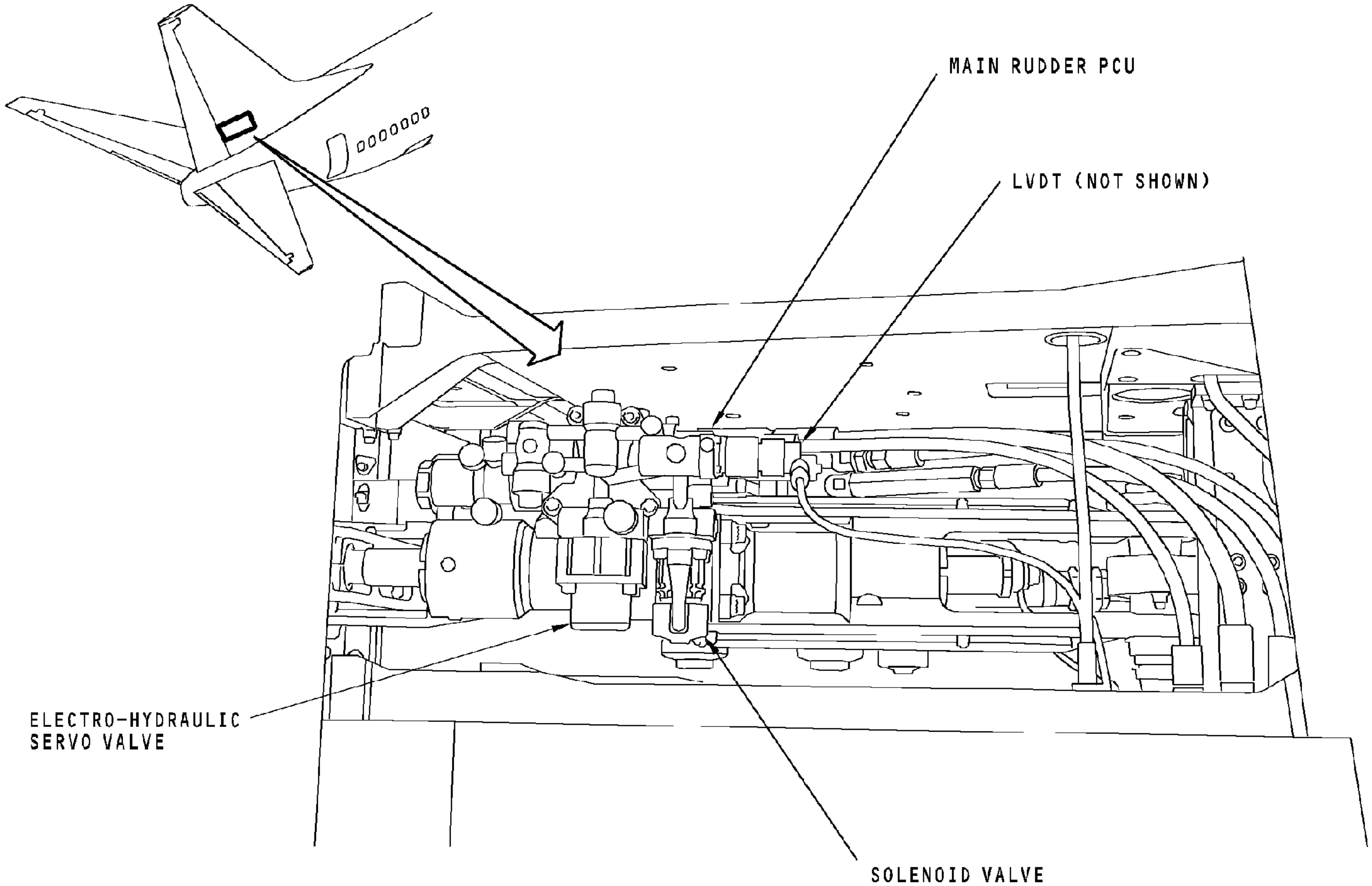
Yaw Damper Components in Vertical Stabilizer

These yaw damper components are on the main rudder PCU in the vertical stabilizer.

- Yaw damper solenoid valve
- Yaw damper electro-hydraulic servo valve (EHSV)
- Yaw damper actuator
- Linear variable differential transformer (LVDT).

The LVDT is not line replaceable.

Access to these yaw damper components is from an access panel on the right side of the vertical stabilizer.



YDS - VERTICAL STABILIZER COMPONENT LOCATION

YDS - INTERFACES

Power Interface

SMYD 1 gets 28v dc from electrical bus 1 and 28v ac from transfer bus 1. 28v dc power goes from SMYD 1 to the yaw damper engage switch.

The yaw damper indicator gets 115v ac from transfer bus 1.

The yaw damper LVDT gets 28v ac from the same circuit as SMYD 1.

Digital Data

The SMYD 1 receives airplane gross weight data from the FMC.

The SMYD 1 receives these air data from the left ADIRU:

- Airspeed
- Impact pressure.

The SMYD 1 receives these inertial data from the left and right ADIRUs:

- Lateral acceleration
- Roll angle
- Roll rate
- Yaw rate.

Analog Signals

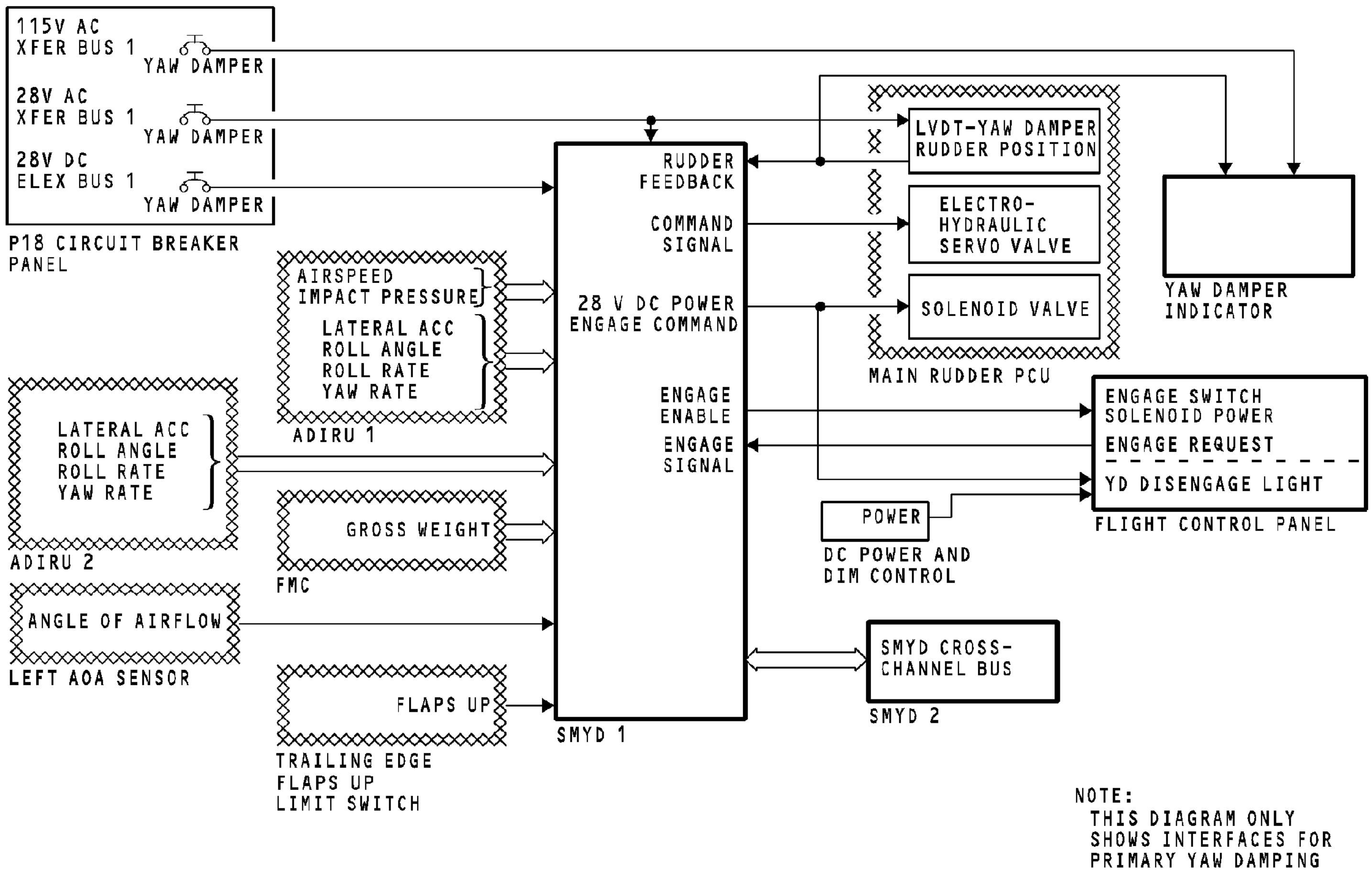
SMYD 1 is enabled for primary yaw damping operation when the FLT CONTROL B switch on the flight control panel is ON.

SMYD 1 calculates and sends yaw damper commands to the yaw damper components on the main rudder PCU to move the rudder. These are the solenoid valve, EHSV, and yaw damper actuator. The LVDT on the main rudder PCU sends rudder position feedback to SMYD 1 and to the yaw damper indicator to show rudder movement.

The trailing edge flaps up limit switch sends flap position data to SMYD 1. The SMYD uses this during yaw damping to limit rudder movement when flaps are up.

The left AOA sensor sends airplane angle of airflow information to SMYD 1.

The yaw damper disengage light receives power from the DC power and dim control.



YDS - INTERFACES

YDS - MAIN RUDDER PCU ACTUATOR - SOLENOID VALVE

Purpose

The yaw damper solenoid valve on the main rudder PCU pressurizes the yaw damper system. When you engage the yaw damper system, the solenoid valve sends hydraulic fluid to the electro-hydraulic servo valve (EHSV) that controls the yaw damper actuator on the main rudder PCU. This moves the rudder for yaw damping.

Physical Description

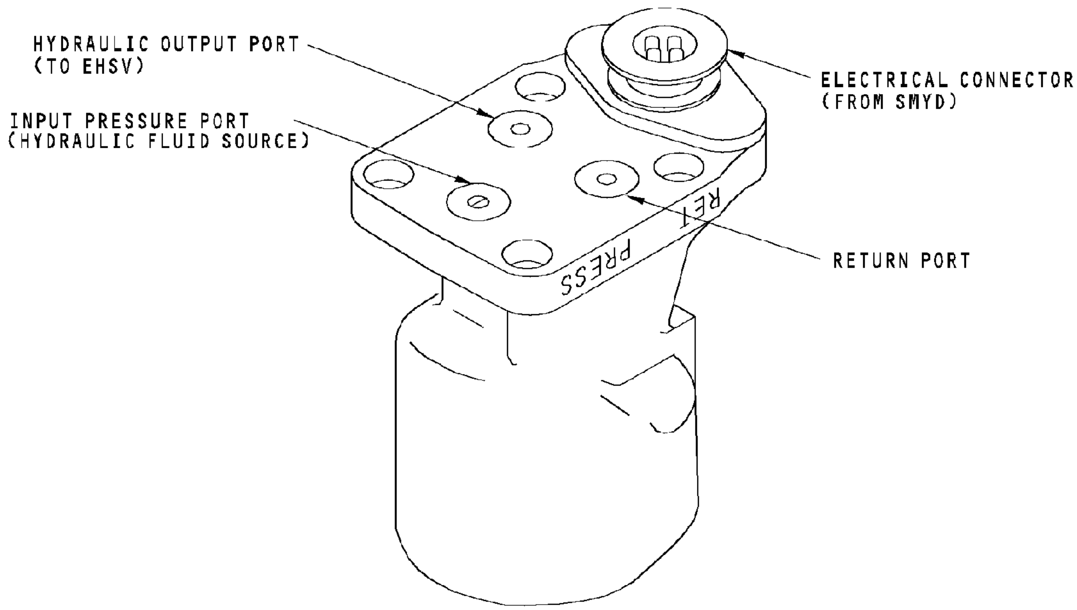
These are the three hydraulic ports in the solenoid:

- Input pressure port for input hydraulic pressure
- Output port for the output to the EHSV and yaw damper actuator
- Return port for hydraulic fluid to the reservoir.

An electrical connector connects the solenoid valve to the SMYD computer.

Functional Description

When the yaw damper is engaged, it energizes the solenoid valve which ports hydraulic fluid under pressure to the EHSV and yaw damper actuator.



YDS - MAIN RUDDER PCU ACTUATOR - SOLENOID VALVE

22-23-00-007

YDS - MAIN RUDDER PCU - ELECTROHYDRAULIC SERVO VALVE

Purpose

For primary yaw damping, the electrohydraulic servo valve (EHSV) on the main rudder PCU changes an electrical command signal from SMYD 1 into a controlled hydraulic flow to the yaw damper actuator on the main rudder PCU. The EHSV controls the rate and direction of the yaw damper actuator motion for rudder movement to provide primary yaw damping.

Physical Description

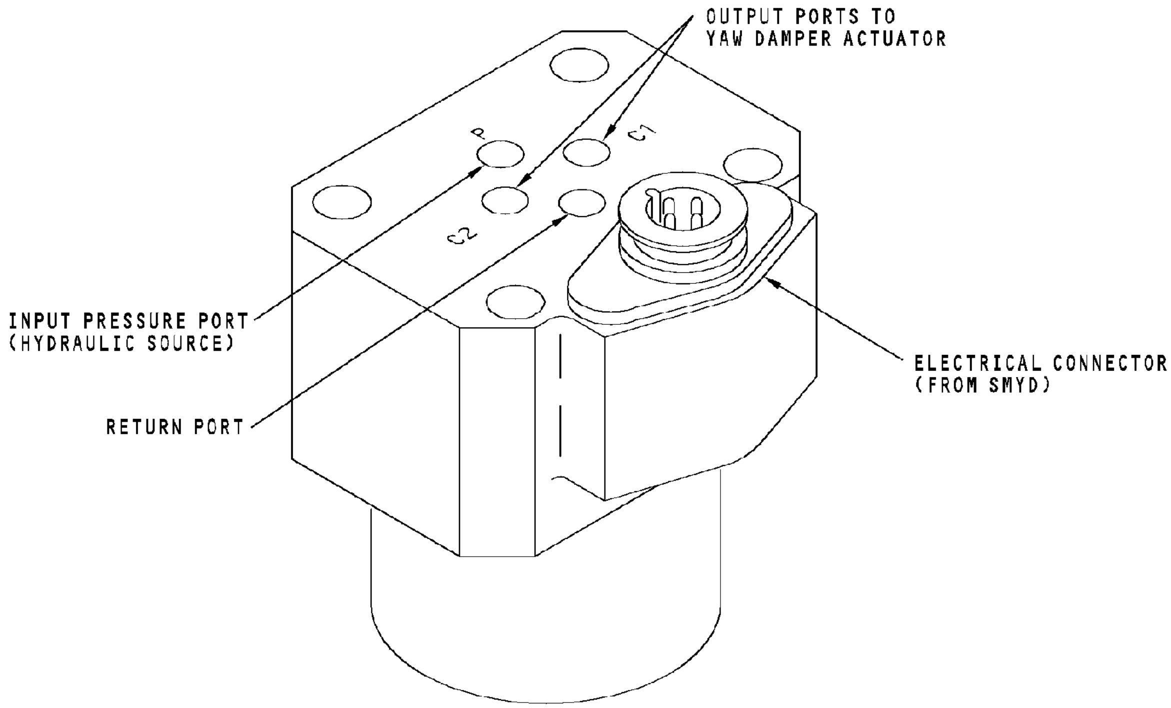
These are the four hydraulic ports on the EHSV:

- Input port for jet pipe controller/control spool
- Return port
- Two output ports to the yaw damper actuator.

A four pin electrical connector the SMYD computer to the EHSV.

Functional Description

When an electrical signal for yaw damping comes from the SMYD computer, it moves a jet pipe in the EHSV. This causes the pressure at each end of the control spool to change. This pressure differential causes the control spool to move, which changes the output pressure in each of the two output ports. This change in the output pressure directs hydraulic fluid under pressure to move the yaw damper actuator in the desired direction for yaw damping.



YDS - MAIN RUDDER PCU - ELECTROHYDRAULIC SERVO VALVE

YDS - STALL MANAGEMENT YAW DAMPER

Purpose

The stall management yaw damper (SMYD) uses inertial data from the ADIRU and other data from airplane sensors to detect unwanted airplane yaw motion caused by dutch roll and turbulence. The SMYD sends commands to the main rudder PCU to move the rudder to reduce unwanted yaw.

Physical Description

The SMYD weighs 10 lbs. It uses 10 watts of power. It has these features on the front of the unit:

- Standard Boeing BITE module
- Bite instructions on the label
- BITE display
- BITE keypad.

Bite Instructions

Bite instructions on the front of the SMYD LRU describe how to do a test of the unit and use the BITE software.

For more information on BITE, see the section on BITE Operation later in this section.

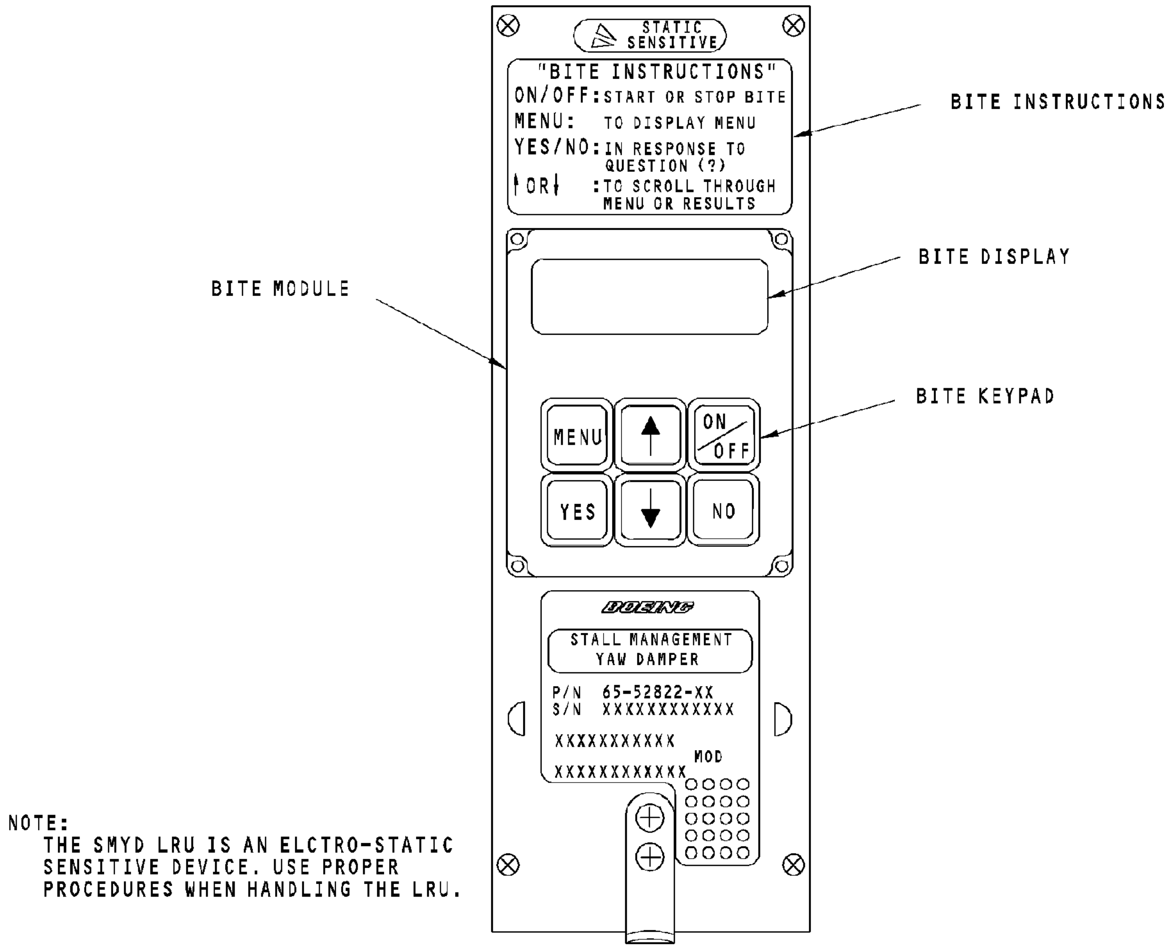
Display

The SMYD BITE module has a two line amber display. Each line has eight alphanumeric characters. The display shows messages about the type of fault, maintenance message number, and fault details. For SMYD 1, the BITE interfaces with the stall management functions and primary yaw damping functions and provides fault data for these functions.

Keypad

You use the keypad to operate the SMYD BITE. The keypad has these keys:

- ON/OFF key to turn ON the BITE
- MENU key to go to the main and previous menu pages
- UP arrow key for previous page selection in a menu
- DOWN arrow key for next page selection in a menu
- YES key to answer questions
- NO key to answer questions.



YDS - STALL MANAGEMENT YAW DAMPER

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YDS - SMYD 1 - FUNCTIONAL DESCRIPTION

General

The stall management yaw damper (SMYD) calculates yaw damping commands using analog and digital inputs from airplane sensors. SMYD 1 provides primary yaw damping through the main rudder PCU.

Engage Interlock

The SMYD supplies 28v dc to the yaw damper solenoid valve on the rudder PCU. When the solenoid energizes, it sends hydraulic fluid under pressure to the EHSV which applies hydraulic pressure to the yaw damper actuator to move the rudder.

Yaw Damping

The SMYD CPU has the control law software for yaw damping. These sensors send inputs to SMYD 1 for software calculations for primary yaw damping:

- MCP
- ADIRUs (inertial and air data)
- Left AOA sensor
- FMC
- LVDT on main rudder PCU
- Trailing edge flap limit switch
- SMYD 2.

If SMYD 1 senses airplane unwanted yaw motion when the yaw damper is engaged, it supplies a signal to the electrohydraulic servo valve (EHSV). The EHSV applies hydraulic pressure to the yaw damper actuator in proportion to SMYD 1 yaw damper commands. The current and polarity determine amount and direction the rudder moves. The yaw damper actuator makes a mechanical input to the rudder PCU main control valve to move the rudder. Yaw damper inputs are mechanically summed to rudder pedal inputs. For primary yaw damping, these are the limits for rudder travel:

- 2 degrees with flaps Up
- 3 degrees with flaps Down.

The LVDT on the main rudder PCU sends yaw damper actuator position data to SMYD 1. The SMYD uses the data to compare its commanded value with actual rudder movement.

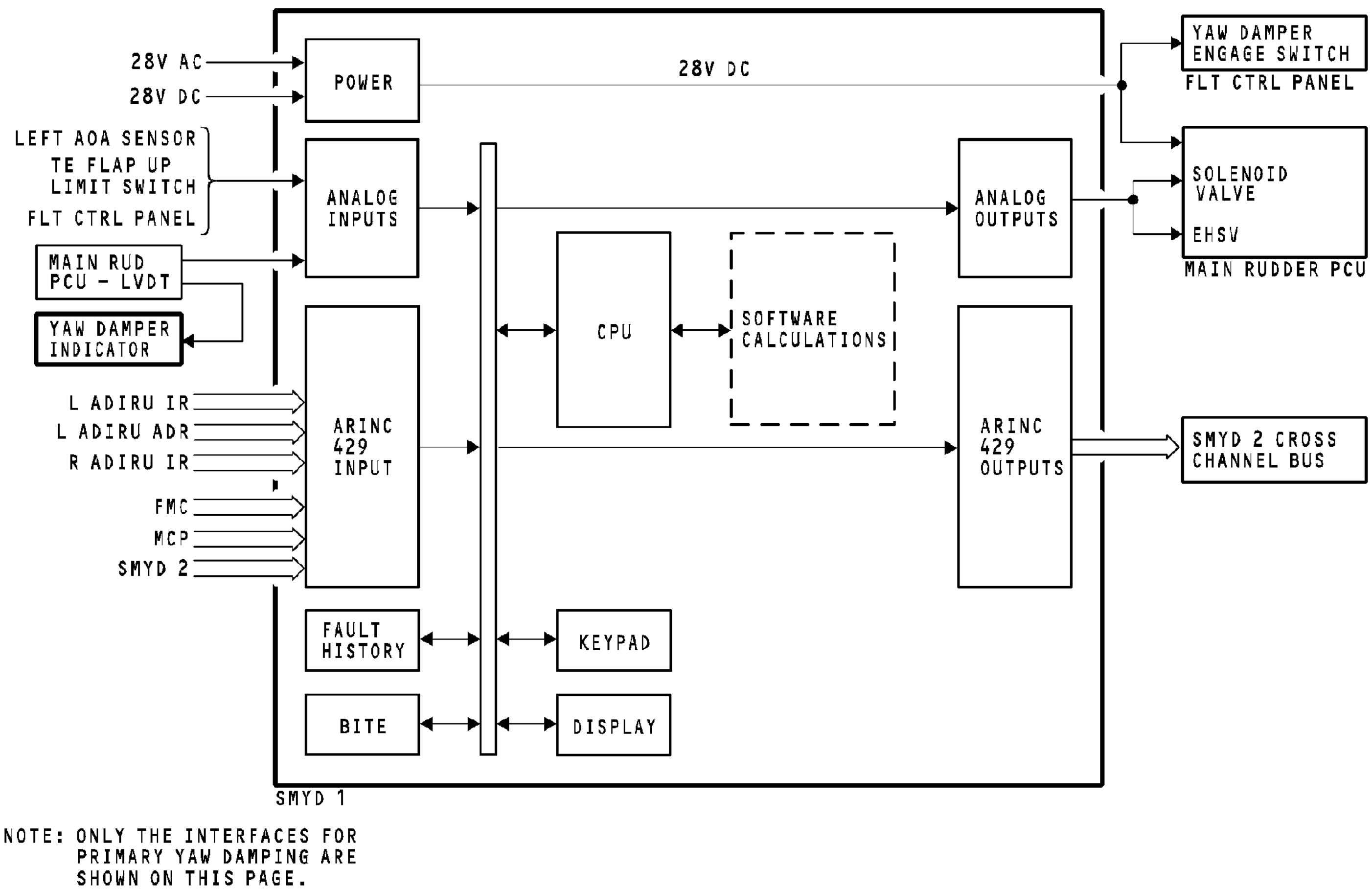
The MCP sends data to the SMYD to show if either A/P is engaged.

For primary yaw damping, SMYD 2 monitors the yaw damping calculations of SMYD 1. These calculations must agree before SMYD 1 commands rudder movement. If the calculations of the two SMYDs do not agree, primary yaw damping disengages.

YDS - SMYD 1 - FUNCTIONAL DESCRIPTION

BITE

The SMYD has BITE test and continuous BITE functions. It stores failures in fault history for yaw damping and stall management functions. You use the keypad to interface with the BITE. The display shows test results and prompts you for input



YDS - SMYD 1 - FUNCTIONAL DESCRIPTION

YDS - OPERATION

General

You use the yaw damper ON/OFF switch on the flight control panel to engage the yaw damper.

For the primary yaw damper system, there are these two indicators in the flight compartment:

- Yaw damper warning light
- Yaw damper indicator.

The yaw damper warning light is on the flight control panel above the yaw damper ON/OFF switch. The yaw damper indicator is on the instrument panel.

Engage Switch and Warning Light

To engage the primary yaw damper system (YDS), put the yaw damper engage switch on the flight control panel to the ON position. These are the conditions necessary to engage the primary yaw damper system:

- Hydraulic system B is ON
- Flight control B is ON.

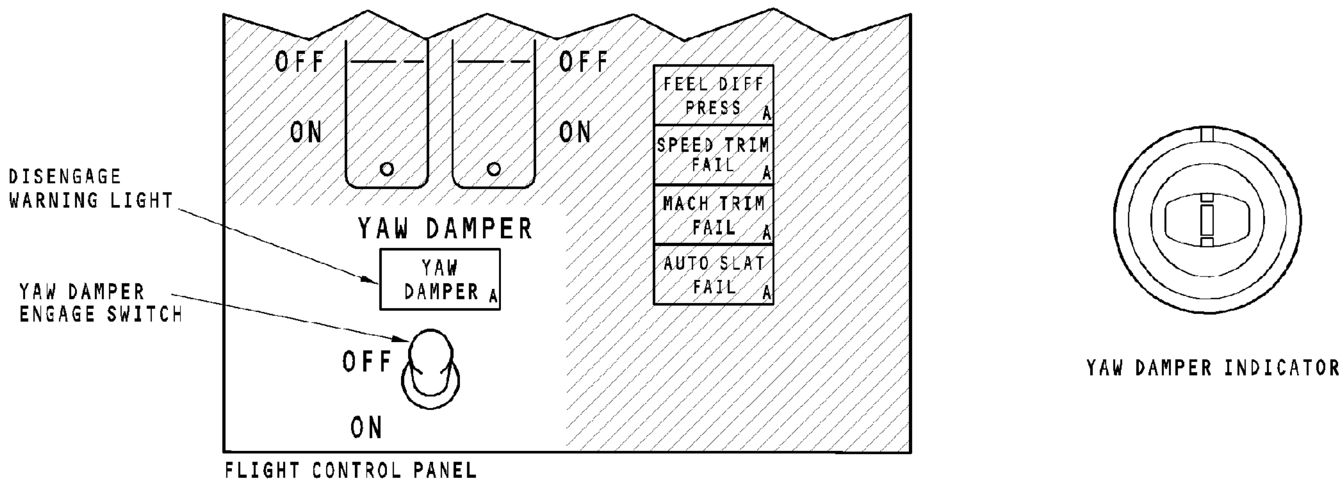
If SMYD 1 does not detect any yaw damper faults, two seconds later the yaw damper warning light will go off to show that there is normal yaw damper operation. This switch is held in the ON position electronically with a solenoid powered from the SMYD. Only SMYD 1 does primary yaw damping.

Put the switch to the OFF position to disengage the YDS. SMYD 1 removes power from the solenoid valve on the main rudder PCU and, after a two-second delay, the yaw damper warning light comes on. The warning light comes on any time the system disengages.

Yaw Damper Indicator

The yaw damper indicator shows the rudder movement due to primary yaw damper commands from SMYD 1. For primary yaw damping, rudder movement is limited to 2 degrees with flaps up and 3 degrees with flaps down. If you move the rudder with the rudder pedals, the indicator does not show rudder movement.

To do a test of the indicator and the primary yaw damper system, do the SMYD 1 servo test in the SMYD BITE - GROUND TEST described at the end of this section.



YDS - OPERATION

YDS - OPERATIONS - ENGAGE INTERLOCKS

General

There are two SMYDs on the airplane.

SMYD 1 controls primary yaw damping and turn coordination during normal operation. SMYD 2 operates WTRIS and standby yaw damping, and is discussed in the WTRIS section. (SECTION 27-24)

Engage Switch and Warning Light

You engage the primary yaw damper system (YDS) with the yaw damper engage switch on the flight control panel and with the FLT CONTROL B switch in the ON position. The SMYD does a self check and two seconds later the yaw damper warning light goes out to show that you have yaw damper operation. The switch is held in the ON position electronically with power from the SMYD.

Put the switch in the OFF position to disengage the YDS. After you put the switch to the OFF position, the yaw damper warning light comes on. The warning light comes on anytime the system disengages.

Training Information Point

The electrical ground for the disengage light is connected in series through both SMYDs. For normal operation, it is necessary to have both SMYDs installed on the airplane.

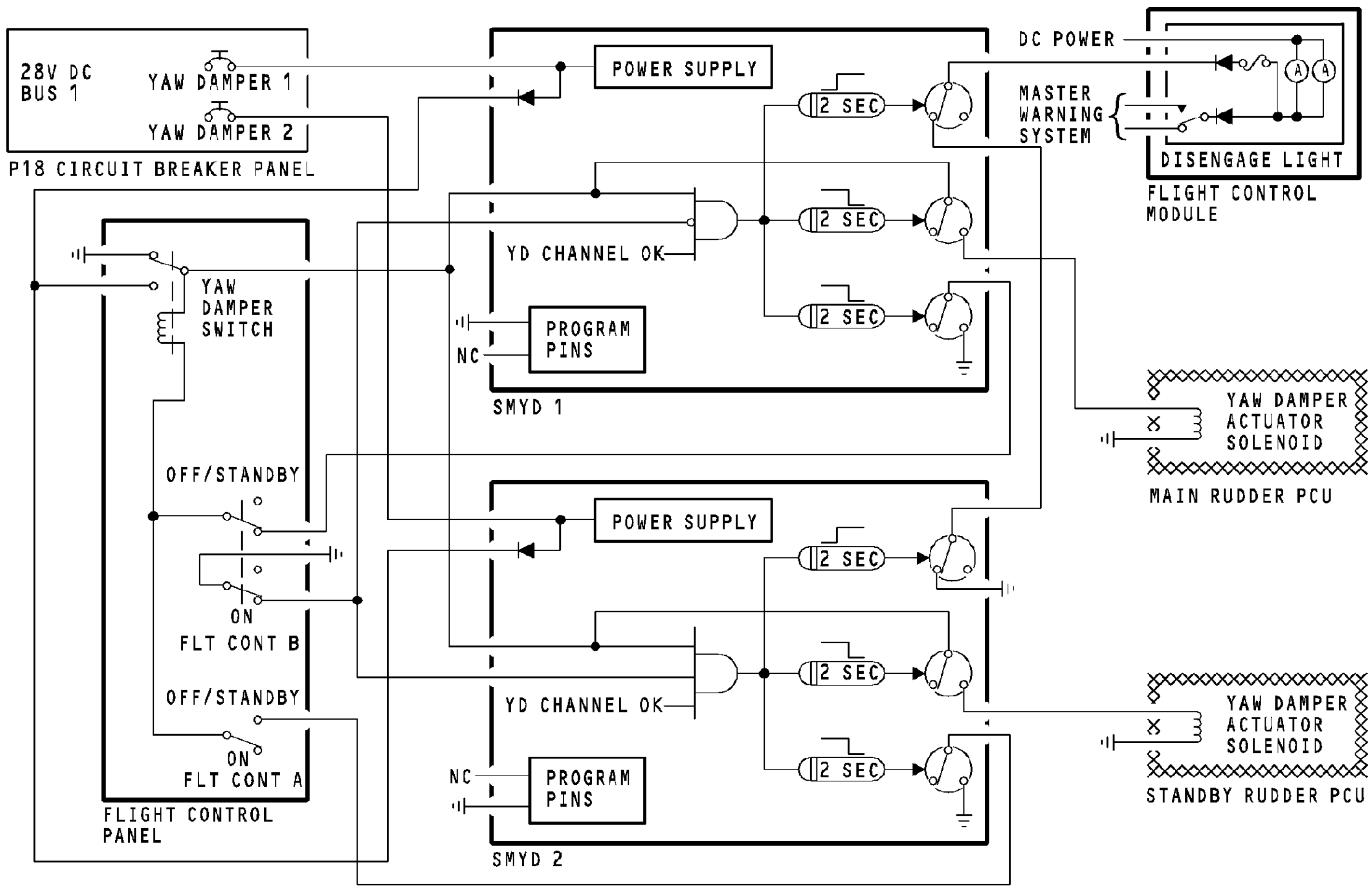
The light test can be done with the master dim and test system.

SMYDs

The two SMYDs are the same. They both do stall management and yaw damper functions. For stall management functions, both SMYDs operate together. If one function fails, the other SMYD will continue to do stall management functions.

Only one SMYD does yaw damping at a time. SMYD 1 does only primary yaw damping during normal operations. SMYD 2 does WTRIS and standby yaw damping during standby operations. This is controlled by the FLT CONTROL A and B switches on the flight control panel.

SMYD 1 uses the main rudder PCU to move the rudder for the primary yaw damper function. For primary yaw damping, SMYD 1 compares its yaw damping calculations with SMYD 2 before it sends a command to the main rudder PCU. If the SMYD 2 calculations disagree or if SMYD 2 fails, the yaw damper function in SMYD 1 disengages even though SMYD 2 is not used for primary yaw damping.



YDS - OPERATIONS - ENGAGE INTERLOCKS

22-23-00-012

YDS - TRAINING INFORMATION POINT - SMYD BITE

General

The SMYD has these BITE functions:

- Continuous monitor
- BITE tests.

Continuous Monitor

The continuous monitor function of BITE monitors the SMYD LRU for proper operation. When the SMYD has an internal failure a fault is recorded in fault history. Some faults will cause the SMYD to have no outputs for the stall management and yaw damper functions.

BITE Tests

The BITE tests are used to do tests of components and sensors that interface with the SMYD. They have these functions:

- Quick system test
- SMYD LRU self test
- Tests of sensors that interface with the SMYD
- Tests to show that functions are within specification
- Supports fault isolation.

The BITE module on the front of the SMYD LRU has a keypad with six push-buttons, and a two-line display with eight characters per line.

BITE Operation

To start the BITE, push the ON/OFF key on the BITE module. EXISTING FAULTS? shows as the first menu item. Push the YES key to answer questions and to move down further in the selected menu item on the display. Push the NO or down arrow key to see the next menu item. In some lists, TOP OF LIST or END OF LIST shows for one second when you move to the top or bottom of the list. Push the MENU key to exit a menu and move back up one level to the previous menu. One of these conditions are necessary to start BITE:

- Flaps Up and VCAS $<$ 60 knots
- On-side engine N1 $<$ 15% and off-side engine N2 $<$ 50%.

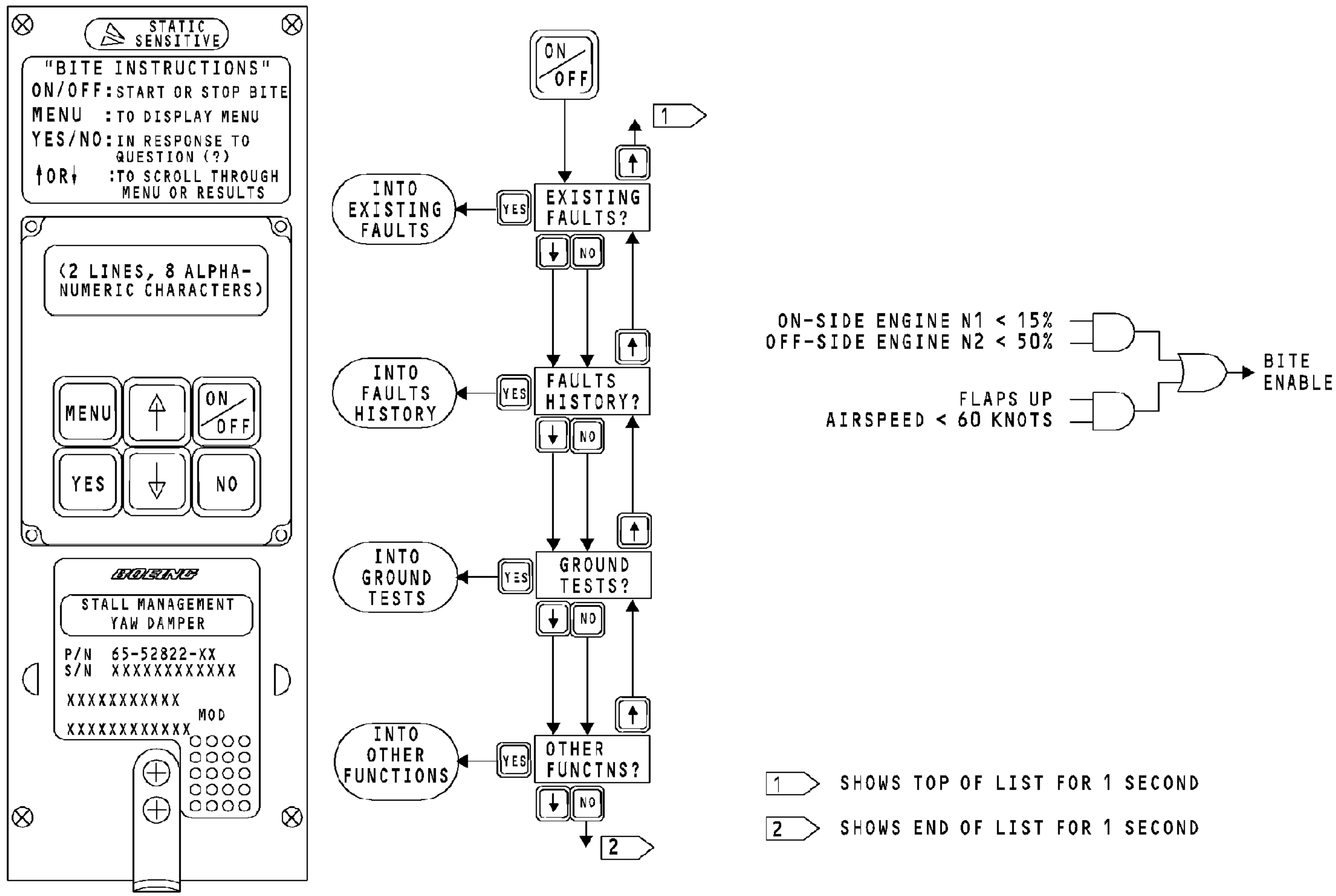
These conditions make sure that if BITE is ON, it will turn off prior to takeoff. Also, a time delay will turn off the BITE control panel if no push-buttons are pushed for five minutes or longer.

Main Menu

These are the BITE main menu selections:

- EXISTING FAULTS
- FAULTS HISTORY
- GROUND TESTS
- OTHER FUNCTIONS.

At the start of the BITE, EXISTING FAULTS? shows. Push the YES key to select this menu or use the NO or down arrow key to go to the next main menu selection.



YDS - TRAINING INFORMATION POINT - SMYD BITE

22-23-00-015

YDS - TRAINING INFORMATION POINT - SMYD BITE - EXISTING FAULTS

Existing Faults

The EXISTING FAULTS test checks the interfaces between the SMYD and airplane sensors to checks for current faults. To do the existing faults test, do these steps:

- Turn ON the SMYD BITE
- EXISTING FAULTS? shows as the first menu item
- Push the YES key to enter EXISTING FAULTS.

When you push the YES key for EXISTING FAULTS, the SMYD BITE will do a check for current faults. If there are no faults, the display shows NO FAULTS.

If there are faults either for yaw damping or stall management functions, the the fault description starts with fault 1. If you then push the down arrow key, the display will ask if you want to see MORE DETAILS? about the fault. You can push YES to see more details for the fault. Or you can push NO or the down arrow key to go to the next fault.

More Details

If you push the YES key when MORE DETAILS? shows, it will show the maintenance message number for fault 1. You can then push the down arrow key to show thesedetails for the fault:

- Flight deck effect(s) for the fault
- Flight phase in which the fault was detected
- The most likely LRU causing the fault
- Hard or intermittent fault and if it is latched.

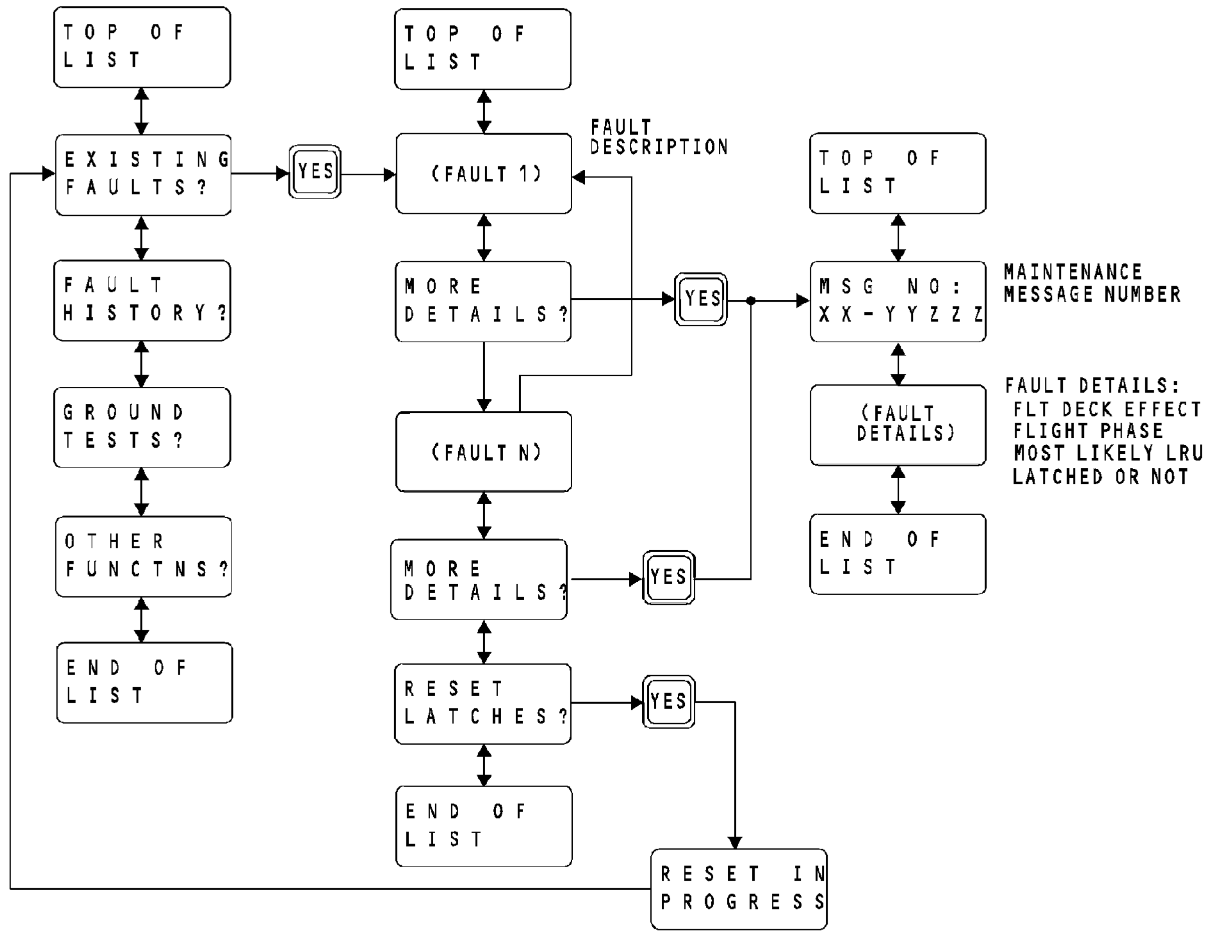
To see more faults, push the up arrow key (previous) to go back to MORE DETAILS?, then push NO or the down arrow key (next) to see if there are more faults.

The BITE for SMYD 1 interfaces with various airplane sensors to record faults for the stall management and primary yaw damper functions for these systems:

- Primary yaw damping system
- Stall Warning System
- Autoslat system
- Performance data.

Reset Latches

After the display of the last fault, the display asks RESET LATCHES?. Only some faults will latch. To reset, push the YES switch. The display shows RESET IN PROGRESS while it resets the latched faults.



YDS - TRAINING INFORMATION POINT - SMYD BITE - EXISTING FAULTS

22-23-00-016

EFFECTIVITY
HAP ALL

YDS - TRAINING INFORMATION POINT - SMYD BITE - FAULT HISTORY

Fault History

The fault history selection in the SMYD BITE shows fault information by flight leg stored in non-volatile memory (NVM). Monitors in the SMYD store fault data in NVM during these conditions:

- System tests using the SMYD BITE
- Continuous monitoring during normal operation
- Power up tests.

Faults are stored for this number of flight legs:

- Last 64 flight legs
- Maximum of 256 faults.

Only flight legs that have faults show in fault history. The flight leg changes when the airplane goes from the ground to air except during touch and go operations when the airspeed remains above 60 KCAS.

For fault information by flight leg, do these steps:

- Turn on the SMYD BITE
- Use the down arrow key to scroll to FAULT HISTORY?
- When FAULT HISTORY? shows, push the YES key
- Use the up or down arrow keys to scroll to the desired flight leg and then push the YES key.

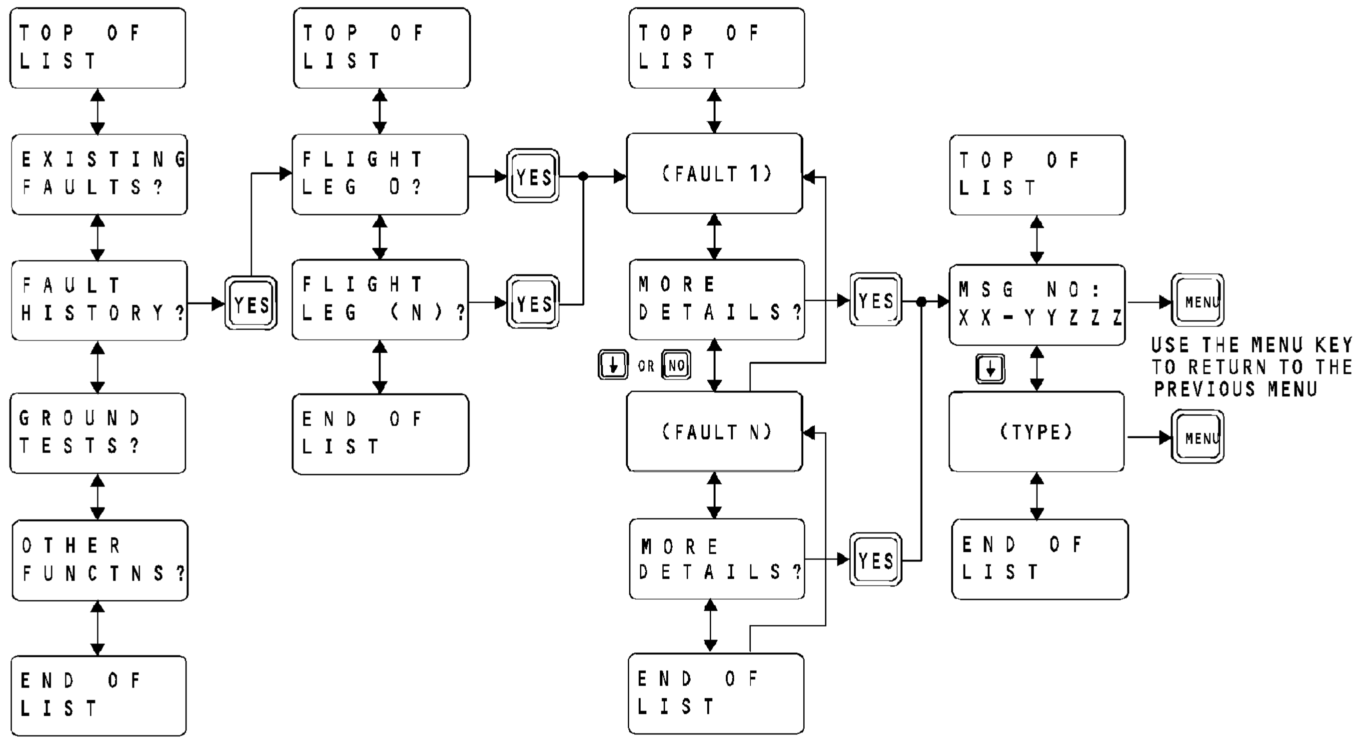
More Details

After you select a flight leg with the YES key, the display shows fault 1 for that flight leg. If you then push the down arrow key, the display first shows MORE DETAILS? to ask if you want to see details for fault 1. If you push the YES key, the display shows details for fault 1. Under MORE DETAILS? if you push NO or the down arrow key, the display goes to the next fault in that flight leg.

Under MORE DETAILS? for fault 1 if you say YES, the display first shows the maintenance message number for fault 1. If you then push the down arrow key, the display shows these details for fault 1:

- Flight deck effect(s) (FDE)
- Flight phase when the fault was detected
- The most likely LRU that caused the fault
- Hard or intermittent fault and if it is latched.

To see more faults, push the up arrow key (previous) to go back to MORE DETAILS? then push the NO or down arrow keys to see if there are more faults under the selected flight leg. To see additional flight legs, push the MENU key to go back to the flight legs sub-menu.



YDS - TRAINING INFORMATION POINT - SMYD BITE - FAULT HISTORY

22-23-00-017

YDS - TRAINING INFORMATION POINT - SMYD BITE - GROUND TESTS

Ground Tests

GROUND TESTS is one of four main menu items in the SMYD BITE. On this menu, you can do these functions:

- SMYD LRU self test
- See the status of discrete inputs and analog inputs to the SMYD
- See the activity status of ARINC 429 inputs
- Servo test of the yaw damper components on the rudder PCU
- Test of the BITE display.

These are the menu selections:

- SELF TESTS
- DISCRETE INPUTS
- ARINC 429 INPUTS
- ANALOG INPUTS
- SERVO TEST
- DISPLAY TEST.

To start one of these tests, do these steps:

- Turn ON the SMYD BITE
- On the main menu, use the down (or up) arrow key to scroll to GROUND TESTS? and push the YES key
- Use the up or down arrow keys to scroll to the ground test that you want and push the YES key.

If the ground test that you selected passes, the display shows TEST PASSED. If the test fails, the display shows a fault message under MORE DETAILS. The information under MORE DETAILS is the same as for the existing faults test that was discussed previously.

Self Tests

The SELF TEST does a check of the SMYD LRU for internal faults. When you push YES for self tests, the display shows TEST IN PROGRESS until the test is complete. If the SMYD passes the test, the display shows SMYD LRU OK. If the SMYD does not pass the test, the display shows SMYD LRU FAIL for 2 seconds, then shows the first fault.

Discrete Inputs

You do a check of the status of these discrete inputs from the DISCRETE INPUTS menu for SMYD 1:

- Air/ground relays
- Flaps Up limit switches
- FLT CONTROL B switch
- Yaw damper engage switch
- TO/GA switches (OPEN or GROUND)
- Program pin selections
- Autoslat power availability (PRESENT or MISSING)
- Stick shaker power availability
- Yaw damper power availability.

Use the up (previous) and down (next) arrow keys to move through the list of discrete inputs.

YDS - TRAINING INFORMATION POINT - SMYD BITE - GROUND TESTS

ARINC 429 Test

On the ARINC 429 INPUT menu, you can do a check of the activity status of these ARINC 429 buses:

- On-side IR bus
- Off-side IR bus
- On-side ADR bus
- CDS DEU bus
- FMC bus
- DFCS MCP bus
- SMYD Cross-channel bus.

Push the YES switch to see if the bus is ACTIVE or INACTIVE. Use the up and down arrow keys to move through the list.

Analog Inputs

On the ANALOG INPUTS menu, you do a check of the status of data from analog sensors that send data to the SMYDs. For SMYD 1, you can do a check of these analog sensors for primary yaw damping:

- Left AOA sensor
- Right flap position transmitter
- LVDT on main rudder PCU.

Push the YES switch to select a sensor. Use the up (previous) or down (next) arrow keys to move through the list.

Servo Test

With the SERVO TEST you do a test of the yaw damper components on the rudder PCUs and the interfaces between the SMYDs and the rudder PCUs. The SMYD 1 BITE does a test of these primary yaw damper components on the main rudder PCU:

- Yaw damper solenoid valve
- Yaw damper EHSV
- Yaw damper LVDT.

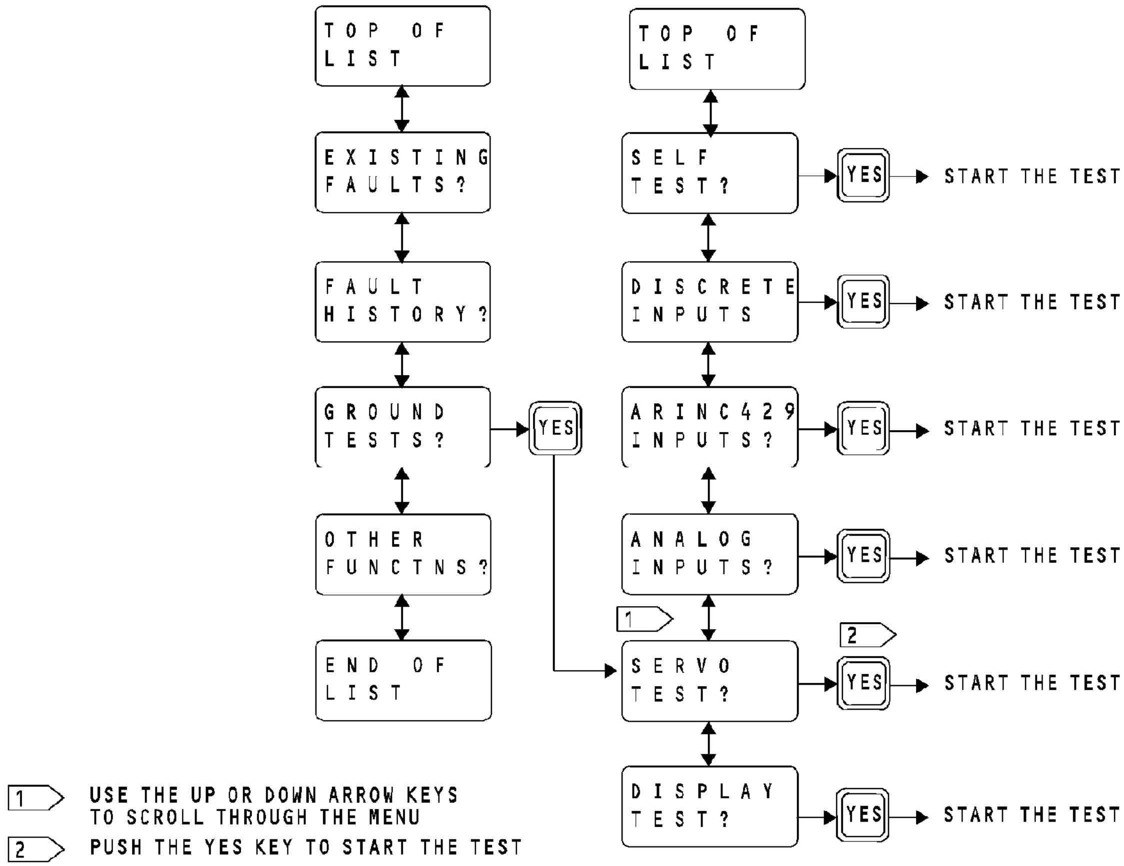
Display Test

The DISPLAY TEST lets you do a test of the display on the BITE module on the front of the SMYD. To do a test of the display, push the YES key when the DISPLAY TEST prompt shows.

This test takes 10 seconds. All the LEDs on the left half of the top line come on first, then all the LEDs on the right half come on. Next, all the LEDs on the left half of the bottom line come on, then all the LEDs on the right half come on. There are eight alphanumeric characters on each of the two lines. When the test is complete, DISPLAY TEST? shows on the display. Push the MENU key to return to the previous menu.

Ground Tests Passed

If the ground test that you selected passes, the display shows TEST PASSED. If the test fails, the display shows a fault message under MORE DETAILS. The information under MORE DETAILS is the same as for the existing faults test that were discussed in a previous section.



YDS - TRAINING INFORMATION POINT - SMYD BITE - GROUND TESTS

YDS - TRAINING INFORMATION POINT - SMYD BITE - SERVO TEST

Ground Tests - Servo Test

Under the GROUND TESTS menu, the SMYD 1 SERVO TEST does a test of the yaw damper components on the main rudder PCU for the primary yaw damping system. The SERVO TEST consists of these two tests:

- ZERO COMMAND
- SWEEP TEST.

For these tests, hydraulic system B pressure is necessary and the flight control system B switch on the flight control panel must be ON.

The BITE provides the instructions to do these tests. BITE provides warnings about rudder movement and asks you to make sure the rudder area is clear of equipment and personnel before you start the test.

Zero Command

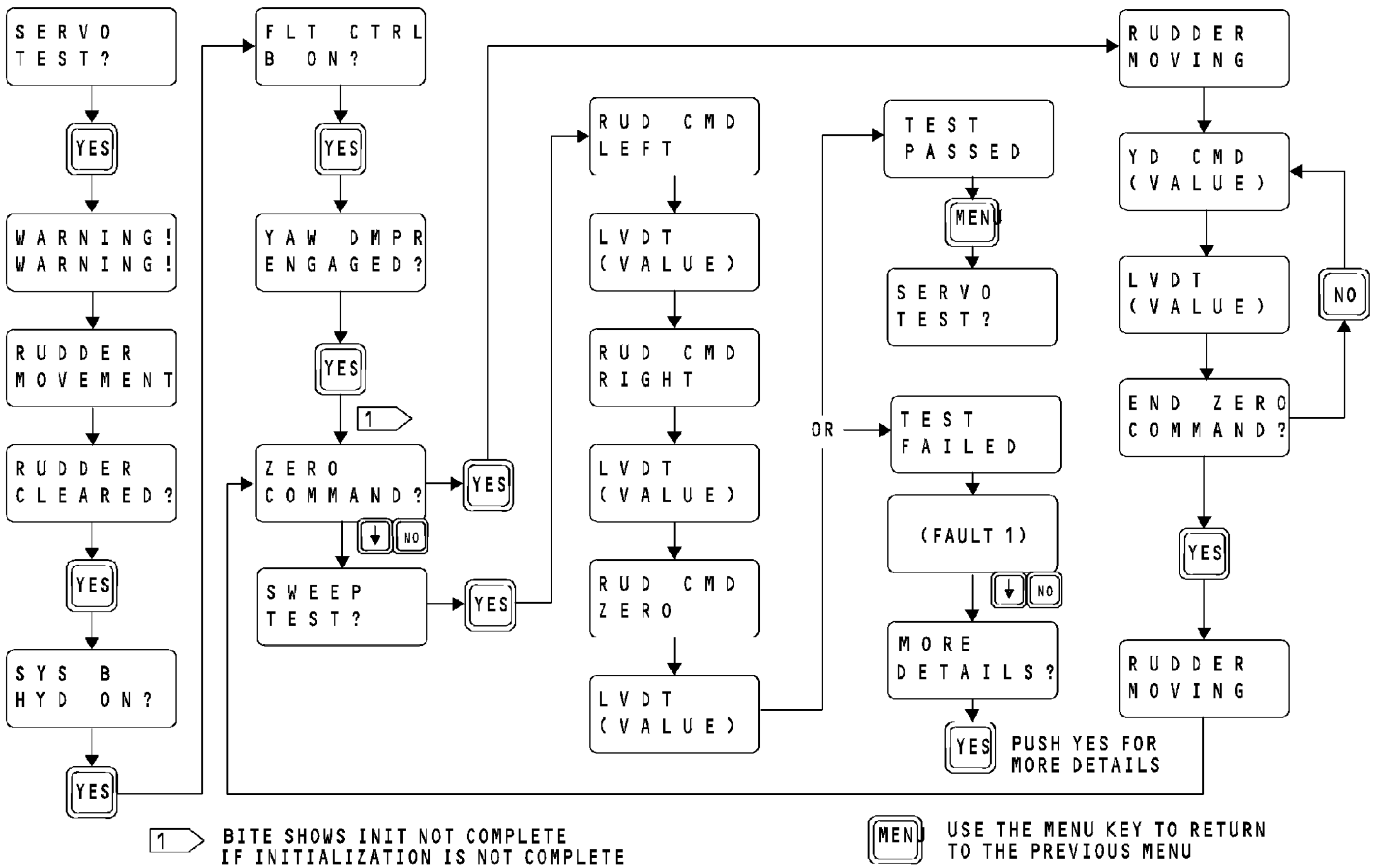
For the ZERO COMMAND test, the SMYD commands the rudder to move to the zero position. SMYD 1 then compares its commanded value to the value from the LVDT on the main rudder PCU for rudder position. BITE shows the LVDT values in degrees.

Sweep Test

For the SWEEP TEST, SMYD 1 commands the main rudder PCU to move the rudder left, right, and then to the zero position. During this test, rudder travel is limited to 2 degrees with flaps up, and 3 degrees with flaps down.

During the sweep test, the SMYD 1 servo command is compared to the LVDT value from the main rudder PCU to see if the rudder moves the commanded value. Rudder movement shows on the SMYD BITE display in degrees of rudder travel, and on the yaw damper indicator in the flight deck.

If the test passes, the display shows TEST PASSED. Push the MENU key to go to the previous sub-menu, SERVO TEST. If the test fails, the display shows TEST FAILED and then shows the first fault. Push the down arrow key and the display asks if you want to see MORE DETAILS. Push YES to see more details about the fault.



YDS - TRAINING INFORMATION POINT - SMYD BITE - SERVO TEST

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YDS - TRAINING INFORMATION POINT - SMYD BITE - OTHER FUNCTIONS

Other Functions

OTHER FUNCTIONS is the last of four main menu items in the SMYD BITE. It has these sub-menus:

- SYSTEM CONFIG
- I/O MONITOR
- SET OUTPUTS.

To enter OTHER FUNCTIONS, push the YES key for this selection. You can then scroll through the sub-menu items with the arrow keys, and push the YES key to see data for the desired selection.

System Configuration

In the SYSTEM CONFIG sub-menu, you can verify these system configurations for the SMYD LRU:

- Part number
- Software Level
- Position (1 or 2) in E/E bay
- Airplane model
- FAA or CAA/FAA.

This menu provides hardware part number and software level, SMYD position, airplane type, and FAA or FAA/CAA configuration for speed tape displays of Vmo/Mmo.

I/O Monitor

In the I/O MONITOR sub-menu you can verify these ARINC 429 input/output data to the SMYD:

- ARINC 429 inputs
- ARINC 429 low speed outputs
- ARINC 429 high speed outputs.

You can see the actual data being transmitted on data words that you select for these systems:

- On-side IR bus
- Off-side IR bus
- On-side ADR bus
- CDS DEU bus
- FMC bus
- DFCS MCP bus
- SMYD cross-channel bus.

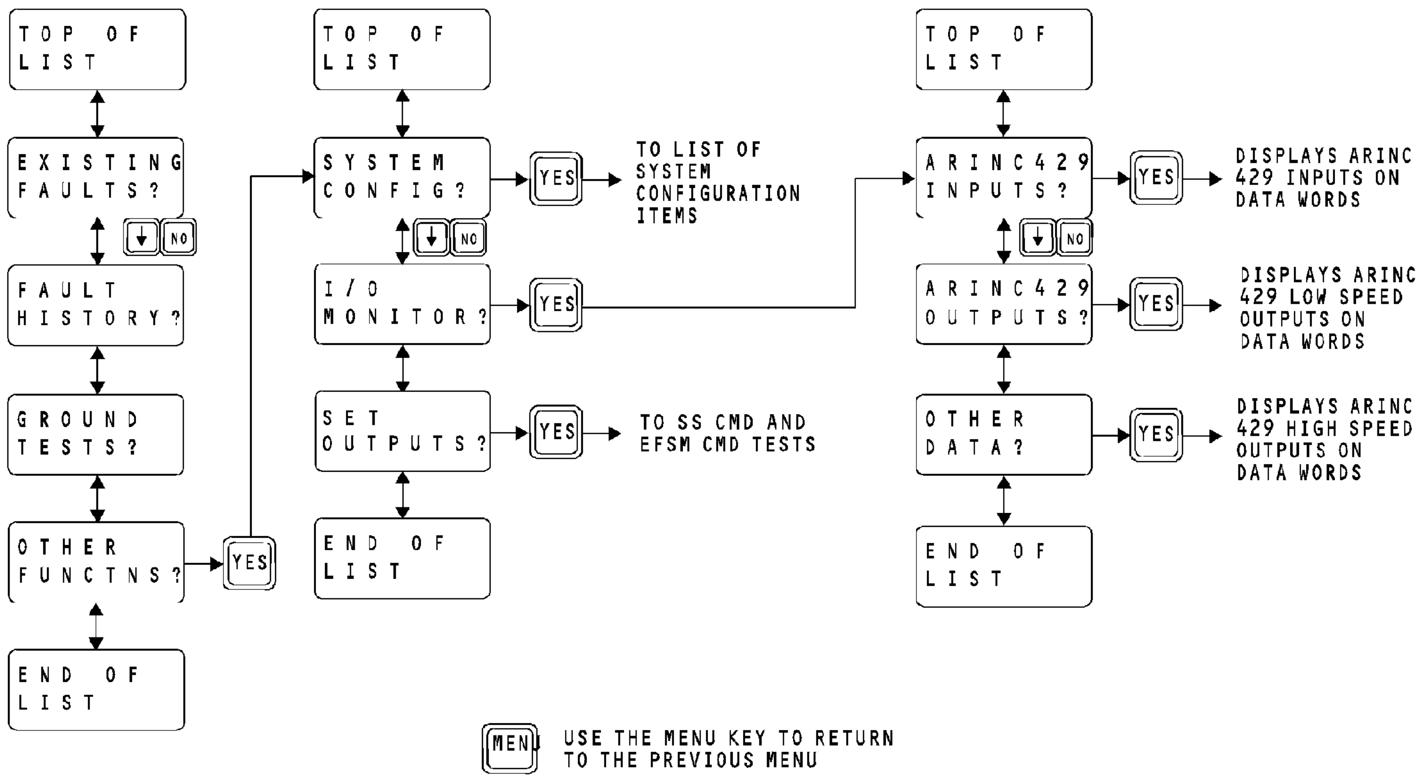
The value of the data transmitted on each data word shows and includes the units such as degrees or degrees per second, knots airspeed, gross weight, and Bit status whether 1 or 0.

Refer to the section on SMYD digital interfaces for information about digital input/output data.

YDS - TRAINING INFORMATION POINT - SMYD BITE - OTHER FUNCTIONS

Set Outputs

In the SET OUTPUTS sub-menu, you do a test of the two output signals for EFSM operation. SS CMD does a test of the 28v dc power supply to the stick shaker (SS) and the elevator feel shift module (EFSM). The combined SS CMD & EFSM CMD does a test of the electrical ground signal provided to the EFSM and completes the circuit for EFSM operation.



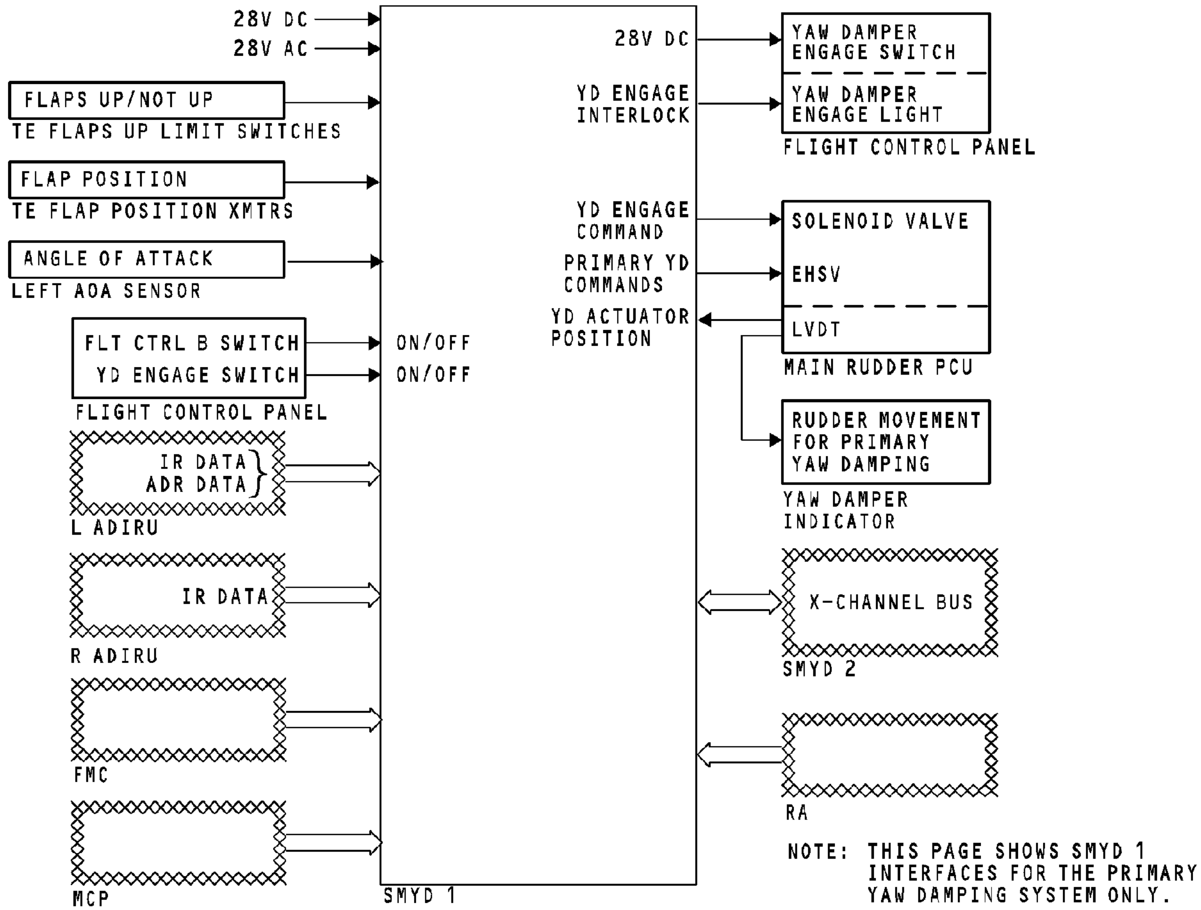
YDS - TRAINING INFORMATION POINT - SMYD BITE - OTHER FUNCTIONS

22-23-00-019

YDS - SMYD 1 - SYSTEM SUMMARY

General

This page is for reference.



YDS - SMYD 1 - SYSTEM SUMMARY

AUTOTHROTTLE SYSTEM - INTRODUCTION

General

HAP 001-013, 015-026, 028-030

The autothrottle (A/T) computer uses data from airplane sensors to calculate engine thrust. The A/T system controls engine thrust in response to mode requests from the flight crew through the DFCS MCP and flight deck switches, and from the FMC. The A/T system operates from takeoff to touchdown.

HAP 031-054, 101-999

The autothrottle (A/T) function in flight control computer A (FCC A) uses data from airplane sensors to calculate engine thrust. The A/T system controls engine thrust in response to mode requests from the flight crew through the DFCS MCP and flight deck switches, and from the FMC. The A/T system operates from takeoff to touchdown.

HAP ALL

The A/T is part of the flight management system (FMS) which includes DFCS, FMCS, and ADIRU.

Abbreviations and Acronyms

- ADI - attitude direction indicator
- AFCS - automatic flight control system
- AGL - above ground level
- A/P - autopilot (DFCS)
- A/T - autothrottle
- ASA - autoflight status annunciator
- ADIRU - air data inertial reference unit
- ADIRS - air data inertial reference system
- ASA - autoflight status annunciator
- ASM - autothrottle servo motor
- BARO - barometric altitude
- capt - captain
- CDS - common display system
- CDU - control display unit (FMC)
- clb - climb
- clr - clear
- cmd - command
- con - continuous
- CPU - central processing unit
- CTM - cycle time monitor
- dc - direct current
- deg - degrees
- des - descent
- DEU - display electronics unit
- DIP - dual in-line package
- disc - disconnect
- disen - disengage

HAP 001-013, 015-026, 028-030

- DFCS - digital flight control system

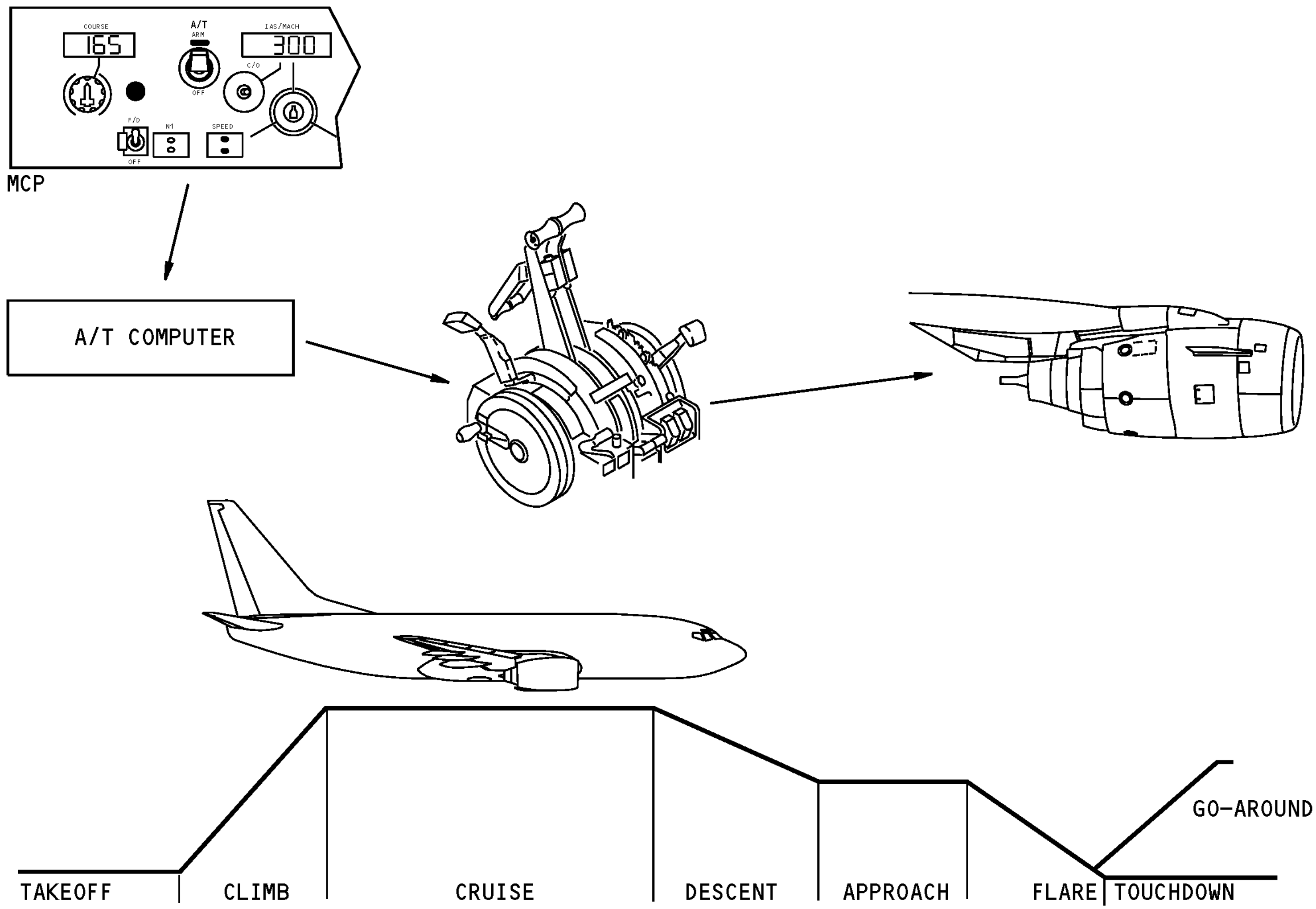
HAP 031-054, 101-999

- EDFCS - enhanced digital flight control system

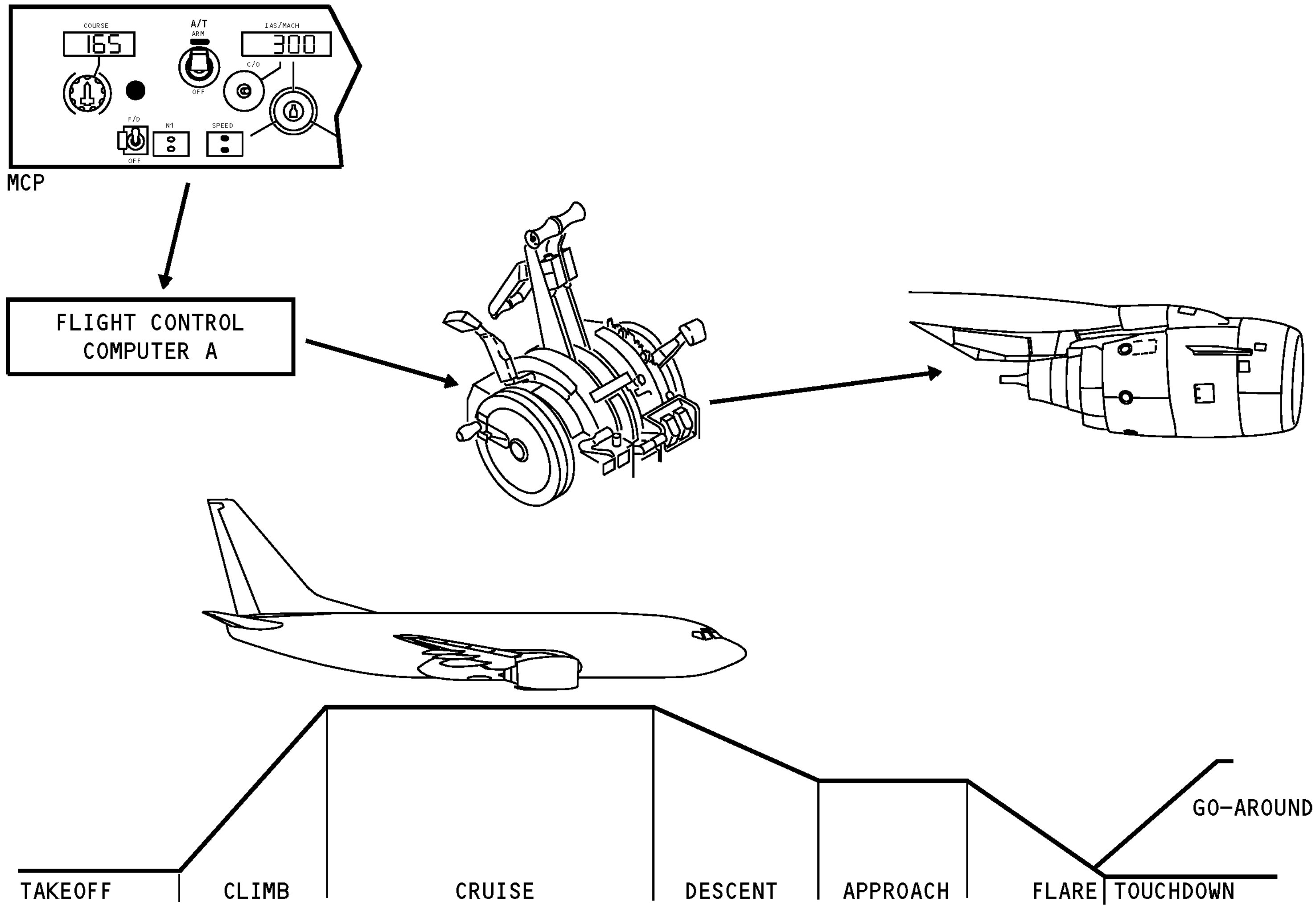
HAP ALL

- DFDAU - digital flight data acquisition unit
- DU - display unit
- EEC - electronic engine control
- elex - electronics
- FADEC - full authority digital engine control
- FCC - flight control computer

- FD - flight director (DFCS)
- FDAU - flight data acquisition unit (DFDAU)
- FDR - flight data recorder
- F/D - flight director
- flt - flight
- FMA - flight mode annunciation
- FMC - flight management computer
- FMCS - flight management computer system
- FMS - flight management system
- F/O - first officer
- fwd - forward
- G/A - go-around
- gnd - ground
- GMT - greenwich mean time
- GW - gross weight
- IAS - indicated airspeed
- KTS - knots (nautical miles per hour)
- L - left
- LSK - line select key
- MCP - mode control panel
- MCU - modular concept unit
- MMO - maximum operating mach
- N1 - low speed compressor RPM
- N2 - high speed compressor RPM
- NCD - no computed data
- POR - power on reset
- PROM - programmable read-only memory
- pth - path
- R - right
- R - repeat
- RA - radio altimeter
- RPM - revolution per minute
- R/T - receiver/transmitter
- SMYD - stall management yaw damper
- spd - speed
- SSM - sign status matrix
- sw - switch
- TACH - tachometer
- TAS - true airspeed
- TAT - total air temperature
- THR HLD - throttle hold
- T/L - thrust lever
- TMA - thrust mode annunciation
- TMD - thrust mode display (same as TMA)
- TOD - top of descent
- T/O - takeoff
- TO/GA - takeoff/go-around
- TRA - thrust lever resolver angle
- V - volts
- VMO - maximum operating velocity
- VNAV - vertical navigation mode
- V/S - vertical speed



AUTOTHROTTLE SYSTEM - INTRODUCTION



AUTOTHROTTLE SYSTEM - INTRODUCTION

A/T SYSTEM - GENERAL DESCRIPTION

General

HAP 001-013, 015-026, 028-030

The autothrottle (A/T) computer receives inputs from airplane systems, sensors, and flight deck switches to calculate and control engine thrust.

HAP 031-054, 101-999

The autothrottle (A/T) function in flight control computer A (FCC A) receives inputs from airplane systems, sensors, and flight deck switches to calculate and control engine thrust.

HAP ALL

Operator interface with the A/T system is through switches on the thrust levers and the DFCS MCP. A/T modes of operation can be selected in these ways:

- Manual mode selection from the DFCS MCP
- Automatic mode selection by DFCS when engaged
- Manual selection from thrust lever TO/GA switches.

The A/T system can be engaged in N1 mode or speed mode, depending on the mode selected and the DFCS mode of operation. A/T operational modes show on the flight mode annunciation (FMA) on the common display system.

A/T System Components

The A/T interfaces with these components:

- A/T servomotors (ASMs)
- Thrust resolver (TR) packs
- Gearbox with friction brake and clutches
- Mechanical linkages to connect T/Ls to ASMs
- A/T Arm switch and mode select switches on MCP
- Thrust lever takeoff/go-around (TO/GA) switches
- Thrust lever A/T disconnect switches.

A/T Interfaces

The A/T receives digital data from these components to calculate servo motor rate commands to control engine thrust:

- Mode control panel (MCP)
- Flight control computers (FCCs)
- Electronic engine controller (EEC)
- Flight management computer (FMC)
- Radio altimeter (RA)
- Stall management yaw damper (SMYD)
- Air data inertial reference system (ADIRS)
- Autothrottle servo motors (ASM).

The A/T receives analog discrete inputs from these components:

- Mode control panel (MCP)
- Thrust lever TO/GA switches
- Thrust lever A/T disconnect switches
- Autoflight status annunciators (ASAs).

A/T SYSTEM - GENERAL DESCRIPTION

The A/T sends mode data and control signals to these components:

- ASAs
- ASMs
- FDAU
- FCCs
- FMCS
- DEUs.

DFCS Mode Control Panel (MCP)

The DFCS MCP has these switches for the A/T system:

- A/T ARM switch
- N1 mode selector
- Speed mode selector.

The A/T ARM switch is used to turn on the A/T.

The A/T N1 and speed modes may be selected manually from the MCP. When DFCS is engaged, the FCC selects the A/T modes with a mode request through the MCP to the A/T. In DFCS VNAV mode, the FCC uses FMC flight plan data to select the A/T modes.

The MCP sends discretes for the selected A/T mode, N1 or speed, to the A/T. The MCP also sends the selected speed or FMC target speed to the A/T to use during the speed mode.

TO/GA Switches

The thrust lever TO/GA switches send analog discretes to the A/T. The TO/GA switches are used to select the takeoff or go-around mode. On the ground, the TO/GA switches select the takeoff mode. In the air, the TO/GA switches select the go-around mode if this mode is armed.

Autoflight Status Annunciators (ASA)

When the A/T disengages, it sends a signal to the ASAs to show a red flashing visual alert. You push the flashing red ASA A/T light or one of the A/T disconnect switches on the thrust levers to cancel the warning. This sends an analog signal to the A/T to reset the warning. There are no aural alerts when the A/T disengages.

Autothrottle Servo Motors (ASM)

The ASMs are below the aisle control stand and flight deck floor. The ASMs receive digital thrust rate commands from the A/T and change the data to electrical pulses to drive the servo motors. The motors drive the thrust resolver (TR) packs through a gearbox and slip clutch to move the thrust levers (T/Ls) to a desired thrust resolver angle (TRA). The ASMs receive maximum resolver position from the EECs. The ASMs monitor the TRA position and will not allow the actual TRA position to exceed the limit TRA position.

The ASMs send tachometer data and feedback signals to the A/T.

A/T SYSTEM - GENERAL DESCRIPTION

Display Electronics Units (DEU)

The A/T sends mode data to the DEUs to show A/T modes of operation on the FMA on the CDS.

The FMC calculates engine N1 limits and N1 targets during each flight phase and sends the data to the DEUs. The DEUs show N1 limits on the engine display. The DEUs send N1 targets to the EECs.

SMYD

The stall management yaw damper (SMYD) sends minimum operating speed data to the A/T for minimum speed floor control.

Radio Altimeter

During approach, the radio altimeter (RA) sends radio altitude data to the A/T. This data is used to arm the go-around mode below 2000 feet, and during Flare RETARD mode, to retard T/Ls to idle for landing.

FMC

The FMC calculates thrust N1 limits and N1 targets for each flight phase. The data goes to the DEUs. The DEUs show the N1 limits on the engine display. The DEUs send the N1 targets to the EECs which calculate equivalent TRA targets to send to the A/T to set thrust. The FMC also sends N1 targets directly to the A/T. During takeoff and max thrust go-around, the A/T uses EEC TRA targets and FMC N1 targets to set thrust.

During takeoff, climb, and max thrust go-around, the FMC N1 targets are the same as the N1 limits. During reduced thrust climb and cruise operations, the FMC N1 targets are less than the N1 limits.

The FMC calculates gross weight and sends it to the A/T to use in calculation of thrust and T/L rate commands.

The FMC has an interface for A/T for BITE.

FCC

The FCCs send mode request discretes to the A/T to select A/T modes consistent with the active DFCS mode. The A/T sends mode status to the FCC.

ADIRU

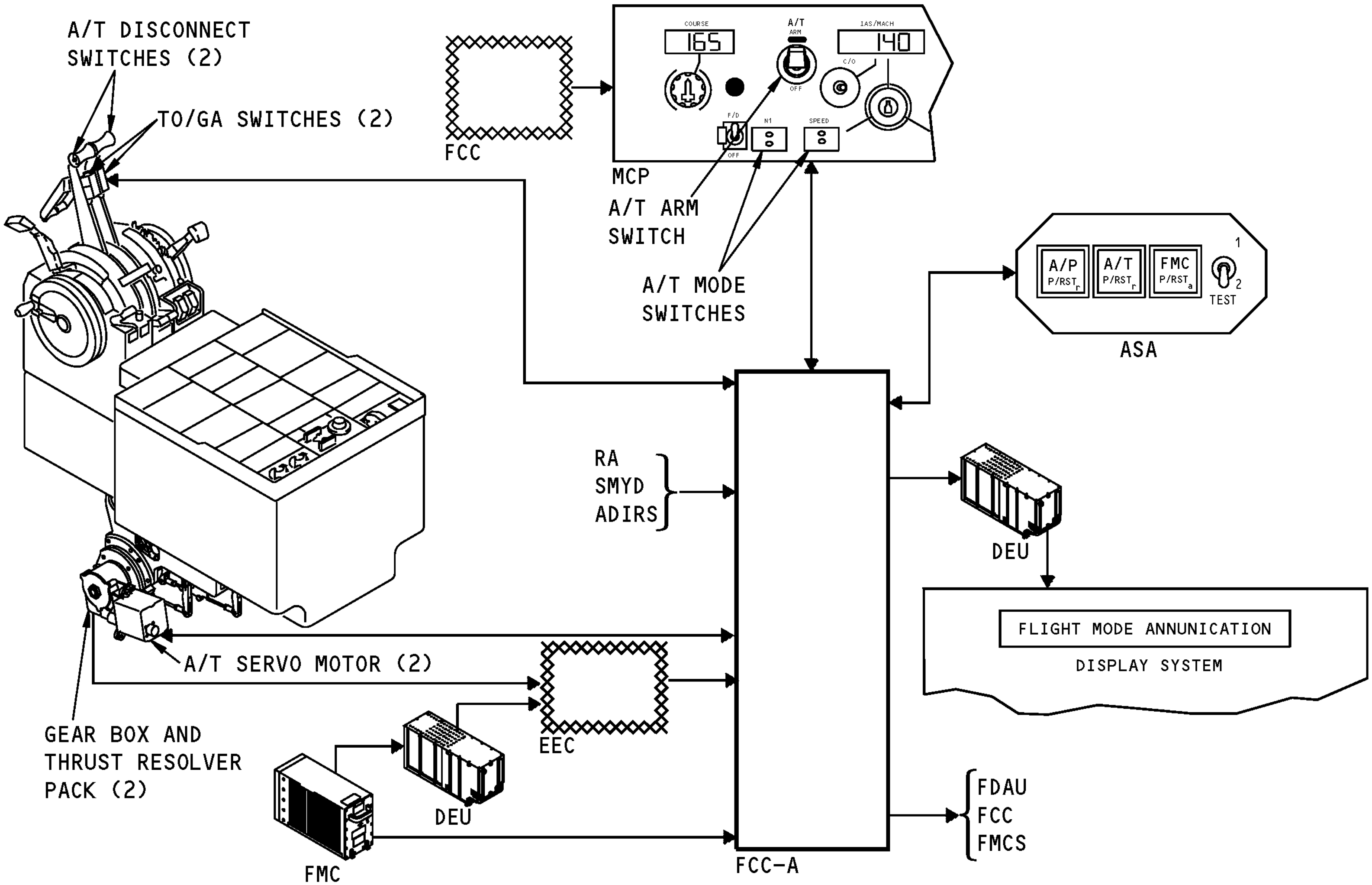
The ADIRUs send this data to the A/T:

- True airspeed
- Mach
- Barometric altitude
- Atmospheric pressure
- Static outside air temperature
- Inertial vertical speed
- Acceleration.

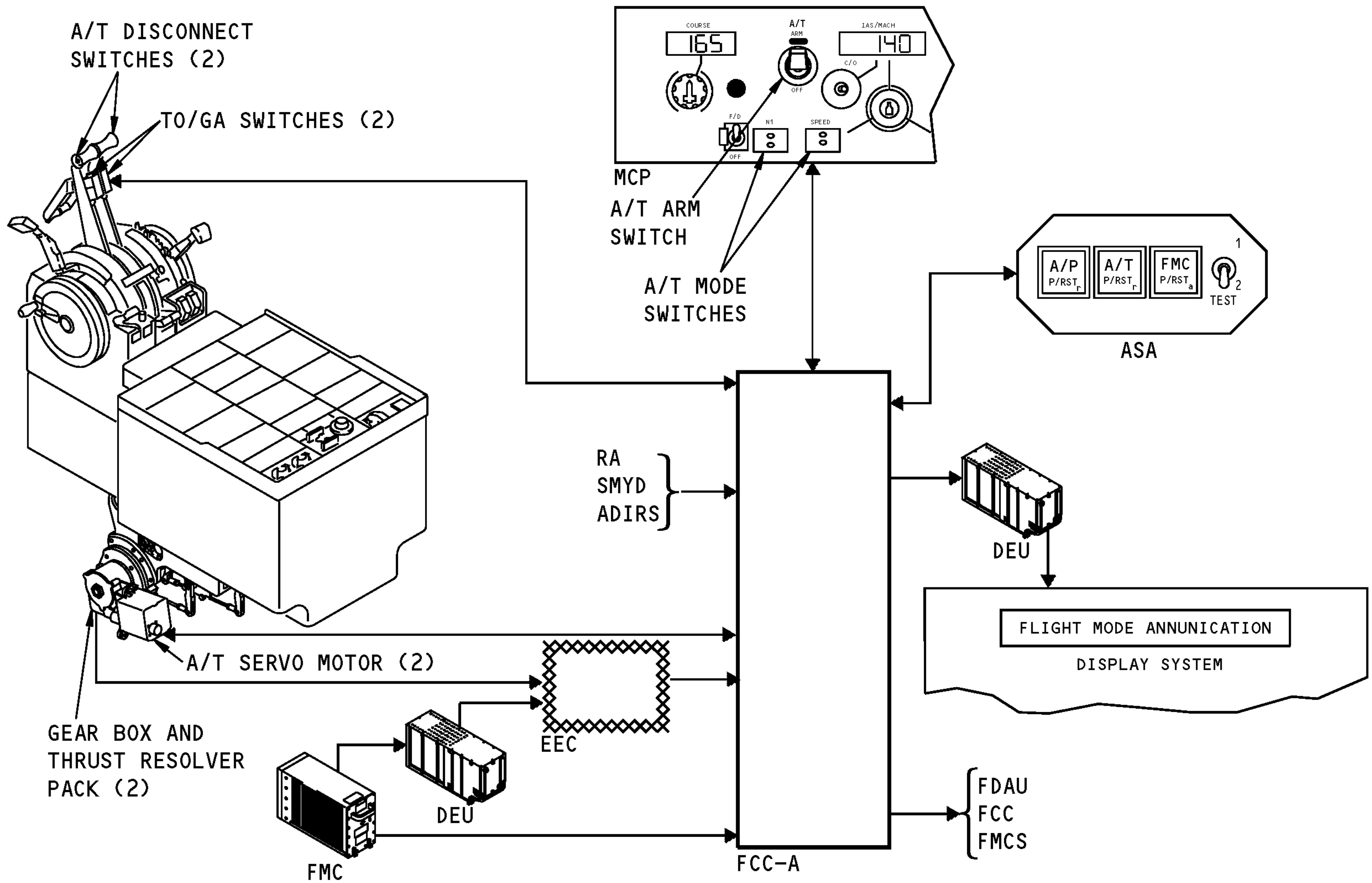
The A/T uses ADIRU data when calculating T/L rate commands to set engine thrust for precise thrust adjustments during changing flight conditions.

EEC

The DEUs send FMC N1 targets to the EECs. The EECs use the data to calculate equivalent TRA targets. The A/T uses the EEC TRA targets to set thrust during takeoff, climb, and max thrust go-around. For takeoff and max thrust go-around, the A/T initially uses EEC TRA targets to advance the T/Ls. As the T/Ls get to within 4 to 6 degrees of the FMC N1 limit, the A/T then uses FMC N1 targets to make final T/L adjustments to the FMC N1 limit.



A/T SYSTEM - GENERAL DESCRIPTION



A/T SYSTEM - GENERAL DESCRIPTION

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A/T SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT LOCATION

Electronic Equipment (E/E) Compartment

HAP 001-013, 015-026, 028-030

The autothrottle computer is on the E1-1 shelf.

HAP 031-054, 101-999

The autothrottle software function is in flight control computer A (FCC A) on the E1-1 shelf.

HAP 001-013, 015-026, 028-030

The autothrottle program switch module is on the left side of the E1-1 shelf.

HAP 031-054, 101-999

The autothrottle program switch modules for FCC A are on the right side of the E1-1 shelf.

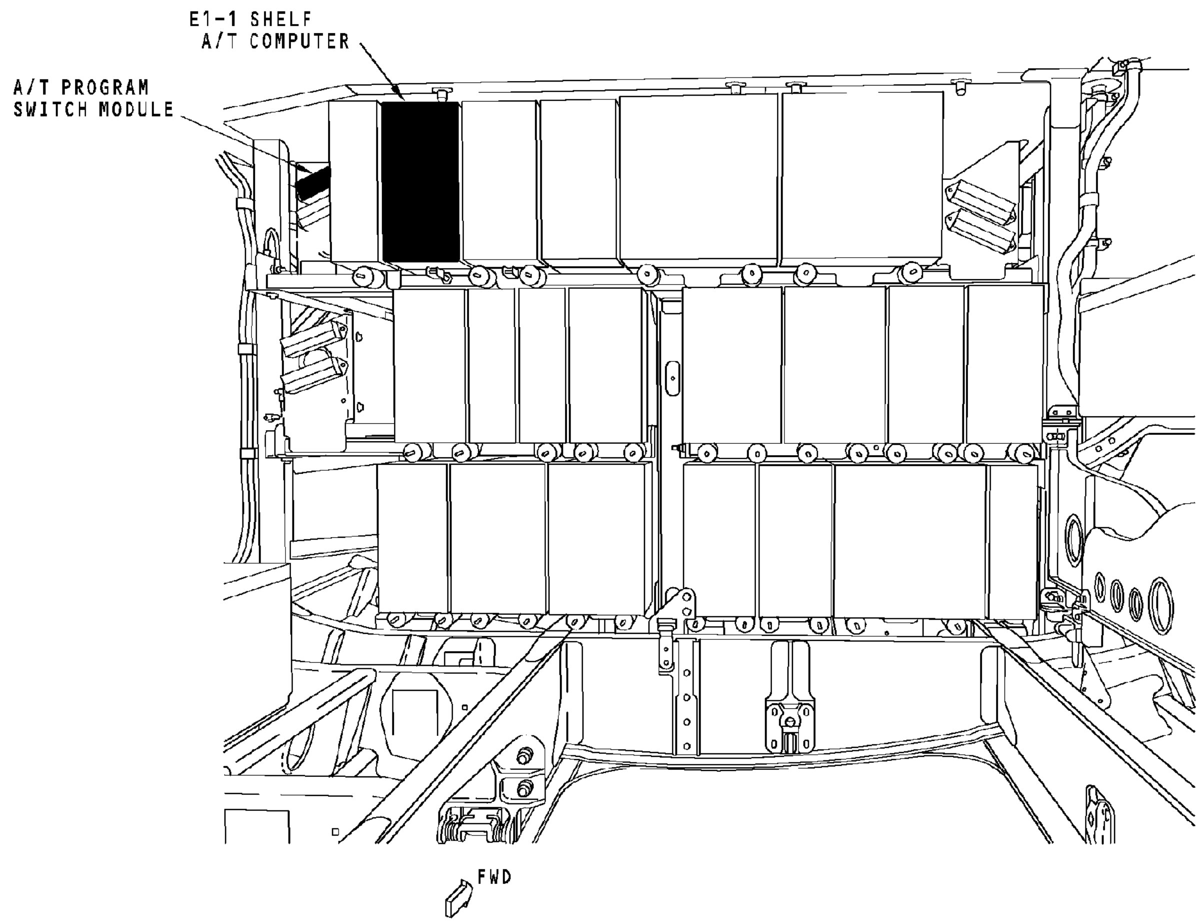
HAP 001-013, 015-026, 028-030

The A/T computer is an ARINC 600 3MCU size and weighs 9 lbs.

HAP 031-054, 101-999

FCC B also has the autothrottle software, but that software is not active.

HAP ALL



A/T SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT LOCATION

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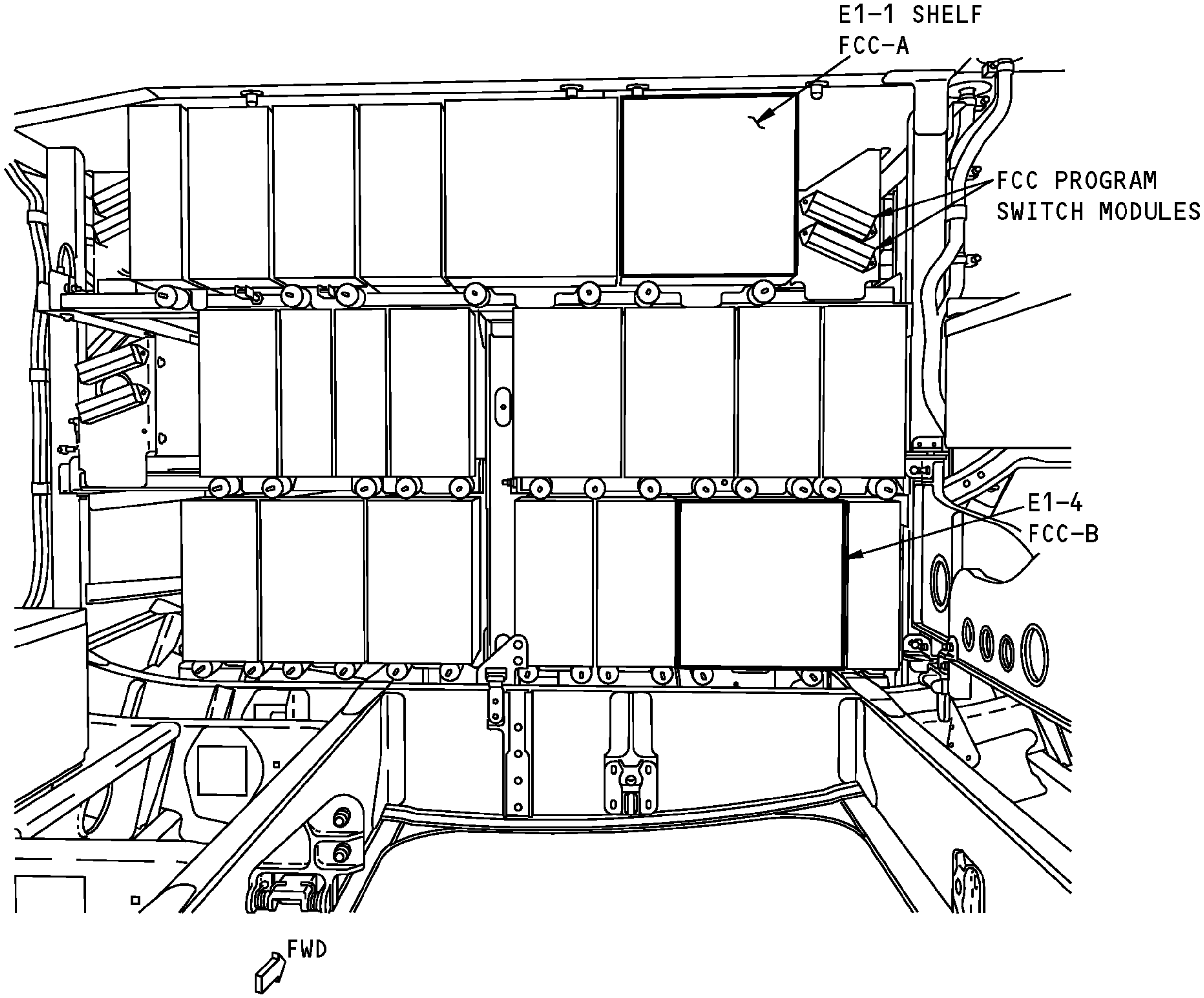

A/T SYSTEM - ELECTRONIC EQUIPMENT COMPARTMENT LOCATION

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A/T SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

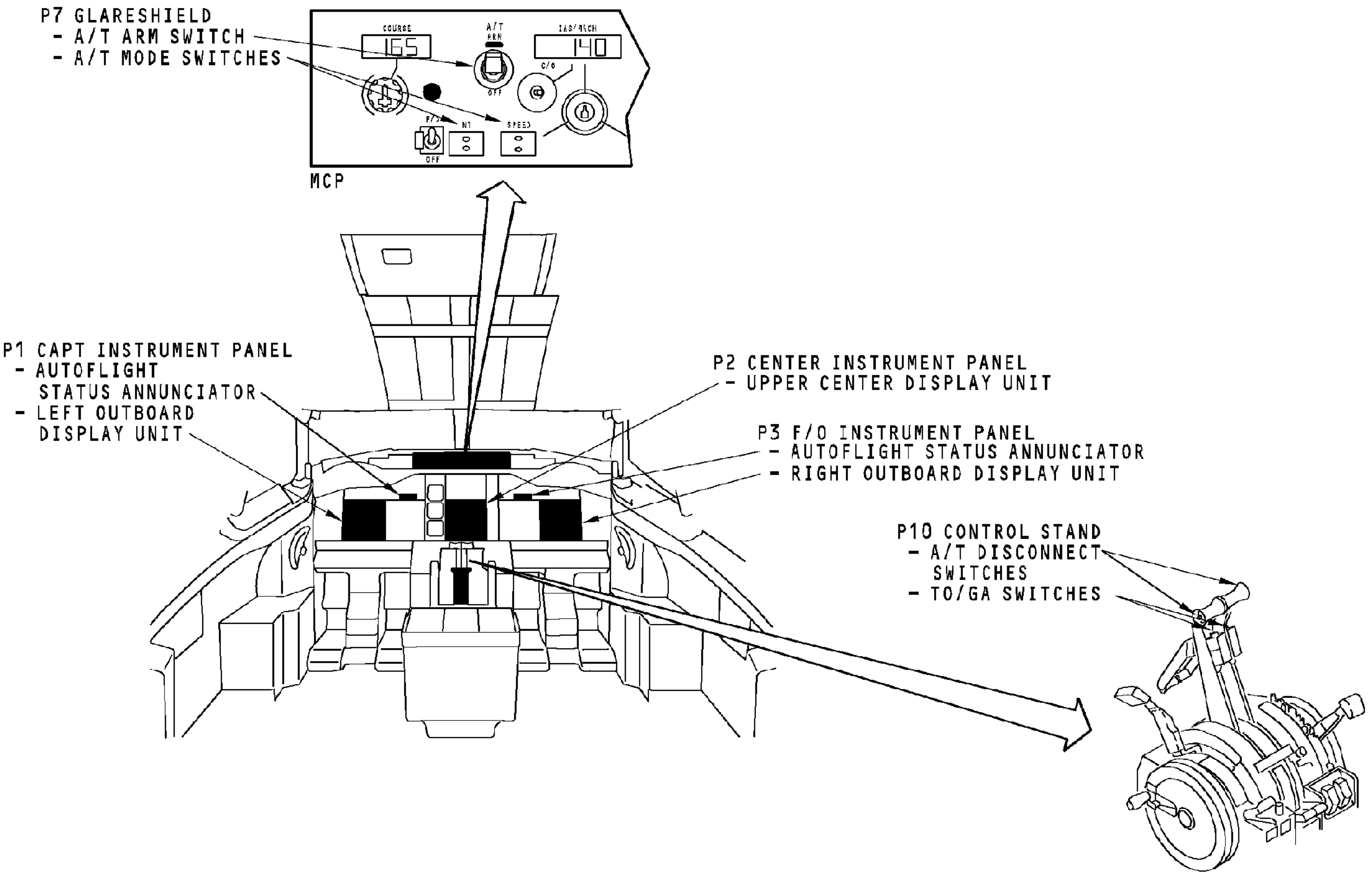
Flight Compartment

These components in the flight compartment have interface with the A/T system:

- DFCS mode control panel (MCP)
- Thrust lever TO/GA switches
- Thrust lever disconnect switches
- Autoflight status annunciators (ASAs)
- Outboard flight displays and center display unit.

The A/T Arm switch and light, and the two A/T mode selector switches are on the MCP on the glareshield.

The A/T disconnect switches and TO/GA switches are on the thrust levers.



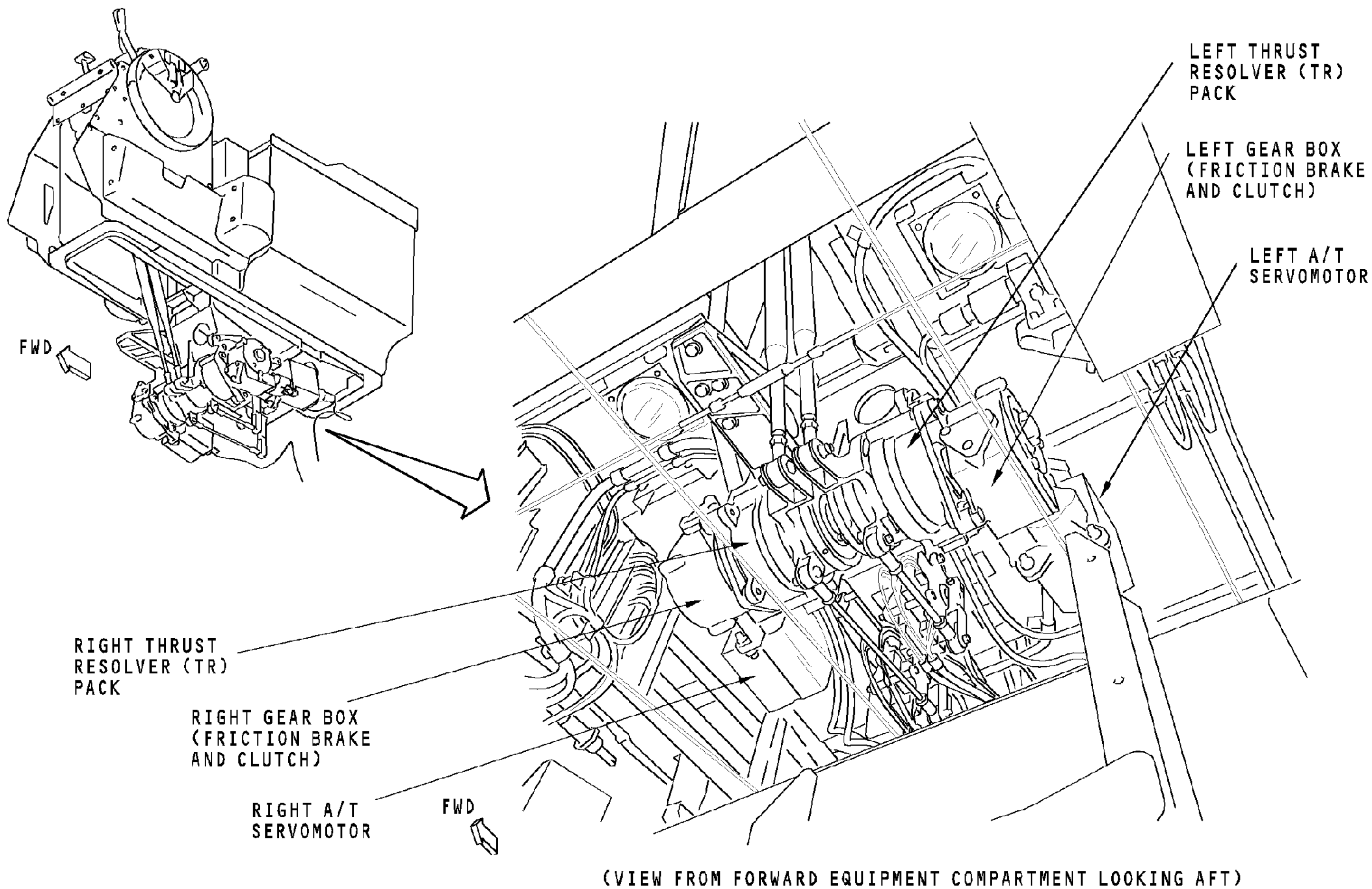
A/T SYSTEM - FLIGHT COMPARTMENT COMPONENT LOCATION

A/T SYSTEM - FORWARD EQUIPMENT COMPARTMENT LOCATION

Forward Equipment Compartment

The A/T servo motors (ASMs) are in the forward equipment compartment under the P10 control stand.

The servo motors connect to the thrust levers (T/Ls) through the gearbox, the thrust resolver (TRs) packs, and mechanical linkages below the control stand.



22-31-00-005

A/T SYSTEM - FORWARD EQUIPMENT COMPARTMENT LOCATION

A/T SYSTEM - ANALOG INTERFACE

General

HAP 001-013, 015-026, 028-030

The A/T computer receives and sends digital data and analog discretes to and from system components, sensors and switches. This section describes analog discretes.

HAP 031-054, 101-999

The A/T function in the FCC A receives and sends digital data and analog discretes to and from system components, sensors and switches. This section describes analog discretes.

HAP 001-013, 015-026, 028-030

Power

Two circuit breakers on the P18-1 circuit breaker panel supply 28v dc to the A/T. The A/T normally uses power from Bus 1. If bus 1 fails, the A/T changes to bus 2. The A/T supplies 28v dc to these components:

- A/T autoflight status annunciators (ASAs)
- A/T arm switch on mode control panel (MCP)
- Autothrottle servo motors (ASMs).

There are two circuit breakers, ASM 1 and ASM 2, on the front of the A/T computer. These circuit breakers receive 28v dc from the A/T computer and provide power to the ASMs. These circuit breakers protect the A/T computer in case of a servo motor overload. The ASM 1 circuit breaker supplies power to the left A/T servomotor and the ASM 2 circuit breaker supplies power to the right A/T servomotor. The circuit breakers also supply power to the ASMs for engage logic.

HAP ALL

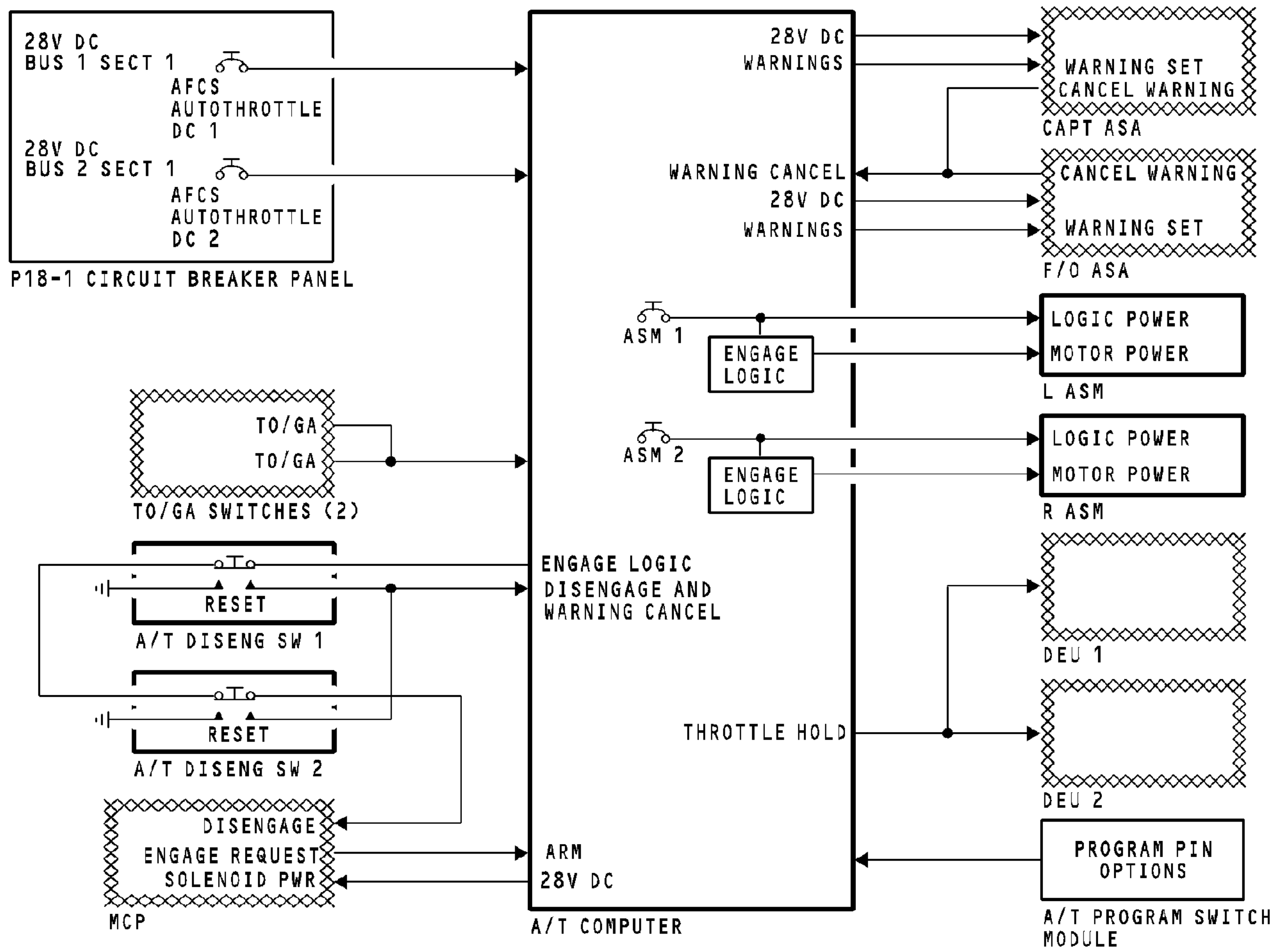
Analog Discretes

The A/T receives these analog discretes:

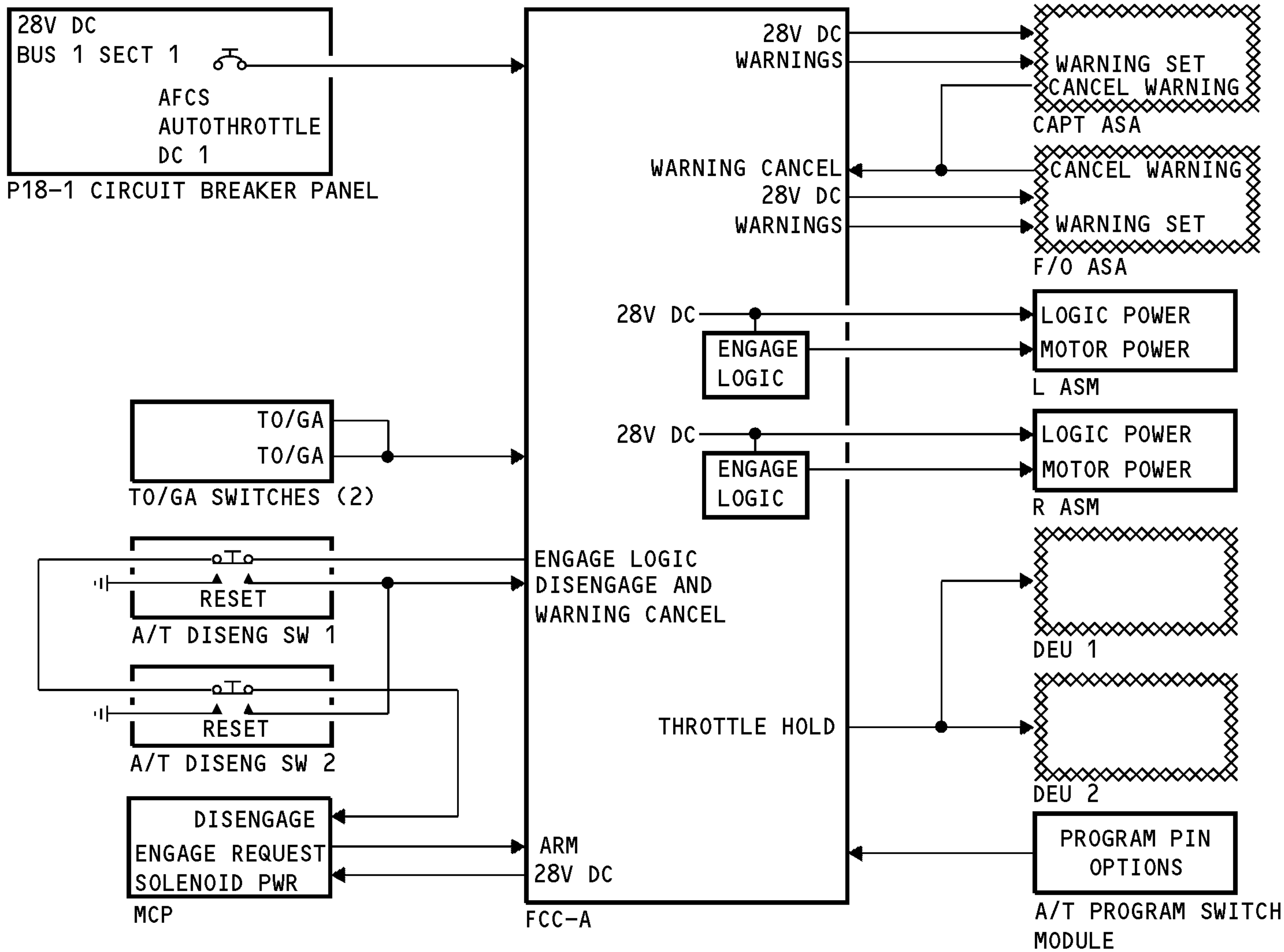
- Takeoff/go-around request from the TO/GA switches
- Disengage/reset from the T/L disengage switches
- Disengage warning cancel/reset from the ASAs
- Selected pin options from program switch modules.

The A/T supplies these analog discretes:

- Disengage logic to the Capt and F/O ASAs
- Throttle hold mode annunciation logic to the DEUs
- A/T arm logic to the DFCS MCP.



A/T SYSTEM - ANALOG INTERFACE



A/T SYSTEM - ANALOG INTERFACE

A/T SYSTEM - DIGITAL INPUT INTERFACE

General

HAP 001-013, 015-026, 028-030

The A/T computer receives digital data from system components and sensors. The A/T computer uses this data to activate A/T modes and to calculate thrust lever commands.

HAP 031-054, 101-999

The A/T function in flight control computer A (FCC A) receives digital data from system components and sensors. The A/T function uses this data to make A/T modes active and to calculate thrust lever commands.

HAP ALL

DFCS Mode Control Panel (MCP)

The MCP sends this data to the A/T:

- Target mach
- Target airspeed
- Selected altitude
- Flight path angle rate
- Spoiler position (left and right)
- DFCS discretes (modes).

The mach and airspeed is used by the autothrottle to control to the MCP speed or FMC speed in the VNAV mode.

Flight path angle rate is used to reduce speed variations during various pitch maneuvers (level change, altitude acquire etc).

The selected altitude is used to anticipate the new altitude during altitude acquire.

Spoiler position is used for weight calculation and for thrust split monitor during cruise.

The DFCS discretes send mode requests, N1 limit selection and mode indications to the autothrottle.

Stall Management Yaw Damper (SMYD)

The SMYD sends this data to the A/T:

- Flap angle
- Minimum operating speed
- Flap up discrete
- Main gear down discrete
- Air/ground discrete.

The flap angle is used by the autothrottle to calculate lift and drag coefficients.

Minimum operating speed is used as the minimum floor speed in the autothrottle control logic.

The discretes are used in autothrottle control logic and BITE.

A/T SYSTEM - DIGITAL INPUT INTERFACE

HAP 031-054, 101-999

SMYD 1 sends data directly to FCC A. SMYD 2 sends data through FCC B to FCC A.

HAP ALL

Flight Management Computer (FMC)

The FMCs send this data to the A/T:

- N1 targets
- Gross weight
- Minimum speed
- FMC altitude
- Static air temperature
- FMC modes
- GMT/Date.
- BITE test information.

The autothrottle converts the target N1 values from the FMC to an equivalent TRA target. The target N1 rating is dependent on the FMC engaged mode.

Gross weight is used in the go around control logic and approach control logic.

Minimum airspeed is the lowest airspeed that is acceptable during VNAV operation.

FMC altitude from the FMC is used for anticipation of altitude acquire during VNAV operation.

SAT is used to calculate a backup TRA limit value.

The FMC mode discretes are used to determine control law gains and limits.

GMT and date are used in BITE for fault data storage.

BITE data is used for interactive display on the CDUs.

Radio Altimeter (RA)

The RA receiver/transmitters (R/Ts) send radio altitude to the A/T. The A/T uses this data to determine control law gains during approach and as a backup for flare retard.

Autothrottle Servo Motor (ASM)

The ASMs sends this data to the A/T for feedback:

- Servo status
- Measured rate
- Measured torque.

Servo status is the current status of the ASM.

Measured rate is the actual rate (deg/sec) that the ASMs are moving the thrust levers.

Measured torque is the actual torque that is being exerted to move the thrust levers.

A/T SYSTEM - DIGITAL INPUT INTERFACE

Electronic Engine Control (EEC)

Each EEC channel sends this data to the A/T:

- Thrust resolver angle (TRA)
- N1 command indicated
- TRA for max forward idle
- Estimated corrected thrust
- TRA for actual N1
- TRA for N1 target
- TRA for N1 max
- TRA for 5 degree/sec response.

Thrust resolver angle is used by the autothrottle to calculate an N1 command.

N1 command indicated is used to set a throttle position using the error between the target N1 (from the FMC) and the commanded N1 from the EEC.

TRA for maximum forward flat is the throttle angle below which the engine is in the idle range.

Estimated corrected thrust is used in the reduced go around control logic.

TRA for actual N1 and TRA for N1 target are used in the N1 mode control logic.

TRA for N1 maximum is used as a reversion limit in the event that the airplane is dispatched without an operative FMC and as a protection from excessive throttle angles.

TRA for 5 degree/sec response is used in the retard control logic.

Air Data Inertial Reference Unit (ADIRU)

The ADIRUs send this air data reference data to the A/T:

- Computed airspeed (CAS)
- Maximum allowable airspeed (VMO/MMO)
- Uncorrected altitude
- Baro corrected altitude
- Mach
- Static air temperature (SAT)
- Total air temperature (TAT)
- Altitude rate
- Static pressure
- Total pressure
- True airspeed
- Angle of attack (AOA).

Computed airspeed is used in the speed mode control logic.

VMO/MMO is used in the speed mode control logic.

Uncorrected altitude is used for autothrottle gain scheduling and in the maximum allowed N1 calculation.

A/T SYSTEM - DIGITAL INPUT INTERFACE

Mach number is used for speed mode Mach control, weight and drag calculations.

SAT is used to calculate a backup TRA limit value.

Altitude rate is used in wind detection calculations.

Static pressure is used for normalizing thrust effects with altitude.

True airspeed is used for calculating the TAS/CAS conversion.

Angle of attack is used in calculating a backup weight for alpha floor calculation.

The ADIRUs send this inertial reference data to the A/T:

- Pitch attitude
- Roll attitude
- Body longitudinal acceleration
- Body normal acceleration
- Groundspeed
- Body pitch rate
- Vertical speed.

Pitch attitude is used for compensating the longitudinal acceleration signal for wind detection.

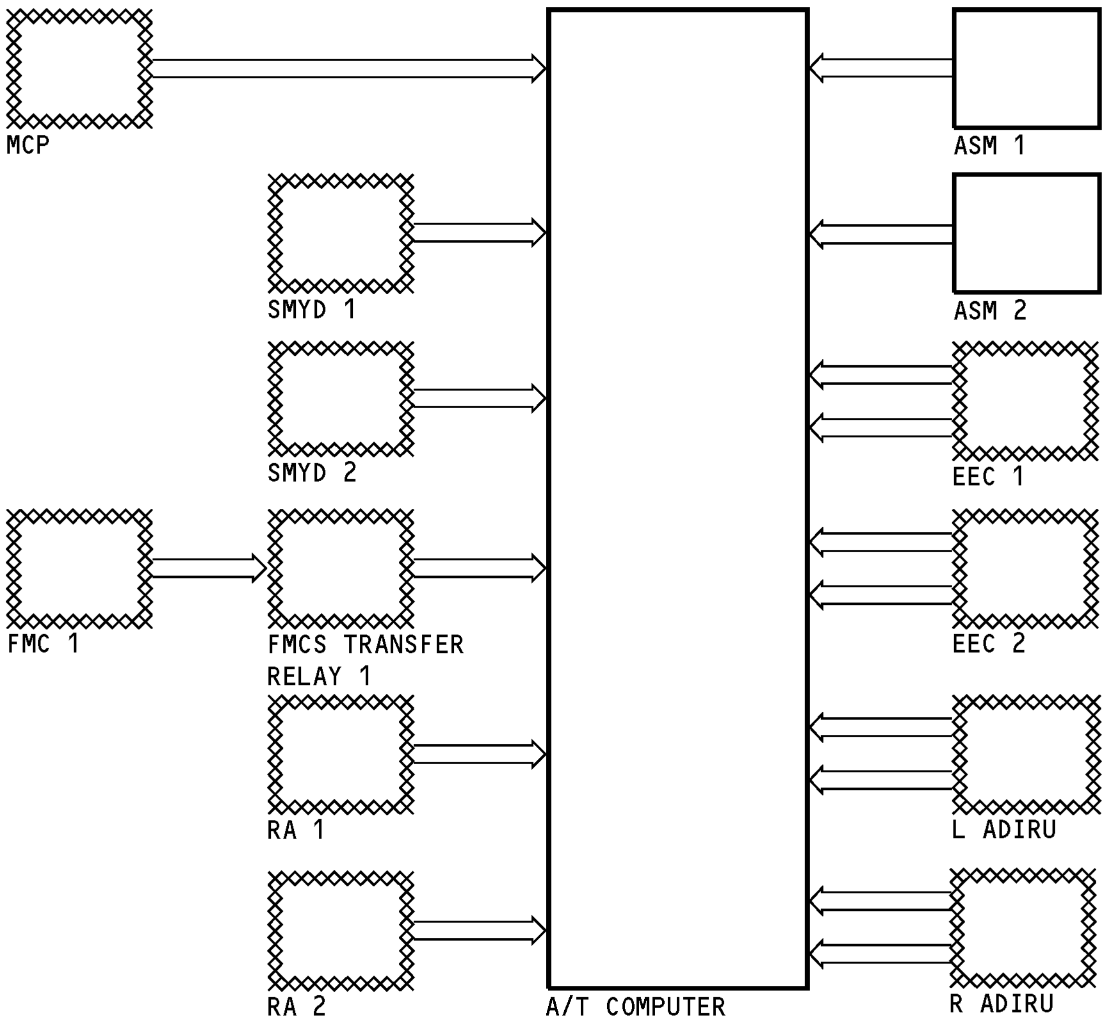
Roll attitude is used for thrust compensation during airplane turns.

Body longitudinal acceleration is used for control law damping and wind detection.

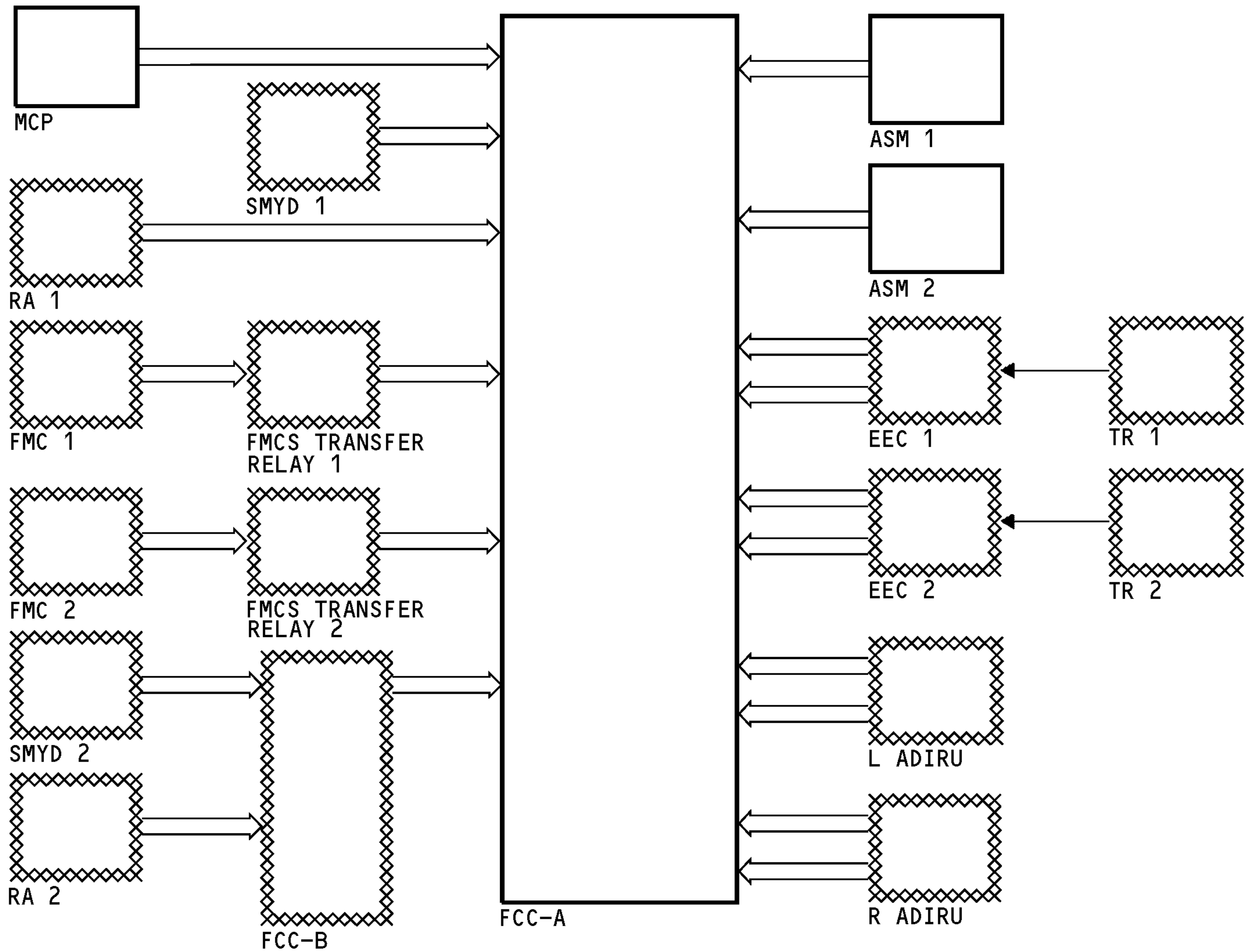
Body normal acceleration is used to derive a vertical speed signal for wind detection.

Groundspeed is used for cruise speed control to indicate when minimal winds are present to allow track mode corrections.

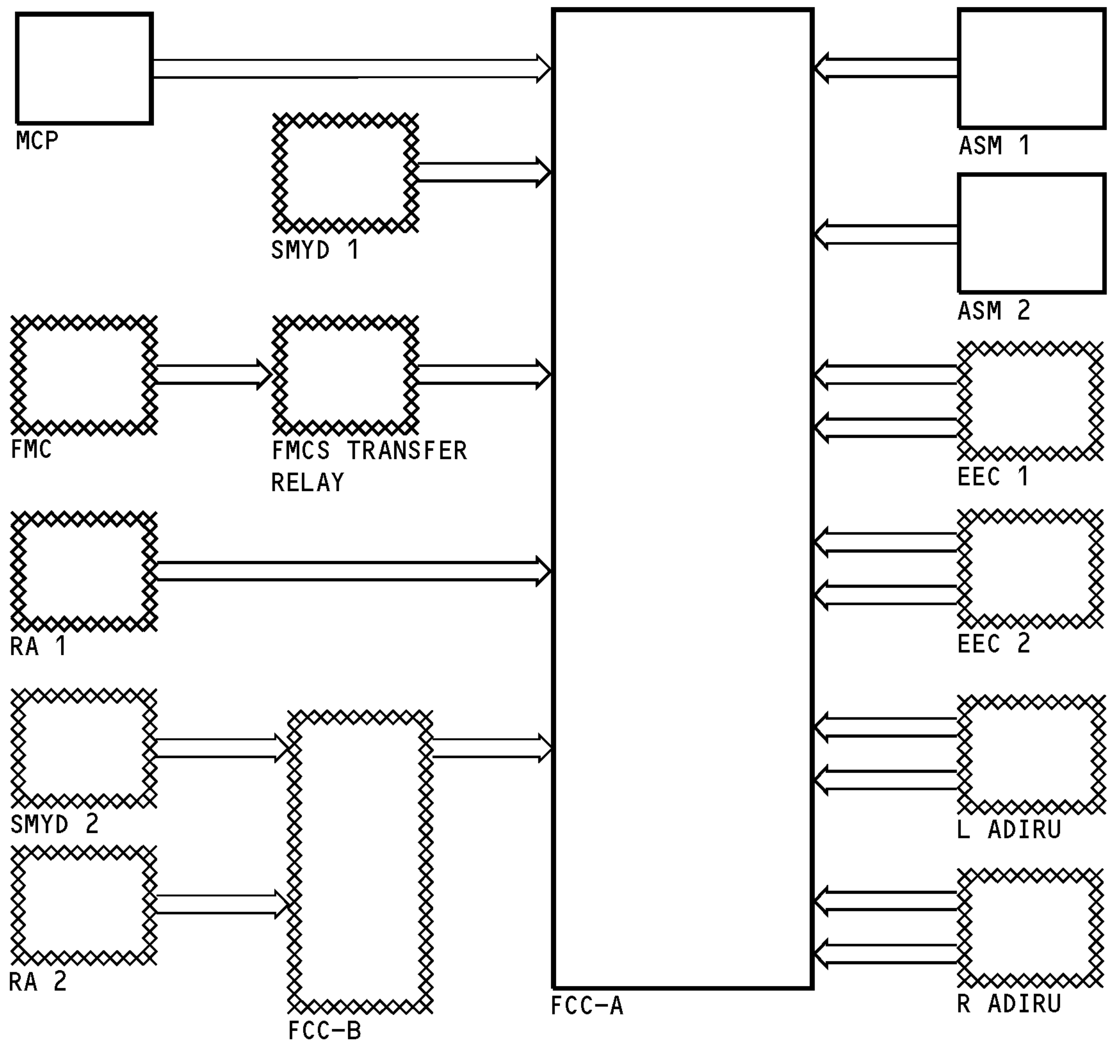
Vertical speed is used in determining windshear.



A/T SYSTEM - DIGITAL INPUT INTERFACE



A/T SYSTEM - DIGITAL INPUT INTERFACE



A/T SYSTEM - DIGITAL INPUT INTERFACE

A/T SYSTEM - DIGITAL OUTPUT INTERFACE

General

HAP 001-013, 015-026, 028-030

The A/T computer sends digital data to system components and sensors. The A/T computer sends this data on two digital buses to the user components.

HAP 031-054, 101-999

The A/T function in flight control computer A (FCC A) sends digital data to system components and sensors. The A/T function in FCC A sends this data on two digital buses to the user components.

HAP ALL

A/T Digital Outputs

A/T bus 1 connects to these components:

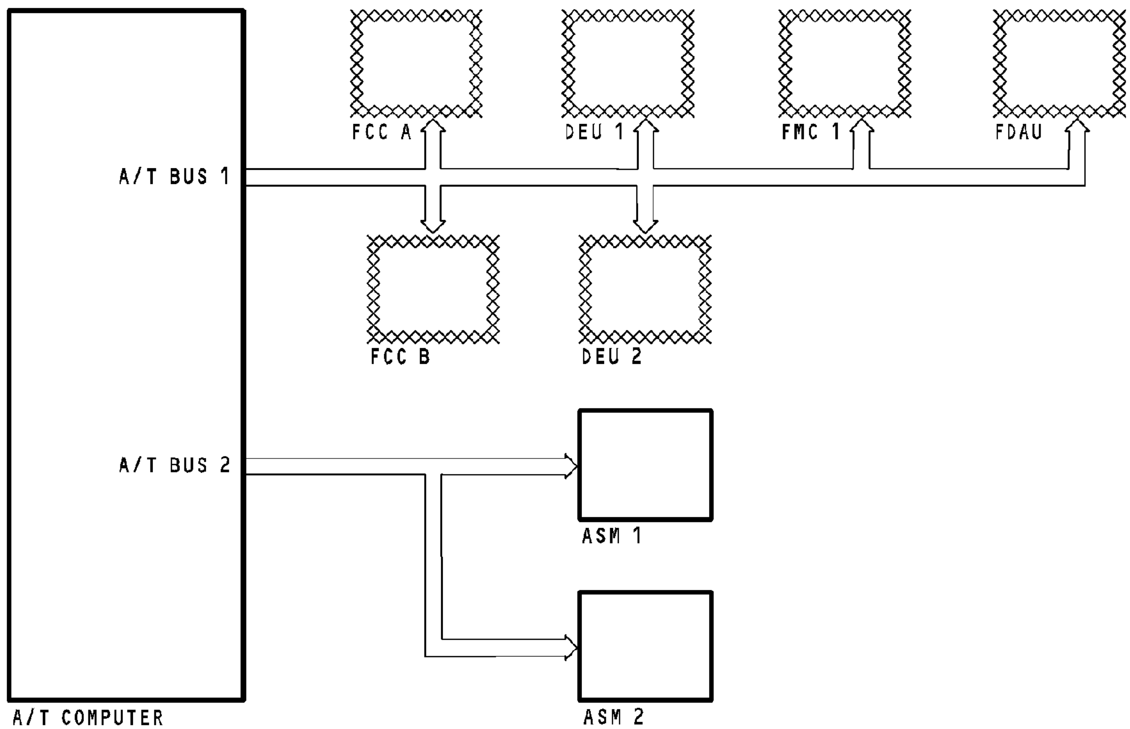
- FCC A and B
- DEU 1 and 2
- FMCs
- FDAU.

The A/T sends these parameters on bus 1:

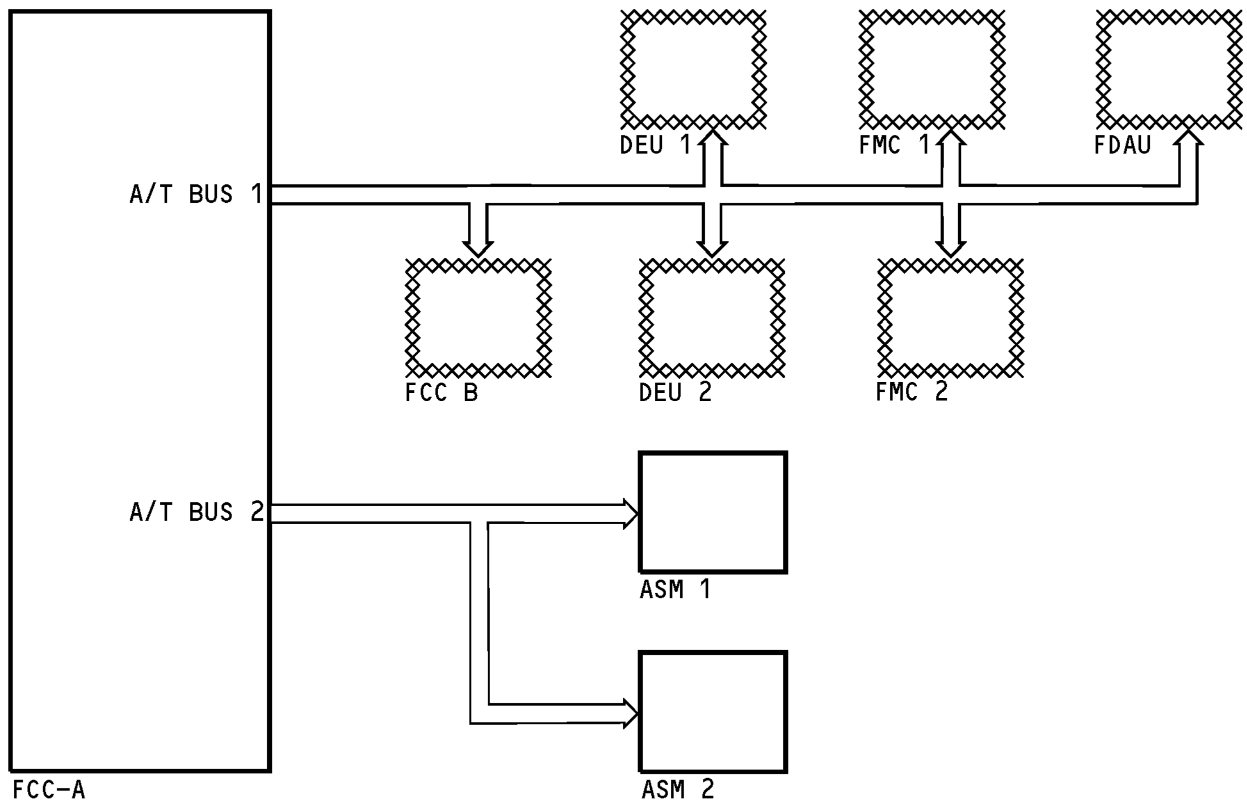
- A/T fast/slow command
- BITE response
- A/T modes and status
- Thrust rate command
- ASM measured torque
- ASM measured rate.

A/T bus 2 connects to ASM 1 and ASM 2. The A/T sends these parameters on this bus:

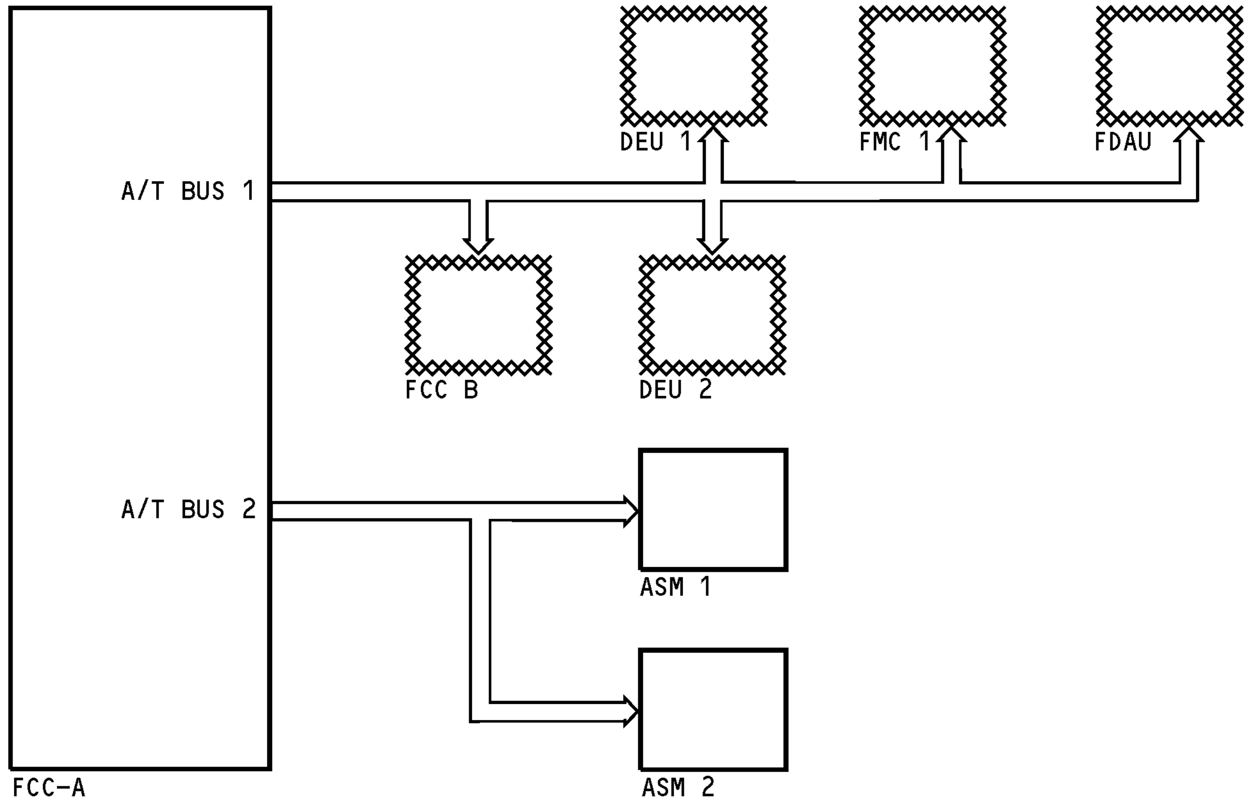
- Thrust rate command
- TRA selection
- TRA max limit.



A/T SYSTEM - DIGITAL OUTPUT INTERFACE



A/T SYSTEM - DIGITAL OUTPUT INTERFACE



A/T SYSTEM - DIGITAL OUTPUT INTERFACE

A/T SYSTEM - A/T COMPUTER

General

The A/T computer does the calculations for automatic control of engine thrust. The A/T computer sends the commands to the autothrottle servo motors to move the thrust levers.

Physical Description

The A/T computer is 3 MCU in size and weighs about 11 pounds. An electrical connector at the back of the computer supplies the interface to other aircraft components.

The A/T computer has two circuit breakers on the front. These circuit breakers are ASM 1 and ASM 2. Power for the autothrottle servo motors comes from these circuit breakers.

Operation

The pilot uses the A/T system during these flight phases:

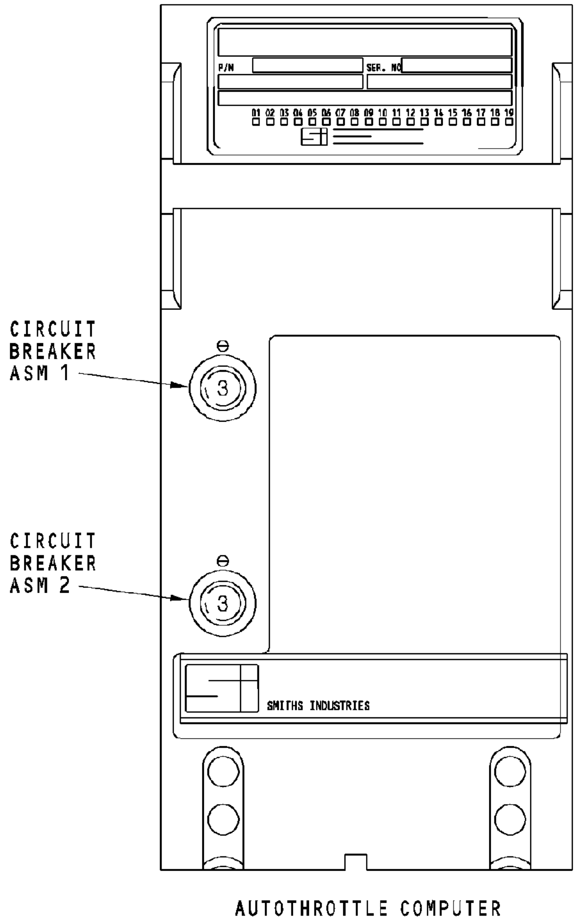
- Takeoff
- Climb
- Cruise
- Descent
- Approach to landing
- Go-around.

The A/T computer continuously monitors the system operation. If it finds a fault, the A/T computer records this fault in its memory.

The A/T computer uses an operational and a built-in test (BITE) program. These programs are in the computer's memory. During the operational program test, the computer uses the sensor and system inputs to make the thrust rate commands.

Training Information Point

A built-in test (BITE) program monitors the system operation. The A/T computer records faults and the suspect component(s) in memory. The technician uses A/T BITE on the FMCS control display units (CDUs) to look at these recorded faults. The technician also uses A/T BITE to check system operation.



A/T SYSTEM - A/T COMPUTER

A/T SYSTEM - FLIGHT CONTROL COMPUTER

General

The A/T function in flight control computer A (FCC A) does the calculations for automatic control of engine thrust. The A/T sends the commands to the autothrottle servo motors to move the thrust levers.

Physical Description

The FCC is 6 MCU in size and weighs about 20 pounds. An electrical connector at the rear of the computer supplies the interface to other airplane components.

The FCC supplies logic power and motor power for ASM 1 and ASM 2.

Operation

The pilot uses the A/T system during these flight phases:

- Takeoff
- Climb
- Cruise
- Descent
- Approach to landing
- Go-around.

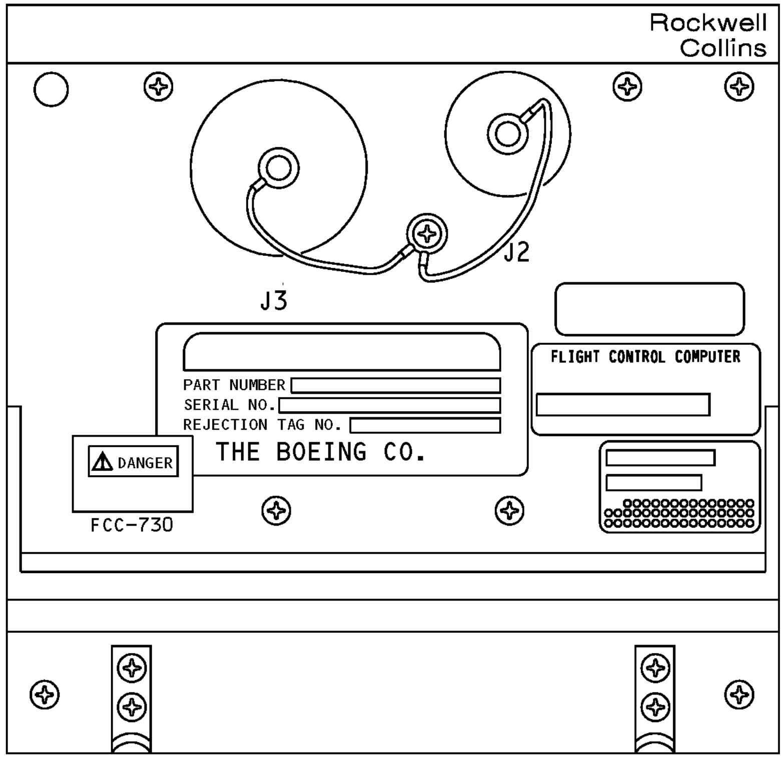
The A/T continuously monitors the system operation. If the A/T finds a fault, it puts the fault in its memory.

The A/T uses an operational and a built-in-test (BITE) program. These programs are in the computer memory.

During the operational program test, the computer uses the sensor and system inputs to make the thrust rate commands.

Training Information Point

A built-in-test (BITE) program monitors the system operation. The A/T puts faults and related components in memory. The technician uses A/T BITE on the FMCS control display units (CDUs) to look at these faults. The technician also uses BITE to do a check of system operation.



A/T SYSTEM - FLIGHT CONTROL COMPUTER

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A/T SYSTEM - A/T COMPUTER - FUNCTIONAL DESCRIPTION

General

The autothrottle computer is a digital computer. It takes inputs from many systems to calculate the thrust lever commands. The A/T computer has these components:

- Direct memory access (DMA)
- Central processing unit (CPU)
- Read only memory (ROM)
- Power supply.

DMA System

The DMA system has these components:

- Input/output (I/O) devices
- Controller
- Random access memory (RAM).

The A/T computer receives and sends digital and analog discrete data.

The DMA I/O devices receive the ARINC 429 and analog discrete data. After conversion, this data then goes to the DMA controller.

The DMA I/O devices also receive digital data from the CPU. The DMA I/O devices changes the data to ARINC 429 data or analog discretes before it goes to other systems.

The DMA controller controls all data to and from the A/T computer.

CPU

The A/T CPU does these:

- Decides when the A/T engages and disengages
- Decides mode of operation
- Calculates thrust lever commands
- Monitors system operation.

The CPU monitors and decides if the control law data is satisfactory. If it is, the CPU allows the A/T to engage. While engaged, the CPU sends a signal to hold the A/T ARM switch in the ARM position. The CPU also allows an excitation voltage to go to the AT servo motors (ASMs).

If the CPU decides that control law data is not satisfactory, the logic disengages the A/T system. The CPU sends a signal to the autoflight status annunciators (ASAs) to give an annunciation.

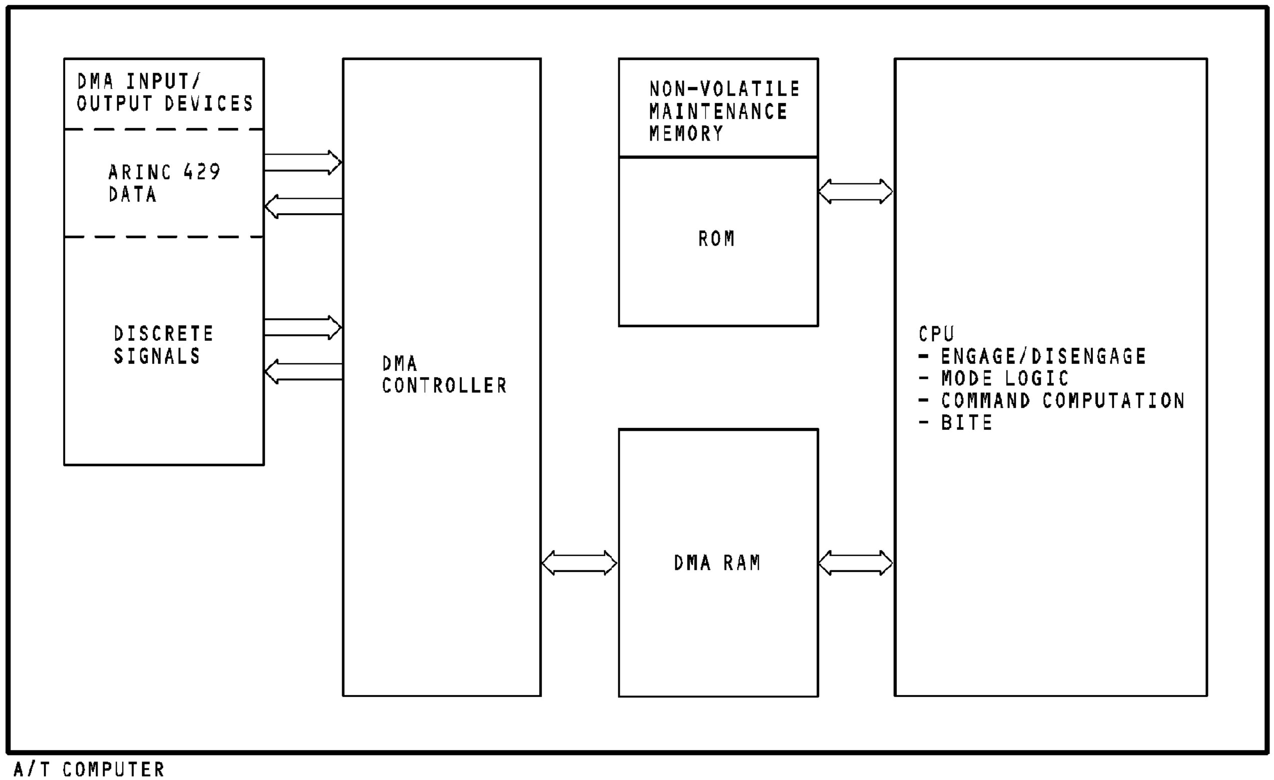
The CPU permits selection of different autothrottle modes. The DFCS system normally selects the mode during different flight phases. You can also select the modes manually with the MCP mode switches.

The CPU calculates the A/T commands using A/T control laws. The control laws give the desired command and compares this command to the actual airplane condition. A difference in this comparison produces a thrust lever rate command for the ASMs.

The CPU continuously monitors system operation. If there is fault, it stores this fault in a non-volatile maintenance memory.

Memory

The ROM stores the computer operational program. The operational program is the computer instructions. The CPU gets these instructions during its operation. The memory also has a non-volatile maintenance memory. The maintenance memory stores the results of BITE.



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A/T SYSTEM - A/T COMPUTER - FUNCTIONAL DESCRIPTION

A/T SYSTEM - FLIGHT CONTROL COMPUTER - FUNCTIONAL DESCRIPTION

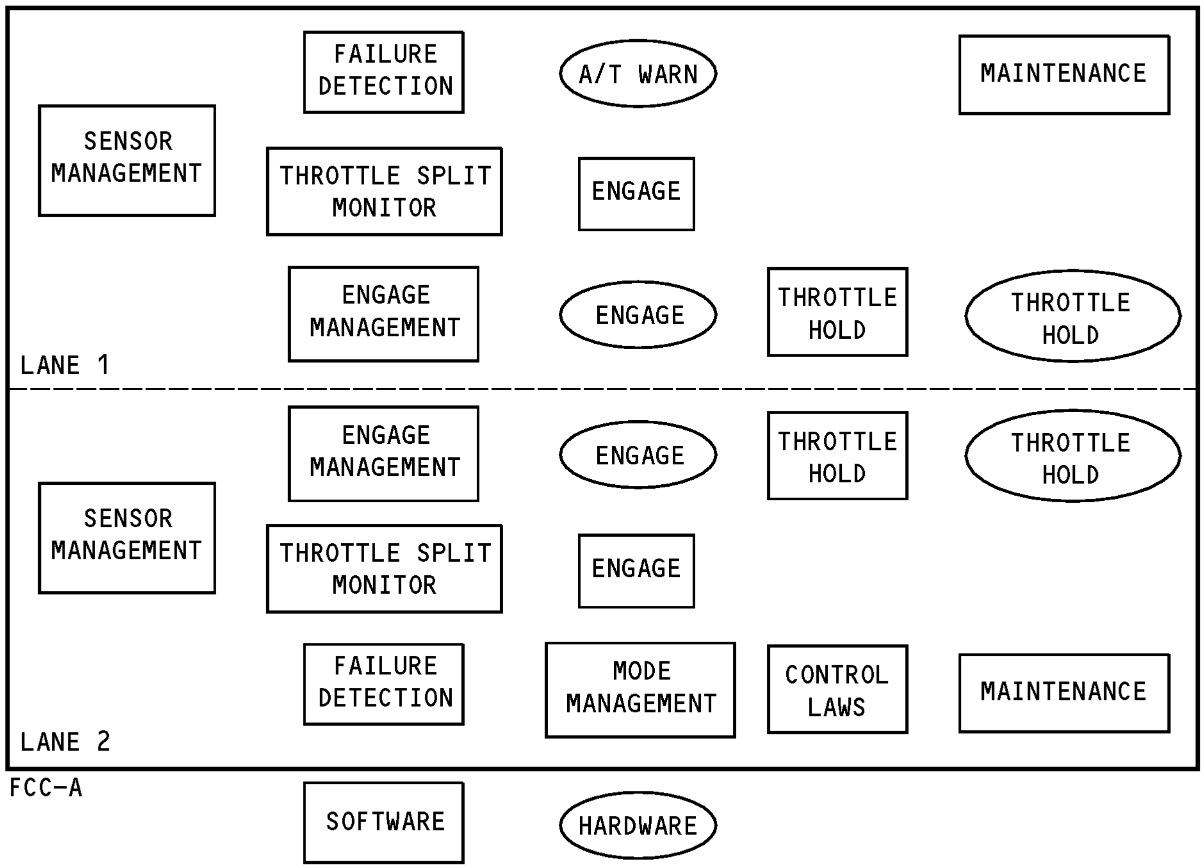
General

The autothrottle function in flight control computer A (FCC A) takes inputs from many systems to calculate the thrust lever commands. The A/T function in the FCC has two lanes.

Lane 1 has the autothrottle warning monitor function. Lane 2 has the mode management and the control laws functions.

Both lanes have throttle split monitors, engage, throttle hold, failure detetction, and maintenance functions.

The throttle split monitor is active in approach and cruise. In cruise this monitor provides protection against a lane 2 failure that might simultaneously command a throttle split and a hard rollover.



A/T SYSTEM - FLIGHT CONTROL COMPUTER - FUNCTIONAL DESCRIPTION

A/T SYSTEM - A/T SERVO MOTOR

General

HAP 001-013, 015-026, 028-030

The A/T servo motors (ASMs) receive commands from the A/T computer. The ASMs use these commands to individually move the thrust levers forward or aft through two separate gear box assemblies. Each thrust lever has its own servo motor and gear box.

HAP 031-054, 101-999

The A/T servo motors (ASMs) receive commands from the A/T function in flight control computer A (FCC A). The ASMs use these commands to individually move the thrust levers forward or aft through two separate gear box assemblies. Each thrust lever has its own servo motor and gear box.

HAP ALL

Physical Description

An ASM assembly weighs about 2 pounds and measures 3 inches by 3.3 inches by 3.5 inches. An electrical connector at the front of the ASM supplies the interface to other aircraft components. An output shaft at the rear joins the ASM to a gearbox.

Operation

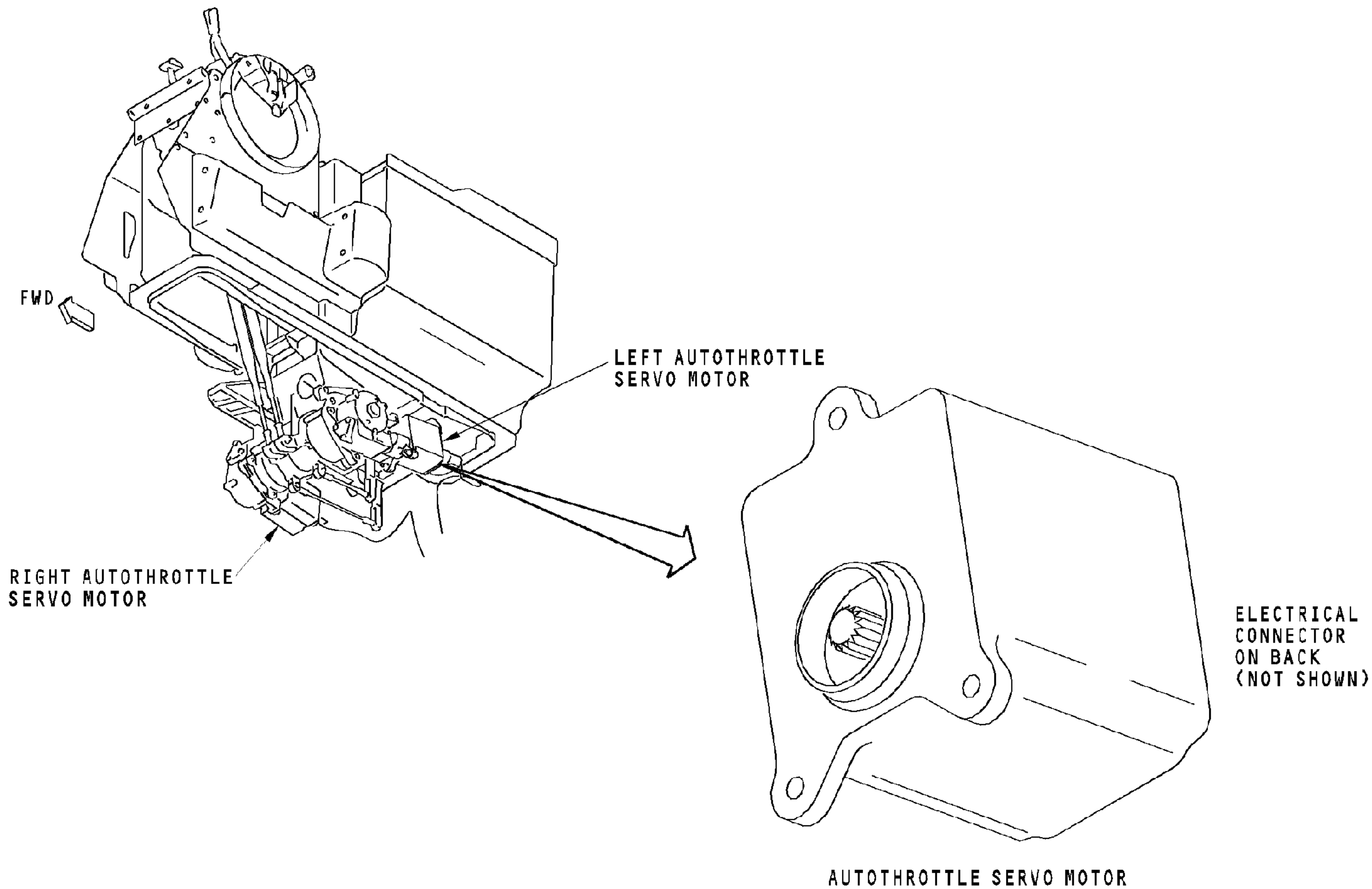
The ASM consists of these components:

- Control unit
- Digital receiver
- Digital transmitter
- Motor
- Power supply.

The A/T sends thrust rate commands to the ASM. The ASM uses this rate command to control the dc motor rotation. The ASM connects an output shaft to a gearbox and sends rate feedback to the A/T.

Training Information Point

A built-in test (BITE) program in the A/T does a check of the ASM operation. If BITE finds a fault, the A/T records the fault in its memory. The technician uses the FMCS CDUs to see the results of A/T BITE. The technician also uses A/T BITE to check system operation.



A/T SYSTEM - A/T SERVO MOTOR

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A/T SYSTEM - A/T SERVO MOTOR - FUNCTIONAL DESCRIPTION

General

HAP 001-013, 015-026, 028-030

The autothrottle servo motor (ASM) receives digital, analog discrete inputs, and power from the A/T computer. The ASM uses these inputs to control a motor which moves the thrust levers.

HAP 031-054, 101-999

The autothrottle servo motor (ASM) receives digital, analog discrete inputs, and power from the A/T function in flight control computer A (FCC A). The ASM uses these inputs to control a motor which moves the thrust levers.

HAP ALL

The ASM has these components:

- ARINC 429 receiver and transmitter
- Control unit
- Motor
- Power supply.

ARINC 429 Receiver

The A/T sends these signals to the ARINC 429 receiver:

- Thrust rate command
- Thrust resolver angle (TRA) selection
- TRA maximum limit.

The ARINC 429 receiver changes these signals to the proper format then sends them to the control unit.

ARINC 429 Transmitter

The ARINC 429 transmitter changes the control unit data to the proper format, and sends these signals to the A/T:

- Measured rate
- Measured torque
- Servo status.

Control Unit

The control unit receives these inputs:

- Installation programing pins
- Logic power
- Data from the digital receiver
- Rate feedback from the motor.

Using these inputs, the control unit does these:

- Decides when to send the motor rate command
- Controls how fast and what direction the motor turns
- Limits the thrust lever angle below the maximum
- Decides the installation position (right or left).

A/T SYSTEM - A/T SERVO MOTOR - FUNCTIONAL DESCRIPTION

Motor

The motor is a reversible DC stepper motor. It receives motor power from the A/T when the A/T is engaged. It also receives rate command from the control unit to control the motor rotation.

The motor sends rate feedback to the control unit. The motor has an output shaft which connects to a gearbox. The gearbox sets the thrust lever and the thrust lever angle resolver to the desired position.

Power Supply

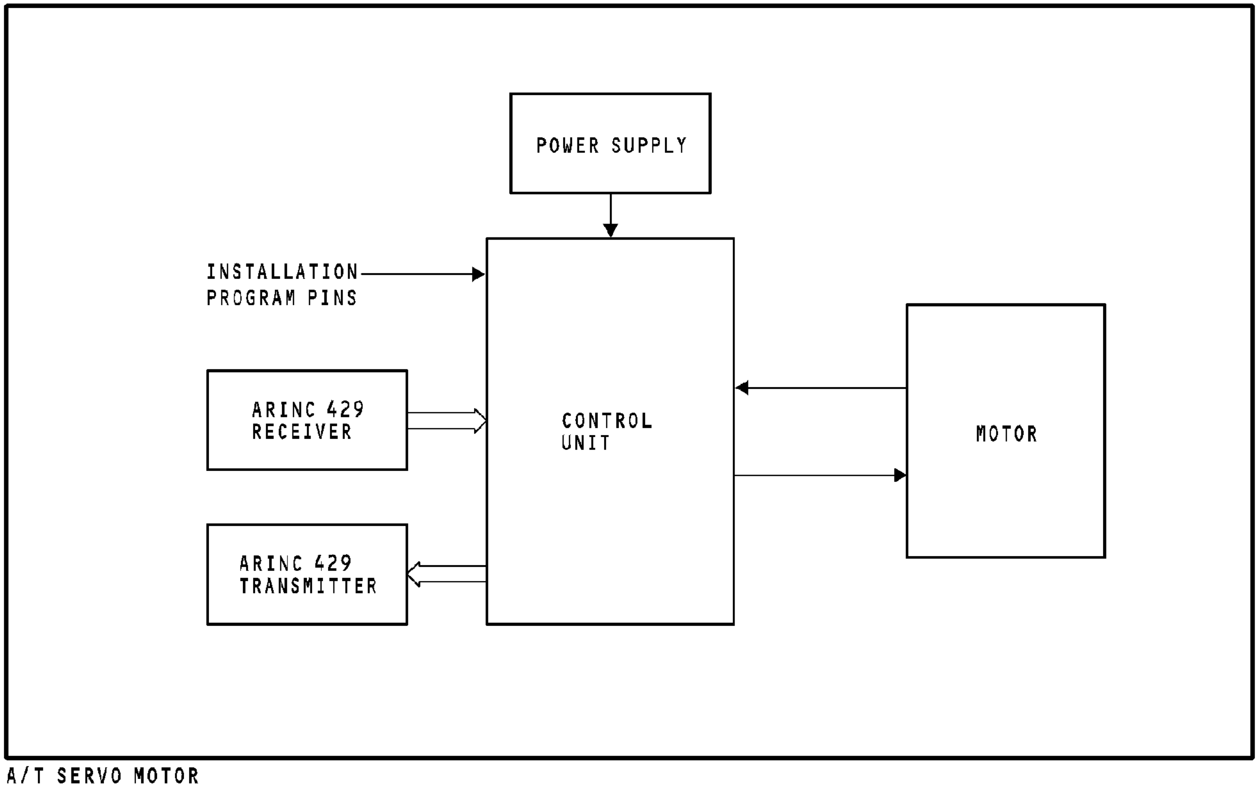
HAP 001-013, 015-026, 028-030

The power supply gets 28v dc from the A/T computer. It supplies the necessary power to the control unit.

HAP 031-054, 101-999

The power supply gets 28v dc from the A/T function in FCC A. It supplies the necessary power to the control unit.

HAP ALL



A/T SYSTEM - A/T SERVO MOTOR - FUNCTIONAL DESCRIPTION

A/T SYSTEM - ARM, MODE SELECT, AND THRUST LEVER SWITCHES

General

Switches on the mode control panel (MCP) and the thrust levers select or disconnect the A/T modes.

MCP A/T Arm Switch

The A/T arm switch is on the MCP. The A/T arm switch engages the A/T system.

When you put the switch in the arm position, the green A/T arm light comes on. An engage solenoid holds the switch in the arm position if conditions are valid. The switch goes to OFF automatically if the A/T senses a problem.

You can also manually disengage the A/T when you put the A/T arm switch to OFF.

MCP A/T Mode Select Switches

The MCP has these A/T mode select switches:

- N1
- Speed.

These mode select switches are lighted. In normal operation, the DFCS automatically chooses the mode. The DFCS turns on the mode selector switch light when that mode is chosen. When a switch light is on, you can cancel that the mode by a push of the switch.

When the autopilot and flight director are off, push on the desired mode select switch to select an A/T mode. Push the active switch to turn off the mode.

Thrust Lever Switches

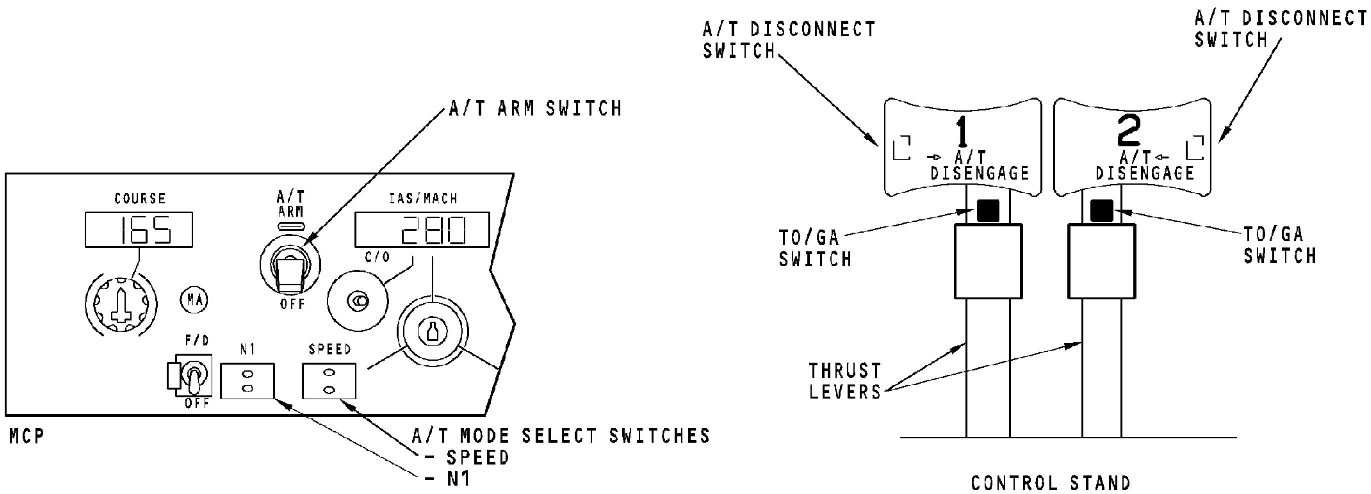
These switches are on the left and right thrust levers:

- TO/GA switches
- A/T disconnect switches.

Push the TO/GA switch to engage the DFCS and the autothrottle to either the takeoff or go-around mode. On the ground, both systems will go to the takeoff mode when you push the switch. During takeoff, the A/T system causes the engine thrust to increase to the takeoff (TO) N1 .

When you push the TO/GA switch during approach, the A/T system increases engine thrusts to a go-around (GA) thrust mode setting. This level of thrust is less than the maximum GA thrust. The engine thrust increases to the full GA thrust limit when you push the TO/GA switch a second time.

Push an A/T disconnect switch to disengage the autothrottle system. The ASA A/T red warning light flashes and the MCP A/T arm switch goes to OFF. Push an A/T disconnect switch a second time to reset the A/T warning.



A/T SYSTEM - ARM, MODE SELECT, AND THRUST LEVER SWITCHES

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A/T SYSTEM - FUNCTIONAL DESCRIPTION - ENGAGE LOGIC

General

HAP 001-013, 015-026, 028-030

The A/T computer does checks of the sensors and A/T system performance. Input data comes in on data buses to the A/T computer. If the system operation and sensors are normal, the engage logic lets the A/T engage.

HAP 031-054, 101-999

The A/T function in flight control computer A (FCC A) does checks of the sensors and A/T system performance. Input data comes in on data buses to the A/T. If the system operation and sensors are normal, the engage logic lets the A/T engage.

HAP ALL

The A/T system uses a hardware and a software monitor. If these monitors finds a problem, the system disengages. The engage logic disengages the A/T if one of these conditions occur:

- An invalid sensor or A/T system condition
- Airplane on the ground after the flight is complete
- Disengage signal from a disengage switch.

When the A/T disengages, a warning circuit starts the A/T flashing warning lights on the ASAs.

Hardware Monitor

The hardware monitor looks at the CPU cycle time and the thrust resolver angles (TRAs). If it senses a problem, it disengages the A/T.

The hardware monitor compares the TRAs for a thrust lever split condition. If both autopilots are in autoland and the A/T rapidly commands a difference of 10 degrees between the two thrust levers, the A/T disengages. This 10 degree difference is from the steady state thrust lever split value. The A/T permits a steady state split angle to let you operate with engine intermix.

Software Monitor

The software monitor uses software logic to permit system engagement. The software monitor does checks for these conditions:

- Normal operation of programmable read only memory (PROM), CPU, RAM, and timing
- Normal thrust lever positions with no thrust lever split in autoland and in cruise
- Invalid sensor conditions for the active mode
- Landing condition.

The software monitor disconnects the A/T if it senses a problem with the A/T, thrust lever split, or with the sensors. It also automatically disconnects the A/T when the airplane makes a landing.

A/T SYSTEM - FUNCTIONAL DESCRIPTION - ENGAGE LOGIC

The software monitor does a check of the TRAs and engine thrust from the EEC for thrust lever split. A rapid A/T command which produces a 10 degree difference between the two thrust levers disengages the A/T. While in cruise, engine thrust differential of 2,000 pounds also disconnects the A/T.

A/T Warning

The red A/T warning lights on the ASAs come on when the A/T disconnects or when the A/T is in BITE. The A/T warning flashes if the A/T disconnects and is steady while in BITE.

The A/T warning flasher latches on when the A/T disconnects. The flasher resets when you do one of these:

- Re-engage the A/T
- Push a disengage switch
- Push an A/T warning light.

HAP ALL; AIRPLANES WITHOUT FCC COLLINS SOFTWARE P/N 831-5854-140

The flasher does come on when the autothrottle disenages automatically during landing.

HAP 031-054, 101-999; AIRPLANES WITH COLLINS FCC SOFTWARE P/N 831-5854-140

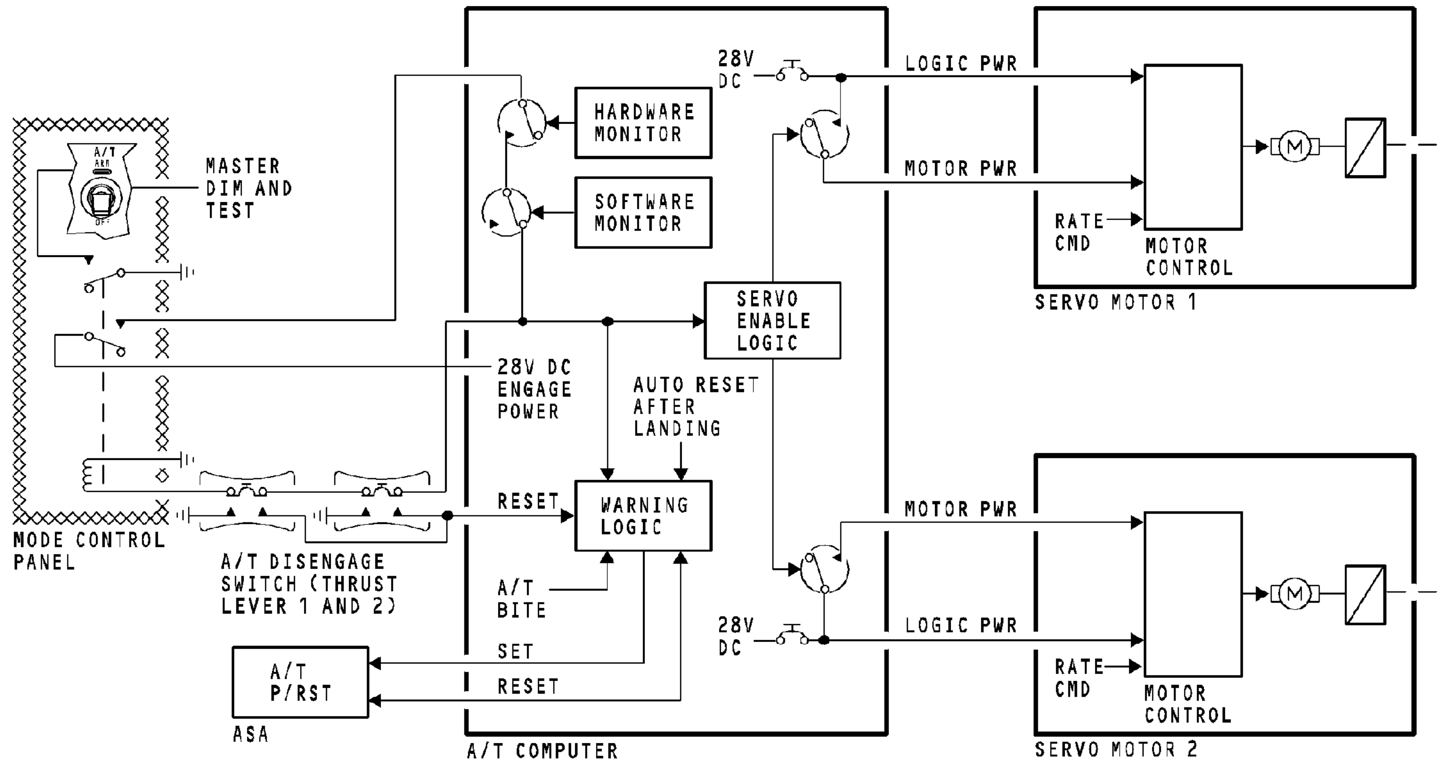
The flasher does not come on when the autothrottle disenages automatically during landing.

HAP ALL

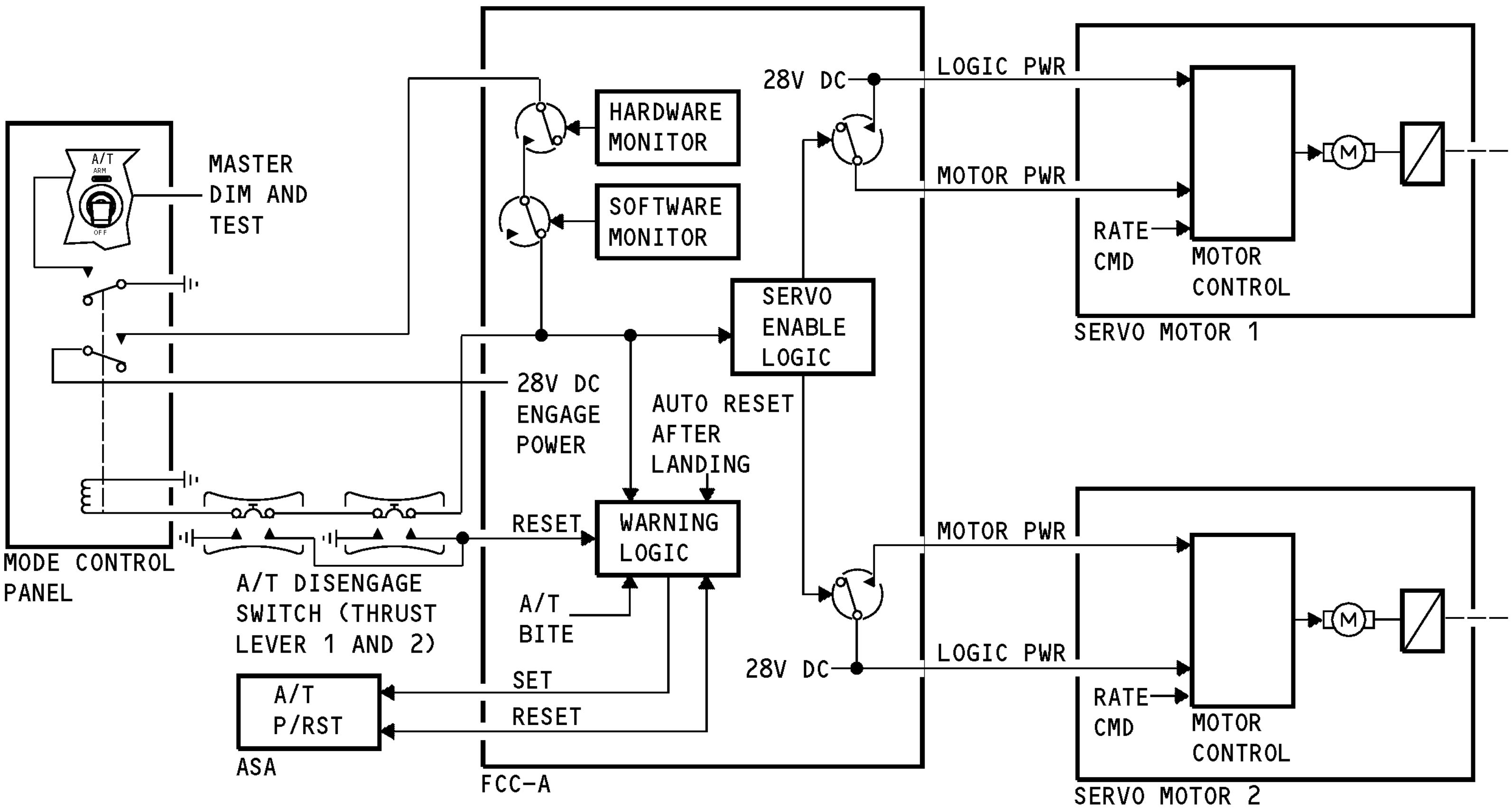
ASM Motor Power

The A/T sends 28v dc to the autothrottle servo motors if all these conditions are true:

- Not in throttle hold
- Not in cutout (disengage switch not pressed)
- A/T is engaged.



A/T SYSTEM - FUNCTIONAL DESCRIPTION - ENGAGE LOGIC



A/T SYSTEM - FUNCTIONAL DESCRIPTION - ENGAGE LOGIC

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A/T SYSTEM - FUNCTIONAL DESCRIPTION - MODE SELECTION

General

HAP 001-013, 015-026, 028-030

The A/T computer receives digital and analog data from different systems and sensors to determine operational modes. This data comes into the A/T computer through the input devices.

HAP 031-054, 101-999

The A/T function in FCC A receives digital and analog data from different systems and sensors to determine operational modes. This data comes into the A/T through the input devices.

HAP ALL

The A/T has two primary modes of operation, speed control and N1 control. These are the only two A/T modes that are selectable on the MCP. Depending on the flight phase and mode selected, the A/T can enter these additional modes:

- Arm
- Retard
- Throttle hold
- Go-around
- Test (on the ground).

After the A/T enters a mode, it puts mode selection data on the general ARINC output bus. These systems use the mode selection data:

- DEUs to show A/T modes
- FDAU for data download and storage to the FDR
- FCCs for A/T mode status.

The A/T controls power to the ASMs. The A/T removes power from the ASMs during throttle hold mode operation during takeoff.

This section discusses each A/T mode of operation.

N1 Mode

The N1 mode is used during these flight phases:

- Takeoff
- Climb
- Maximum thrust go-around.

In N1 mode, the A/T controls thrust to the EEC TRA target, calculated by the EEC for the equivalent FMC N1 target. The N1 mode can be selected in these four ways:

- Pilot manually selects N1 mode from the MCP
- DFCS requests N1 mode when DFCS is engaged
- TO/GA switch is pushed for takeoff (on ground)
- TO/GA switch is pushed a second time during reduced thrust go-around (in the air).

When DFCS is engaged in VNAV climb or LVL CHG climb, the FCCs command the A/T to N1 mode. When the DFCS is not engaged, the pilot can push the N1 selector switch on the MCP to manually select the N1 mode.

Throttle Hold Mode

The throttle hold mode is automatic and the A/T goes into this mode during the takeoff ground roll. In this mode, the A/T removes power to the ASMs to prevent the A/T from moving the T/Ls during the takeoff roll and initial climbout. The A/T uses two separate functions to remove power from the ASMs. One is a software function and the other is a hardware function. When both throttle hold functions agree and remove power to the servos, the A/T mode shows THR HLD on the FMA.

Arm Mode

ARM mode means that no active A/T mode has been selected. In the ARM mode, the A/T is enabled and ready to receive commands. The ASMs are powered but the A/T control logic prevents the servo motors from moving the throttles. The A/T goes to ARM mode during these conditions:

- On the ground when A/T is armed during preflight
- After THR HOLD mode above 800 feet barometric alt
- During Descent RETARD when T/Ls reach aft stops.

Speed Mode

HAP 001-013, 015-026, 028-030

In the speed mode, the A/T controls engine thrust to control airplane speed. It does this by comparing the actual computed airspeed (CAS) from the ADIRU, to the target speed from the MCP. These are the two A/T Speed modes:

HAP 031-054, 101-999

In the speed mode, the A/T controls engine thrust to control airplane speed. It does this by comparing the actual computed airspeed (CAS) from the ADIRU, to the target speed from the MCP or the FMC. These are the two A/T Speed modes:

HAP ALL

- FMC SPD from the FMC target speed
- MCP SPD from the speed selected on the MCP.

In FMC SPD mode, the A/T controls thrust to control airplane speed to the FMC flight plan target speed. When the A/T is in MCP SPD mode, it controls thrust to control airplane speed to the target speed selected on the MCP.

The A/T Speed mode can be selected automatically or manually. If the DFCS is engaged, the DFCS selects the A/T speed mode automatically, either FMC SPD or MCP SPD, consistent with the active DFCS pitch mode. A/T MCP SPD mode may also be selected manually by a push of the A/T speed mode selector switch on the MCP.

Retard Mode

In the RETARD mode, the A/T moves the T/Ls to the aft stops. These are the two retard modes.

- Descent RETARD
- Flare RETARD.

A/T SYSTEM - FUNCTIONAL DESCRIPTION - MODE SELECTION

Descent RETARD occurs during descent from altitude. Flare RETARD occurs during flare to landing. Both modes show as RETARD on the FMA on CDS.

Descent RETARD occurs during DFCS VNAV SPD decent, or when LVL CHG descent is selected on the MCP. During DFCS VNAV SPD descent, the A/T usually starts to retard the T/Ls to idle at the FMC top of descent (TOD) point. When the T/Ls get to the aft stops, the A/T mode changes from RETARD to ARM. The A/T stays in the ARM mode until a new mode is selected.

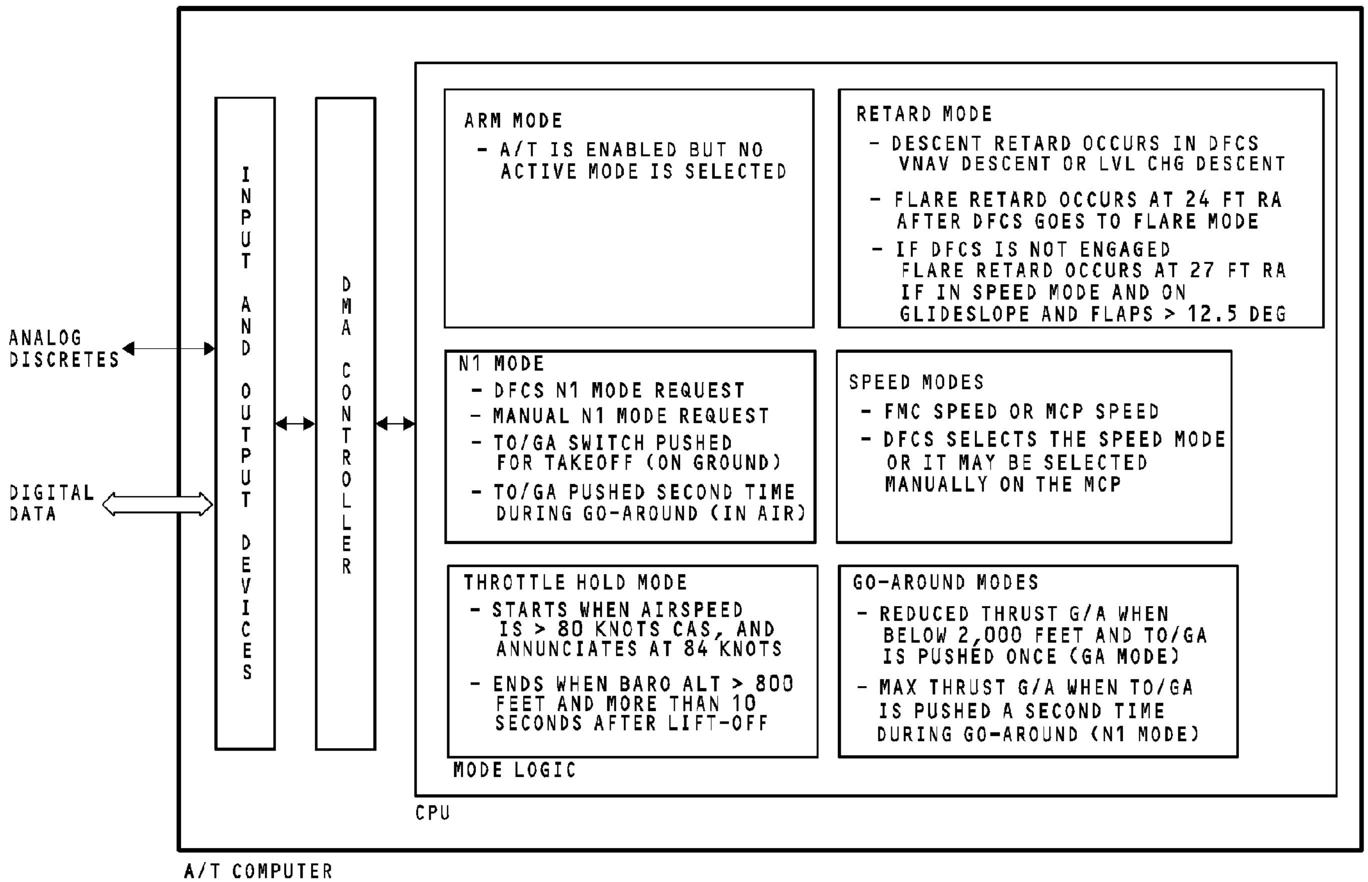
Flare RETARD occurs during landing flare. During flare retard, the A/T retards the T/Ls to idle and RETARD shows on the FMA. The T/Ls move back to the aft stops as the airplane flares for landing and touchdown. The A/T disengages 2 seconds after touchdown.

Go-Around Mode

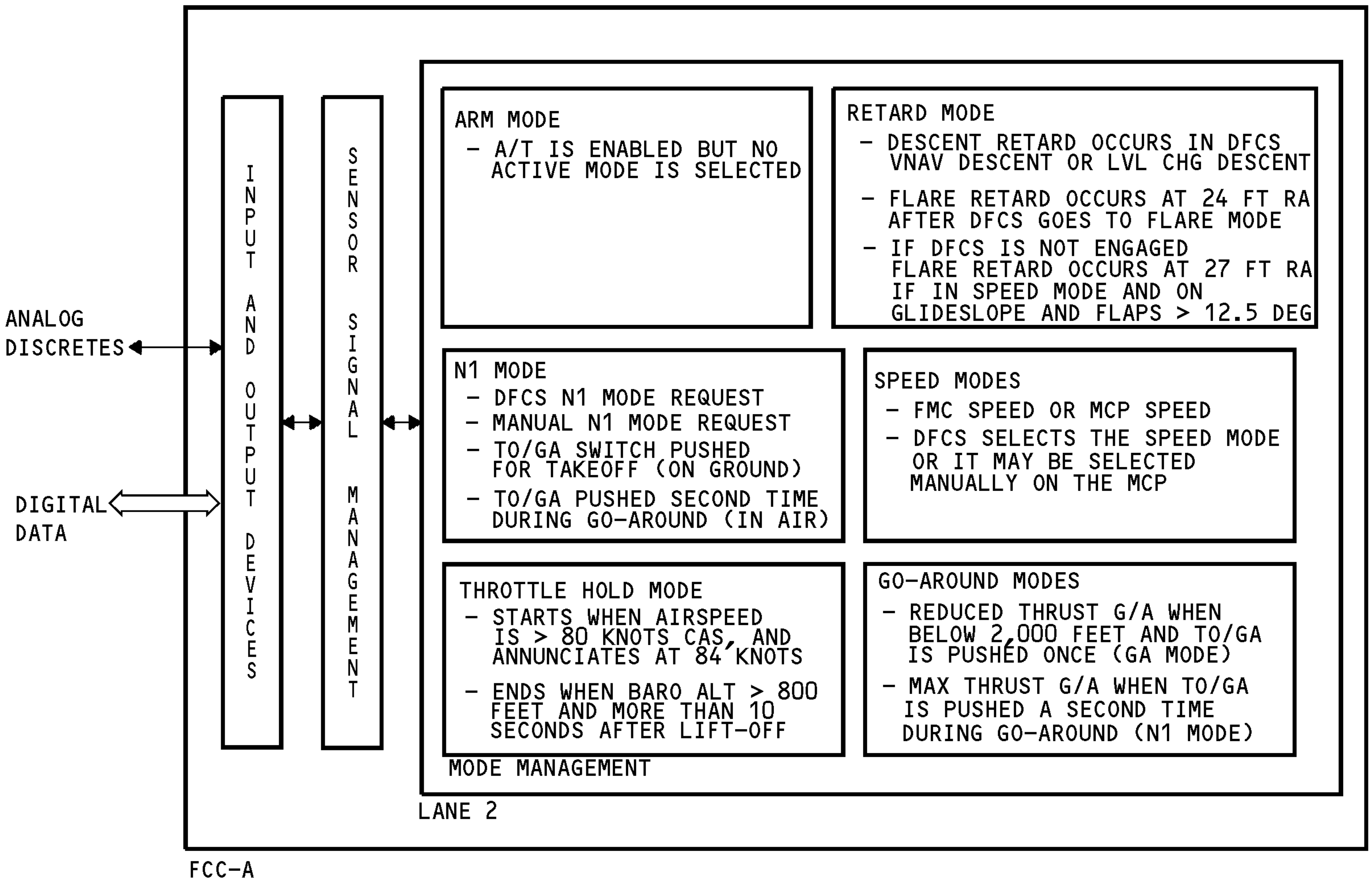
During approach when you push a TO/GA switch once, the A/T commands a reduced thrust go-around. The A/T mode on the FMA shows GA.

During go-around, if you push a TO/GA switch a second time, the A/T commands maximum thrust go-around to the FMC go-around N1 limit. The A/T mode on the FMA changes from GA to N1.

The go-around mode resets if the N1 or the speed mode is selected on the MCP.



A/T SYSTEM - FUNCTIONAL DESCRIPTION - MODE SELECTION



A/T SYSTEM - FUNCTIONAL DESCRIPTION - MODE SELECTION

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A/T SYSTEM - FUNCTIONAL DESCRIPTION - COMMAND CALCULATION

General

The autothrottle (A/T) receives digital data from many airplane systems to calculate thrust lever commands. The A/T calculates rate commands for the servo motors to set thrust for each mode of operation. The two primary A/T operational modes are the N1 mode and speed mode. Other A/T modes are ARM, RETARD, GA and THR HLD.

Arm

When the A/T is engaged, it is in ARM mode unless one of these modes are selected or are active:

- N1
- Speed
- Throttle Hold
- Retard.

The A/T goes into the ARM mode during takeoff after THR HOLD mode and during descent retard after RETARD mode when the T/Ls get to the aft stops.

Throttle Hold

The A/T uses these inputs during takeoff while in throttle hold mode:

- Computed airspeed
- Barometric corrected altitude
- Air/ground input.

The A/T goes into the throttle hold mode during the takeoff ground roll when computed airspeed is 80 knots. THR HLD mode annunciates on the FMA at 84 knots. In the THR HLD mode, the T/Ls remain at the takeoff N1 setting and the pilot may move the T/Ls if desired. The A/T stays in throttle hold mode until both of these conditions occur:

- Barometric altitude is 800 feet AGL
- 10 seconds after lift-off.

After takeoff is complete, the A/T changes from THR HLD to ARM mode. The A/T stays in the ARM mode until the N1 or speed mode is selected.

N1

The N1 mode is used during takeoff, climb and maximum thrust go-around. In the N1 mode, the A/T uses these inputs:

- Target N1 (FMC)
- N1 command (EEC)
- TRA target (EEC)
- TRA actual (EEC)
- TRA for N1 max (EEC).

A/T SYSTEM - FUNCTIONAL DESCRIPTION - COMMAND CALCULATION

In the N1 mode, to set thrust, the A/T uses EEC TRA targets. The EECs receive N1 targets from the FMC and calculate an equivalent TRA target and send these to the A/T. Using these EEC TRA targets, the A/T sends rate commands to the ASMs and TR packs to set thrust. Actual TRA data is transmitted from the TR packs to the EECs. The EECs compare this with the actual thrust set on the engines to provide feedback to the A/T. The EECs calculate a maximum TRA target to make sure the engine limits are not exceeded.

For takeoff and maximum thrust go-around only, the A/T uses FMC N1 targets with EEC TRA targets for more precise thrust control to the FMC N1 limit.

In takeoff or go-around, the A/T moves the T/Ls at a rate of 13.5 deg/sec to a predicted position. For final adjustments, the A/T moves the T/Ls at a maximum rate of 5 deg/sec. In modes other than TO/GA, the A/T limits thrust lever rates to 3 deg/sec.

When the A/T is not engaged and the T/Ls are moved manually, TRA data is sent from the TR packs to the EECs to set engine thrust.

Speed

In the speed mode, the A/T uses these inputs:

- Target airspeed
- Target mach
- Computed airspeed
- Mach
- True airspeed
- Longitudinal acceleration
- Minimum operating speed (from SMYD).

In the speed mode, the A/T controls thrust to a target airspeed. The target speed can be either the MCP speed which is the speed selected by the pilot or FMC speed if in DFCS VNAV mode. The A/T compares the target airspeed with the actual airplane speed from the ADIRUs, either CAS or Mach. A difference between the actual and target speed causes a T/L rate command to set thrust.

The A/T compares the minimum operating speed from the SMYD and the computed airspeed from the ADIRU to set a minimum speed floor. The A/T will not allow the speed to go less than the speed floor.

Retard

There are two A/T retard modes, descent RETARD and flare RETARD. They annunciate as RETARD on the FMA.

For descent retard from cruise flight, at FMC top of descent (TOD) the A/T commands the T/Ls to reduce engine thrust to idle. In descent RETARD, the thrust levers move to the aft stops at 1 deg/sec.

Flare RETARD is used during landing flare. For flare retard, the A/T uses these inputs:

A/T SYSTEM - FUNCTIONAL DESCRIPTION - COMMAND CALCULATION

- Speed mode selection
- Flap position
- Radio altitude
- A/P flare.

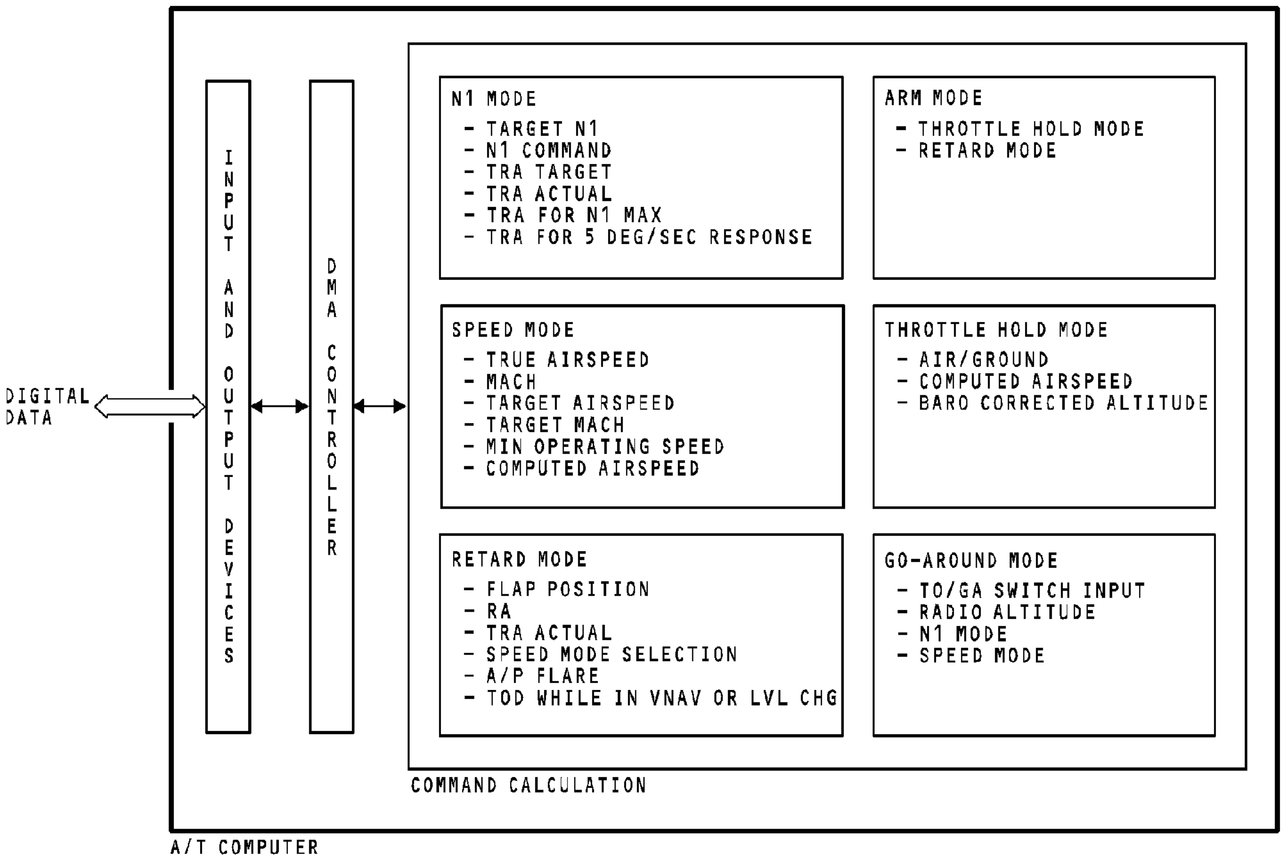
The A/T goes into the flare retard mode during landing if on G/S and in MCP SPD mode. The A/T commands the T/Ls to move to the aft stops at 3 deg/sec. After landing, the T/Ls move to the idle stop at 8 deg/sec. During the flare retard mode, the T/Ls get to idle within 6 seconds.

Go-Around

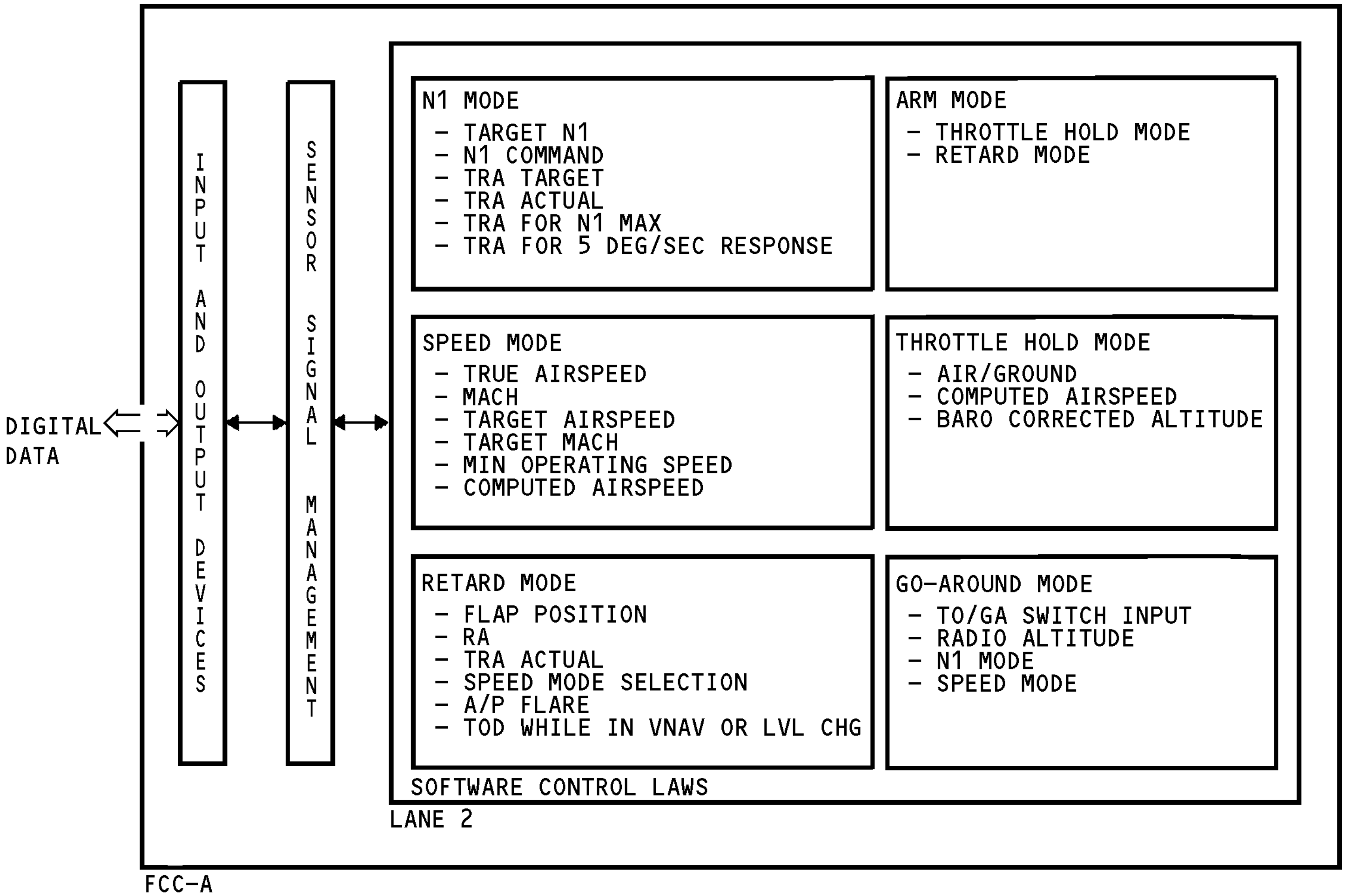
In the go-around mode, the A/T uses these inputs:

- N1 mode
- Speed mode
- TO/GA switch input
- Radio altitude
- Gross weight
- Flap position.

There are two A/T go-around modes, GA and N1. For reduced thrust go-around the A/T uses an internally calculated thrust value to achieve an eight percent climb gradient. For max thrust go-around, the A/T uses FMC N1 targets and EEC TRA targets to set thrust.



A/T SYSTEM - FUNCTIONAL DESCRIPTION - COMMAND CALCULATION



A/T SYSTEM - FUNCTIONAL DESCRIPTION - COMMAND CALCULATION

A/T SYSTEM - OPERATION - FMA

General

A/T modes of operation show on the flight mode annunciation (FMA) at the top of the primary flight display above the ADI.

A/T Modes

The FMA shows these A/T modes:

- ARM
- N1
- THR HLD
- FMC SPD
- MCP SPD
- RETARD
- GA
- TEST.

ARM shows when the A/T system is enabled and is ready to receive commands but no active modes are selected.

N1 shows when the A/T system controls engine thrust to the FMC calculated N1 target during takeoff, climb, or max thrust go-around.

THR HLD shows during takeoff at more than 84 knots. In the throttle hold mode, the A/T removes power from the ASMs. The T/Ls stay at the thrust set for takeoff. When the airplane gains a barometric altitude of 800 feet AGL and ten seconds after liftoff, the A/T restores power to the ASMs and changes to the ARM mode. Above 800 feet, you can select either N1 or speed mode during climb out.

FMC SPD shows when the A/T controls thrust to hold the FMC target speed during DFCS VNAV pitch mode.

MCP SPD shows when the A/T controls thrust to hold the airplane speed you select on the MCP.

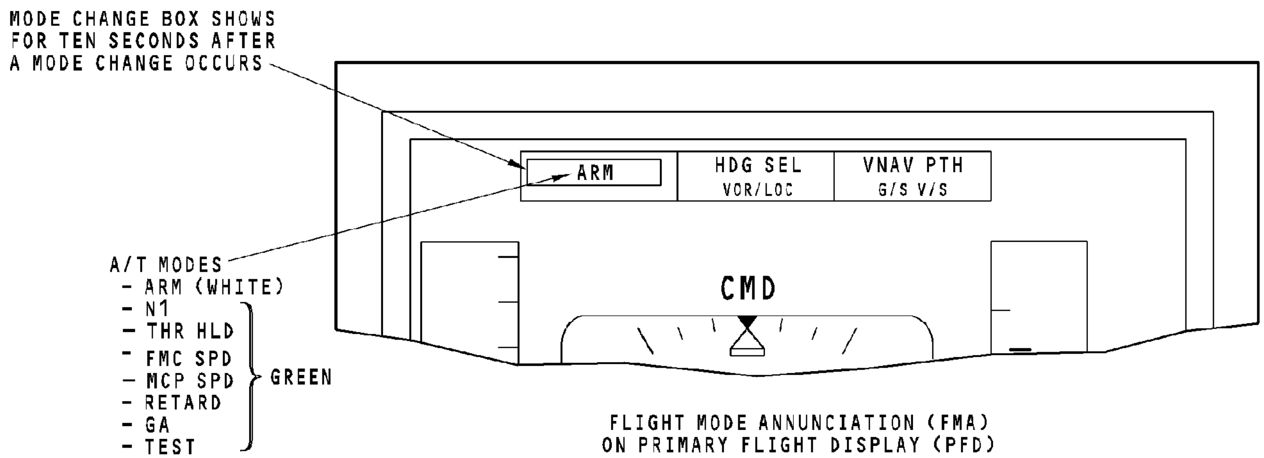
RETARD shows when the A/T moves the thrust levers to the idle stop. This can be either descent retard or flare retard. During descent retard, after the T/Ls reach the idle stops the A/T goes to the ARM mode.

The A/T goes into reduced thrust go-around (GA mode) when you push a TO/GA switch once during the approach. The A/T commands the thrust levers to an internally calculated thrust to achieve a reduced thrust go-around. During go-around when you push a TO/GA switch a second time, the A/T goes into N1 mode and commands the T/ls to set thrust to the FMC N1 limit for go-around.

TEST displays when you enter A/T BITE from the FMC CDU.

A/T SYSTEM - OPERATION - FMA

When there is a mode change, a box shows around the A/T mode on the FMA display for 10 seconds.



A/T SYSTEM - OPERATION - FMA

A/T SYSTEM - ENGINE DISPLAY

General

The upper engine display shows these thrust annunciations that are calculated by the FMC:

- Thrust mode annunciation (TMA)
- Reference N1 cursors on the N1 dials.

Normal Operation

During normal operation, the FMC calculates the engine thrust N1 limits. The FMC sends these to the DEUs to show the reference N1 cursors on the N1 dials on the engine display. During normal operation, the reference N1 displays above the actual N1 box are blank.

The FMC also calculates the thrust modes for each flight phase and sends them to the DEU to show on the TMA at the top of the engine display.

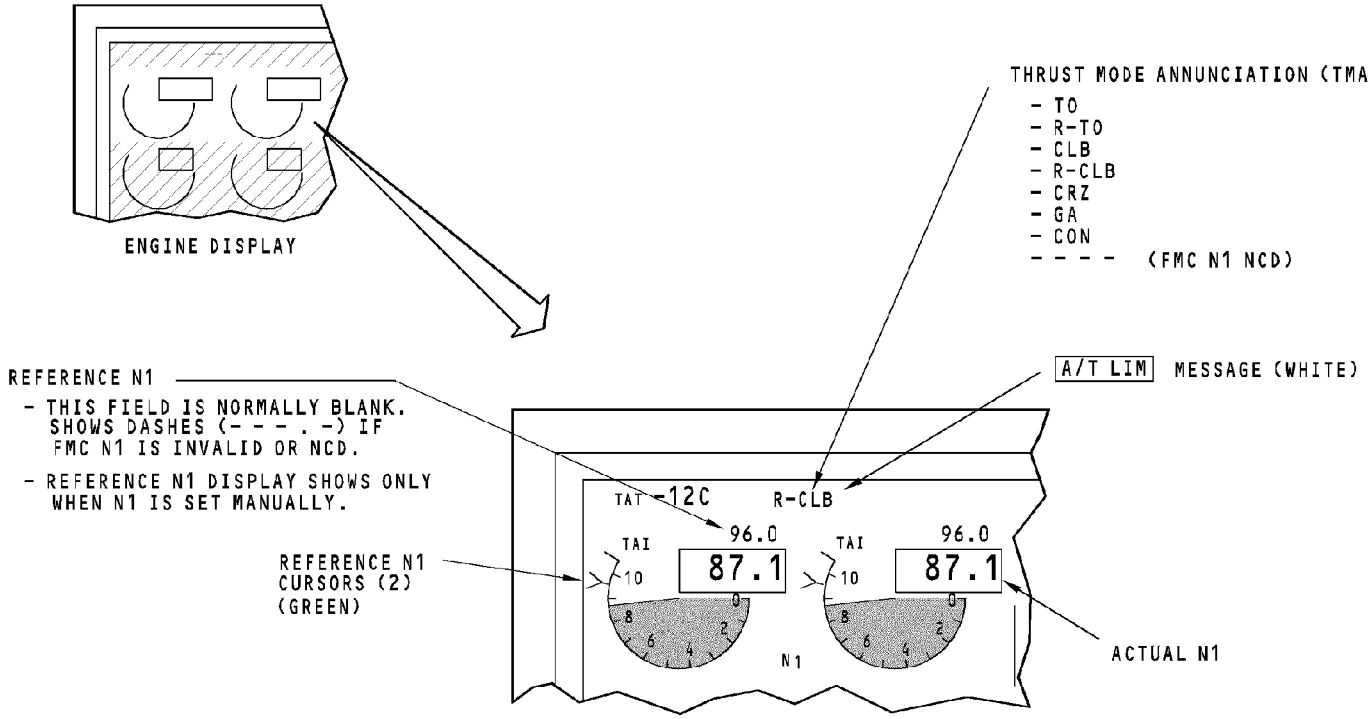
See the flight management computer system section for more information about the thrust mode displays. (SECTION 34-61)

Non-Normal Operation

During non-normal operation when FMC N1 data is invalid or no computed data (NCD), three dashes show on the TMA in place of the FMC thrust modes. The reference N1 displays above the actual N1 box show dashes to show that the reference N1 cursors on the N1 dials are not set by the FMC.

When FMC N1 data is invalid, you can use the N1 set selector on the engine control panel to manually set the reference N1 cursors on the N1 dials. This sets the N1 cursors and shows the selected reference N1 readout digitally above the actual N1 box. The manually set N1 data is for reference only and does not go to any airplane user system.

When FMC N1 data is invalid or NCD, the A/T computer calculates a single N1 limit for both engines. The message A/T LIM shows on the engine display. In this mode, the A/T computer calculates an engine N1 limit for climb, cruise, and go-around, but not for takeoff.



A/T SYSTEM - ENGINE DISPLAY

A/T SYSTEM - OPERATION - OVERVIEW

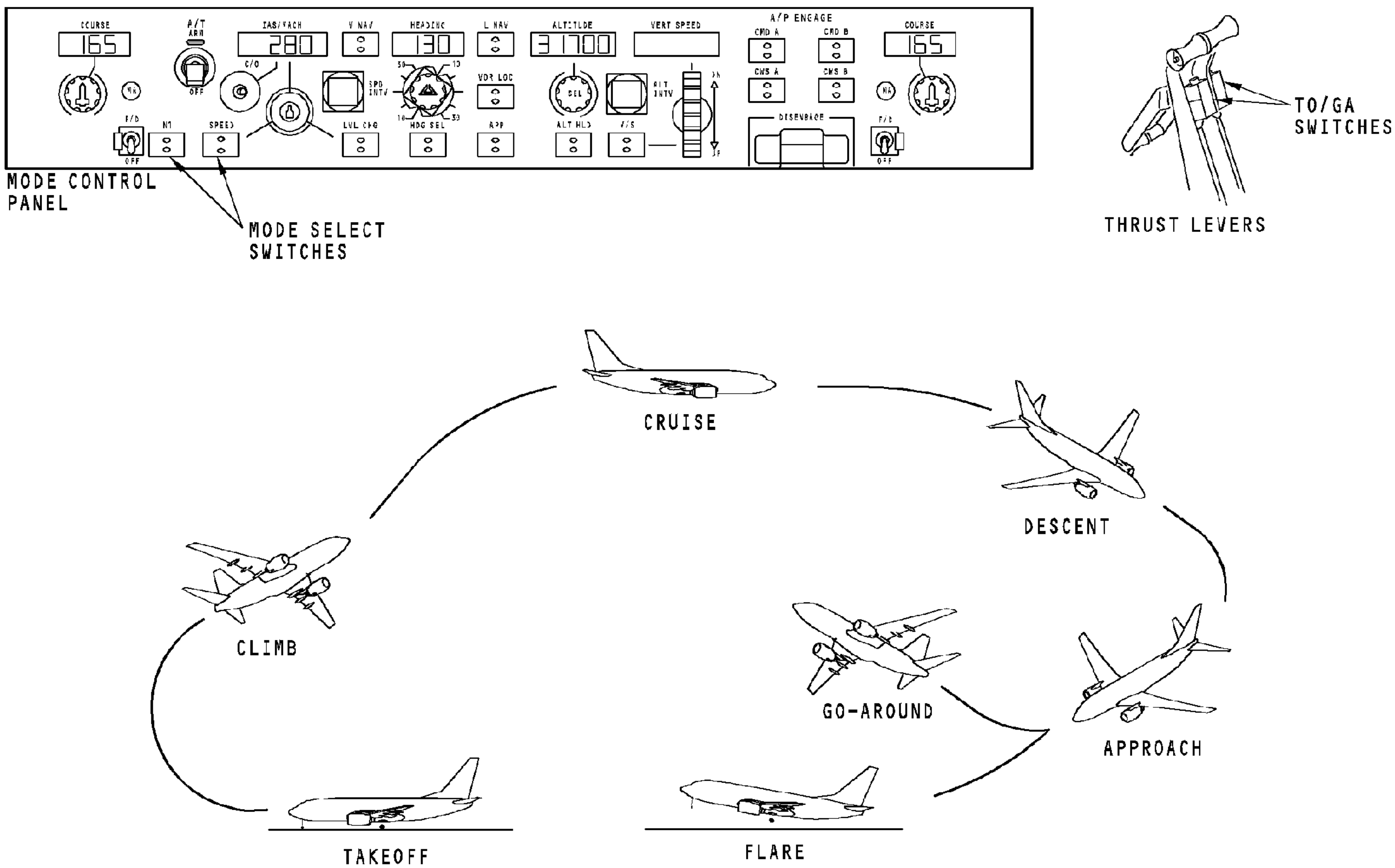
General

The A/T operates on the ground for takeoff, and during flight. The A/T system controls engine thrust for these flight sequences:

- Takeoff
- Climb
- Cruise
- Descent
- Approach
- Flare
- Go-around.

For each flight phase, the A/T N1 or speed modes may be selected from the MCP. If the DFCS is engaged, it selects the A/T mode. The N1 or speed mode select switch light comes on to show the mode is active. When the light is on, a second push removes the mode from active status.

You use the TO/GA switches to start the takeoff or go-around modes.



A/T SYSTEM - OPERATION - OVERVIEW

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A/T SYSTEM - OPERATION - TAKEOFF

General

To prepare the FMS and the A/T for takeoff, you use the FMC CDU to enter the necessary preflight data, and the DFCS MCP to select parameters and set desired modes.

This is the takeoff sequence:

- Preflight
- Takeoff Start
- Takeoff Roll
- Climbout.

Preflight

These are the steps for preflight prior to takeoff:

- To preflight the FMS, enter data on the FMC CDU
- Set the DFCS MCP to takeoff modes and parameters
- Put the A/T arm switch to the ARM position on the MCP.

These are the indications after preflight is complete:

- A/T is in ARM mode
- A/T mode lights are off on the MCP
- TO is the FMC thrust mode
- N1 reference cursors are at FMC takeoff N1 limit.

Takeoff Start

At the start of the takeoff roll, the pilot pushes a TO/GA switch on the thrust levers. The A/T active mode becomes N1 for takeoff, and the A/T moves the thrust levers to the FMC calculated takeoff N1 limit.

These are the indications at the start of takeoff:

- A/T goes to N1 mode
- N1 mode light is OFF
- TO is the FMC thrust mode
- N1 reference cursors are at FMC takeoff N1 limit
- T/Ls move forward to a target TRA for the N1 limit.

Takeoff Roll

As engine thrust and RPM increase to the takeoff N1 limit, the airplane accelerates. When the airspeed gets to 80 kts, the A/T goes in to throttle hold mode. At 84 knots, the A/T mode changes from N1 to THR HLD on the FMA. These are the indications at 84 kts:

- THR HLD shows on the FMA as the active A/T mode
- TO shows on the TMA as the FMC thrust mode
- N1 reference cursors are at FMC takeoff N1 limit.

In throttle hold mode, the A/T removes power from the ASMs and does not command thrust. The T/Ls remain at the target TRA for the takeoff N1 limit. The pilot can control thrust manually if desired.

A/T SYSTEM - OPERATION - TAKEOFF

Climb Out

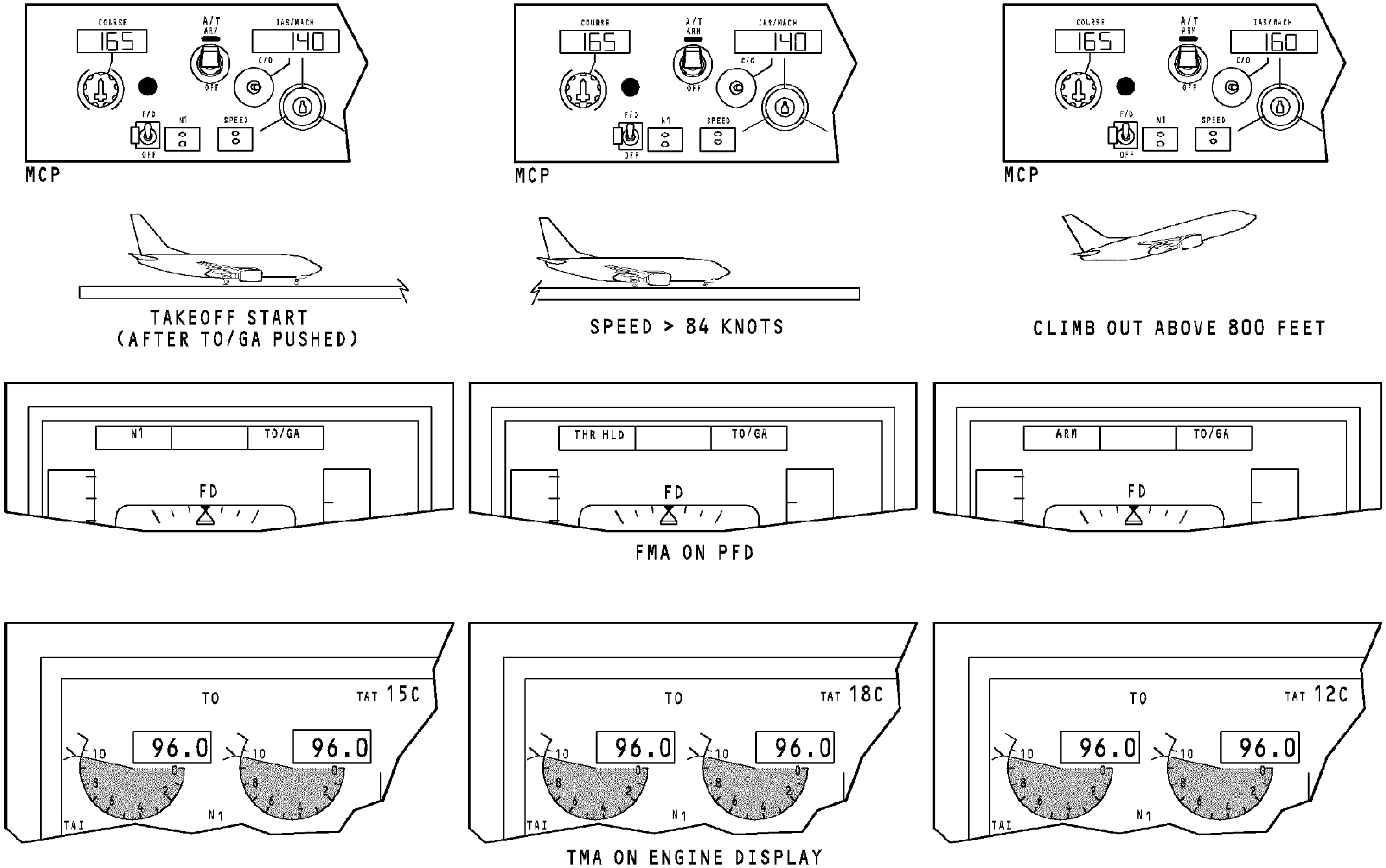
During the initial climb out, above a barometric altitude of 800 feet above field elevation and 10 seconds after liftoff, the A/T mode changes from THR HLD mode to ARM mode. These are the indications:

A/T goes to

- ARM mode
- TO is the FMC thrust mode
- N1 reference cursors are at FMC takeoff N1 limit
- T/Ls remain at target TRA for takeoff N1 limit.

After takeoff is complete, the pilot may select a new A/T mode from the MCP, either N1 or speed mode, when above 800 feet barometric altitude. If DFCS is engaged during climb out, DFCS selects an A/T mode, either N1 or Speed mode, consistent with the DFCS mode selected. During climb out above 800 feet baro altitude, the N1 or Speed mode light may be ON depending on the mode selected.

A/T modes show on the FMA on the primary (outboard) EFIS displays. FMC thrust modes and FMC N1 limits show on the upper engine display.



A/T SYSTEM - OPERATION - TAKEOFF

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A/T SYSTEM - OPERATION - CLIMB

General

During climbout, the A/T controls engine thrust to the A/T mode selected on the DFCS MCP. This may be either N1 or speed mode, depending on what you select, or if the DFCS is engaged, the DFCS selects the A/T mode. During climb in N1 mode, the A/T advances the throttles to the target TRA calculated by the EEC for the FMC climb N1 target.

Initial Climbout

These are the possible DFCS pitch modes for climb:

- Vertical navigation (VNAV SPD)
- Level change (LVL CHG)
- Vertical speed (V/S).

After takeoff, you can engage the A/P above 400 feet radio altitude and select a DFCS pitch mode for climb. The normal pitch mode during climb is VNAV.

During takeoff and initial climbout, the A/T is in throttle hold mode. As the airplane climbs above a barometric altitude of 800 feet and 10 seconds after lift-off, these mode annunciations show:

- A/T goes from THR HLD to ARM mode
- A/T mode lights on the MCP are off
- MCP IAS/MACH window shows the selected speed
- TO is the FMC thrust mode
- N1 ref cursors stay at the FMC takeoff N1 limit
- T/Ls are at target TRA for FMC takeoff N1.

During climbout above 800 feet barometric altitude, you can select an A/T mode such as N1 or speed. If the DFCS is engaged, the DFCS selects an A/T mode consistent with the DFCS pitch mode.

VNAV Climb

Normal climbout is in DFCS VNAV pitch mode. In VNAV, the DFCS selects N1 as the A/T mode. These are the mode annunciations during VNAV climb:

- A/T is in N1 mode
- N1 mode light is ON
- MCP IAS/MACH speed window is blank
- VNAV SPD is the DFCS pitch mode
- CLB is the FMC thrust mode
- N1 ref cursors are at FMC climb N1 limit
- A/T controls T/Ls to a target TRA for FMC climb N1.

During VNAV climb, the A/T controls engine thrust to the FMC climb N1 target. The A/P uses elevators to control airspeed.

LVL CHG Climb

During climb, you can select LVL CHG on the MCP as the DFCS pitch mode and the DFCS will select N1 mode for the A/T. These are the mode annunciations in VNAV climb:

- A/T is in N1 mode
- N1 mode light is ON

A/T SYSTEM - OPERATION - CLIMB

- MCP IAS/MACH window shows the selected speed
- MCP SPD is the DFCS pitch mode (for LVL CHG).

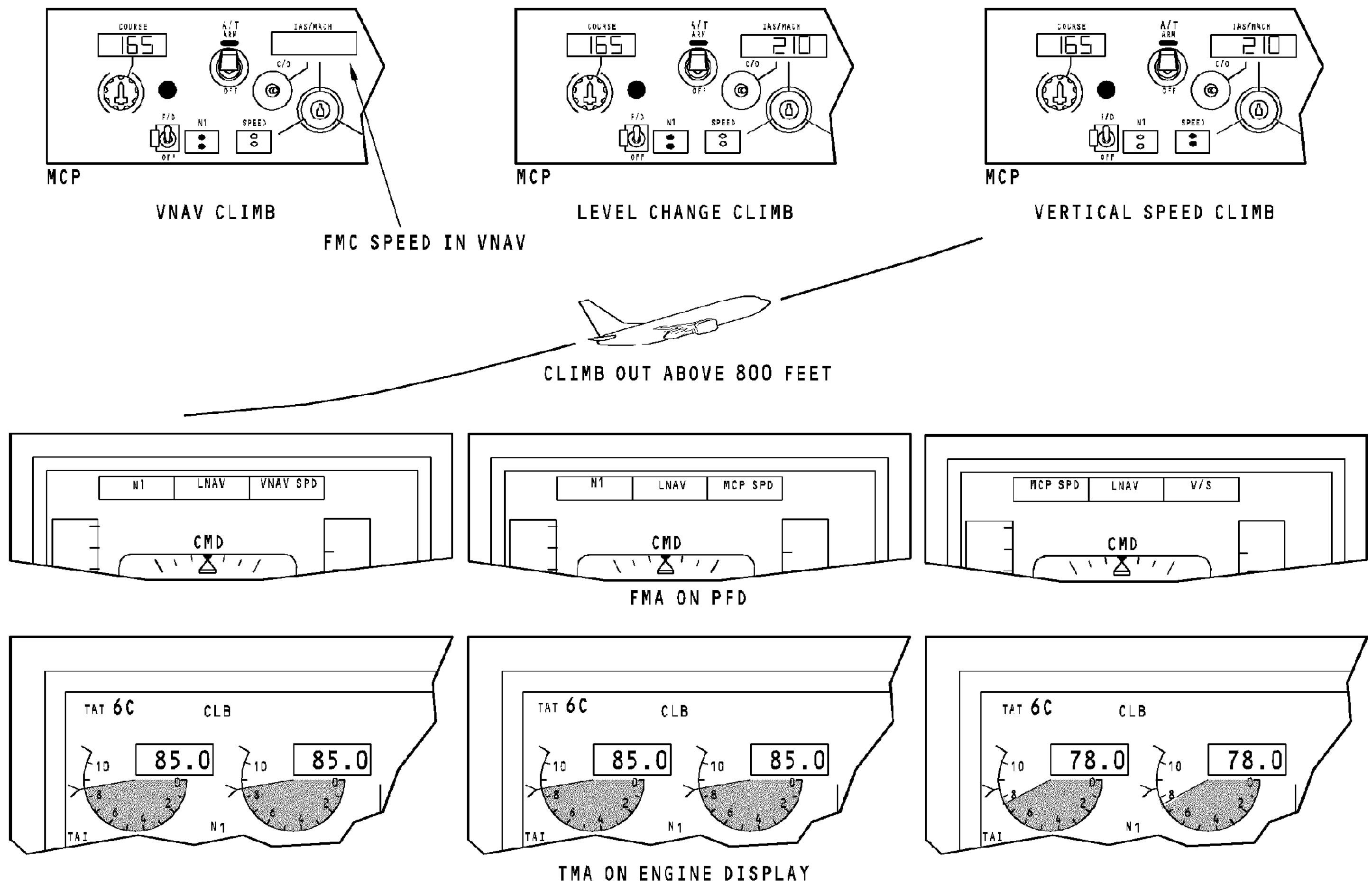
In DFCS LVL CHG climb, the A/T sets thrust to the EEC TRA target. This TRA target is calculated by the EEC for an equivalent FMC climb N1 target.

V/S Climb

During climb-out, you can select V/S as the DFCS pitch mode and set the desired vertical speed. The DFCS will select MCP SPD mode for the A/T. These are the mode annunciations in V/S climb:

- A/T is in MCP SPD mode
- Speed mode light is ON
- MCP IAS/MACH window shows the selected speed
- V/S is the DFCS pitch mode.

During the V/S climb mode, the A/T controls engine thrust to control airspeed to the speed selected on the MCP. The A/P uses the elevator to hold the climb rate to the vertical speed rate selected on the MCP.



A/T SYSTEM - OPERATION - CLIMB

A/T SYSTEM - OPERATION - CRUISE

General

During cruise flight, the A/T controls engine thrust to control airspeed. This may be an FMC target speed or a speed selected on the MCP.

During cruise flight, the normal DFCS pitch mode is VNAV. You can also select altitude hold (ALT HOLD) as the DFCS pitch mode.

VNAV Altitude Acquire/Altitude Hold

During DFCS VNAV climb, the airplane climbs to either the FMC target altitude or to a lower intermediate altitude selected on the MCP. The A/T is in the N1 mode. As the airplane gets near the selected altitude, the DFCS acquires and levels off at the altitude. The A/T goes from the N1 to the FMC SPD mode. These are the annunciations as the airplane levels off:

- A/T goes from N1 to FMC SPD mode
- MCP IAS/MACH window is blank
- DFCS pitch mode is ALT ACQ then ALT HOLD for level off at MCP altitude, or VNV PTH for FMC altitude.

VNAV Cruise

During DFCS VNAV cruise, the A/T is in FMC speed mode. The A/T controls thrust to hold the FMC target airspeed while the autopilot uses the elevators to hold altitude. These are the annunciations during VNAV cruise:

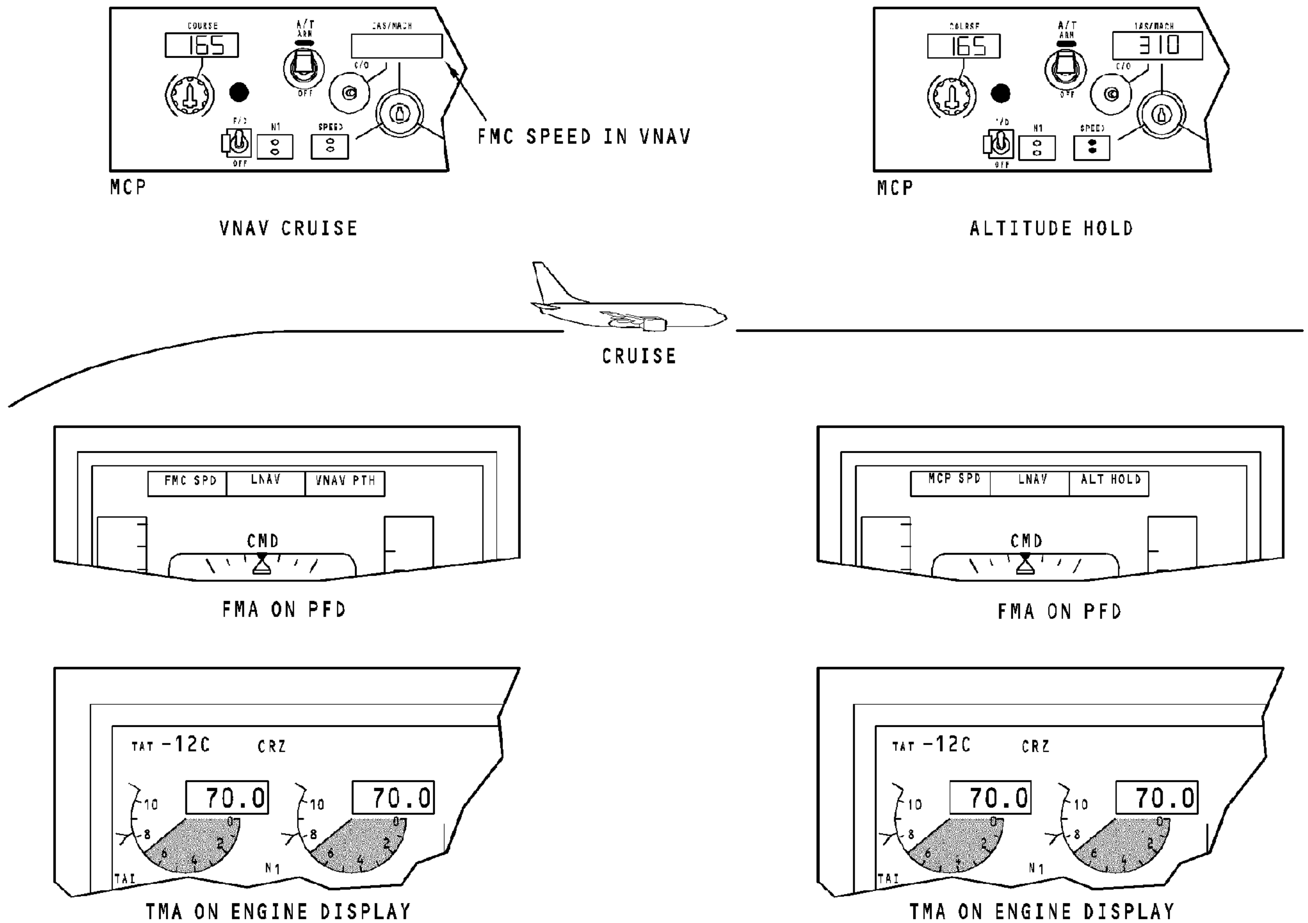
- A/T is in FMC SPD mode
- A/T N1 and Speed mode lights are off on the MCP
- MCP IAS/MACH window is blank
- VNAV PTH is the DFCS pitch mode.

In VNAV cruise, the A/T is in FMC SPD mode and the A/T speed mode switch light on the MCP is off. When the MCP mode switch lights are off, this means that you can not de-select the active mode by a push of the switch. To change the mode you must select a new mode.

ALT HOLD

In the DFCS altitude hold mode (ALT HOLD), the target altitude is the altitude selected on the MCP. During the climb (or descent), as the airplane gets near the MCP selected altitude, DFCS acquires and then holds this altitude. The A/T controls the thrust levers to hold the selected target airspeed on the MCP while the A/P uses the elevators to hold the selected altitude on the MCP. These are the mode annunciations as DFCS acquires and holds the selected altitude in the ALT HOLD mode:

- A/T is in MCP SPD mode
- Speed mode light is ON
- MCP IAS/MACH window shows the selected speed
- ALT ACQ then ALT HOLD is the DFCS pitch mode.



A/T SYSTEM - OPERATION - CRUISE

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A/T SYSTEM - OPERATION - DESCENT

General

During descent, the A/T controls engine thrust to control either the airspeed or descent rate (V/S), depending on the mode selected.

During descent, the A/T normally retards thrust to idle consistent with the DFCS pitch mode selected. The normal DFCS pitch mode during descent is VNAV. The pilot can select other modes. These are the DFCS pitch modes available for descent:

- Vertical navigation (VNAV)
- Level change (LVL CHG)
- Vertical speed (V/S).

VNAV Descent

During DFCS VNAV cruise, when the airplane gets to the FMC calculated top of descent (TOD) point, the A/T moves the T/Ls slowly to the aft stops to retard thrust to idle for descent. These are the mode indications:

- A/T goes from MCP SPD to RETARD to ARM mode
- A/T mode lights are off
- MCP IAS/MACH window is blank (FMC speed)
- VNAV is the DFCS pitch mode.

During DFCS VNAV descent, normally the thrust levers are at idle and the A/T mode is ARM. The DFCS may request an A/T mode change from ARM to FMC SPD mode to increase thrust to hold the FMC target speed or descent rate.

The airplane continues to descend to the FMC or MCP selected altitude. As the DFCS acquires and levels off at the selected altitude, the A/T changes from ARM to FMC SPD mode (if not already in FMC SPD). The A/T controls engine thrust to hold the airspeed to the FMC target speed. The autopilot stays in VNAV and uses the elevators for pitch control to hold the selected altitude.

LVL CHG Descent

LVL CHG can be selected as the DFCS pitch mode for descent (or climb). For descent, the pilot selects a lower target altitude on the MCP and selects LVL CHG. The A/T retards the engine thrust to idle and the airplane descends to the selected altitude. During LVL CHG descent, these are the mode annunciations:

- A/T goes from MCP SPD to RETARD to ARM mode
- A/T mode lights are off
- MCP IAS/MACH window shows the selected airspeed
- MCP SPD is the DFCS pitch mode.

A/T SYSTEM - OPERATION - DESCENT

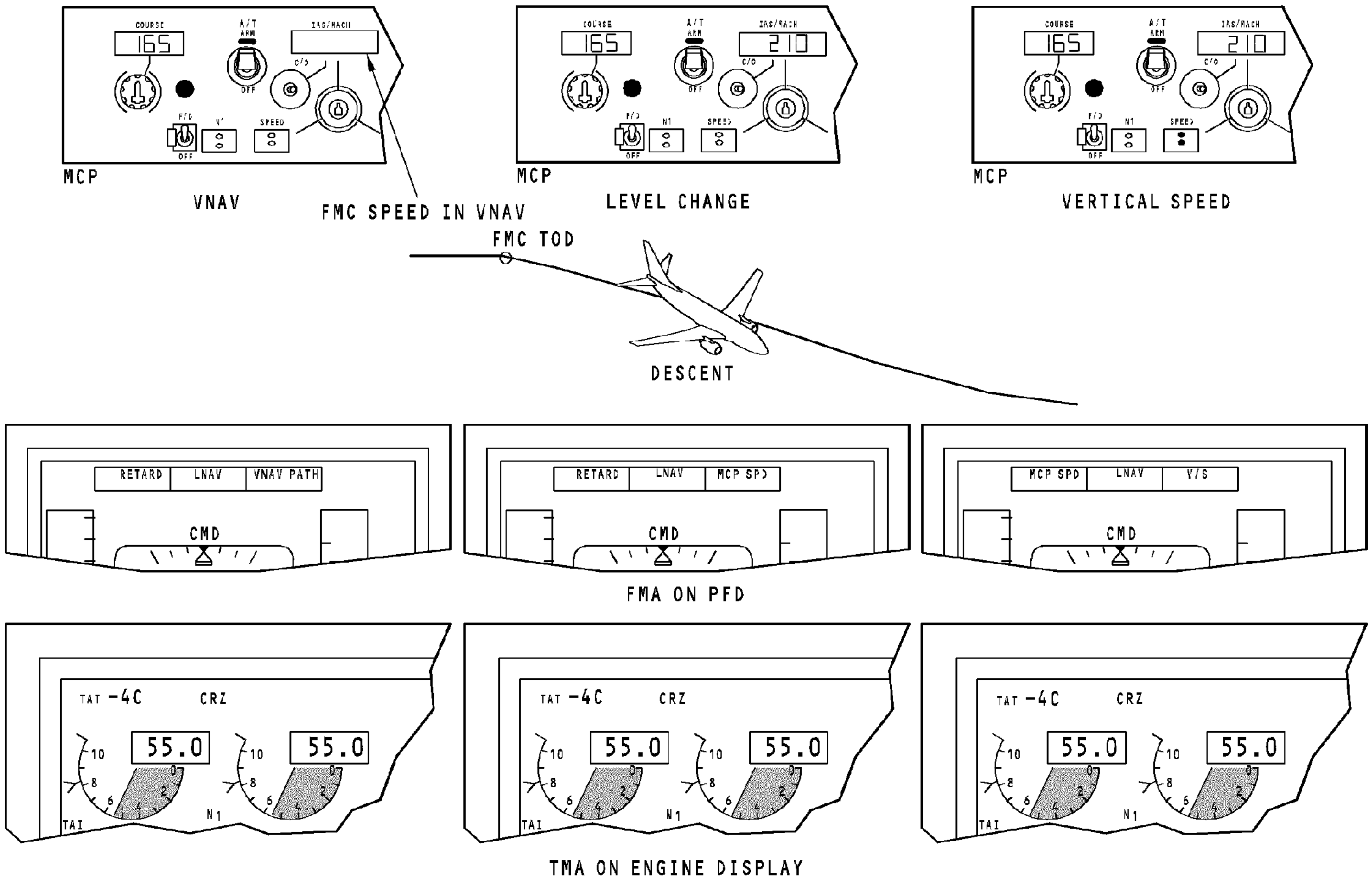
During LVL CHG descent, the A/T sets the thrust to idle, and the DFCS uses the elevators to hold the selected MCP airspeed. The airplane descends to the selected altitude on the MCP. At level-off to this altitude, the A/T engages in speed mode and controls the throttles to provide engine thrust to keep the airplane at the MCP speed. The DFCS changes from LVL CHG to ALT HOLD pitch mode and uses the elevators to hold the MCP altitude.

V/S Descent

The V/S mode is another DFCS pitch mode used for descent (or climb). You push the V/S mode switch on the MCP to arm V/S, then set the V/S rate with the thumbwheel. These are the mode annunciations:

- A/T goes to MCP SPD mode
- Speed mode light comes ON
- MCP IAS/MACH window shows selected airspeed
- V/S is the DFCS pitch mode.

In the DFCS V/S mode, the A/T controls thrust to keep a target airspeed on the MCP. The DFCS uses the elevators to control to a V/S descent rate on the MCP, and the airplane descends to the target altitude on the MCP. When the airplane gets to the selected altitude, the A/T stays in the speed mode as it increases thrust to continue to maintain the MCP selected target airspeed. The DFCS changes from the V/S mode to ALT HOLD mode and uses the elevators to control and hold the MCP altitude.



A/T SYSTEM - OPERATION - DESCENT

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A/T SYSTEM - OPERATION - APPROACH

General

During descent and before glideslope capture, the A/T is in either the ARM mode or speed mode, depending on the mode selected.

Descent Retard

During DFCS VNAV descent before glideslope capture, the A/T will normally be in descent retard and set thrust to idle or it may be in speed mode, depending on the DFCS pitch mode selected. These are the indications during descent in VNAV SPD:

- A/T retards T/Ls to idle
- RETARD mode annunciates on the FMA then ARM
- N1 and Speed mode lights are off on the MCP
- MCP IAS/MACH window is blank.

To use the A/T in speed mode during descent, select speed mode on the MCP. The DFCS can also select the A/T speed mode. These are the indications during descent in A/T MCP SPD:

- A/T is in MCP SPD mode on FMA
- A/T Speed mode light is ON on the MCP
- MCP IAS/MACH window shows pilot selected speed.

Glideslope (G/S) Capture

During descent, the DFCS approach mode (APP) may be selected. At glideslope capture, the A/T mode is MCP SPD. The DFCS pitch mode is G/S as the DFCS uses the elevator to hold the glideslope vertical path. The A/T uses the selected speed on the MCP to adjust the T/Ls for speed during the remainder of the approach. During the approach, the pilot extends flaps and reduces the airspeed on the MCP. These are the indications after G/S capture:

- A/T goes to MCP SPD mode and Speed mode light is ON
- MCP IAS/MACH window shows the selected airspeed.

Flare Retard

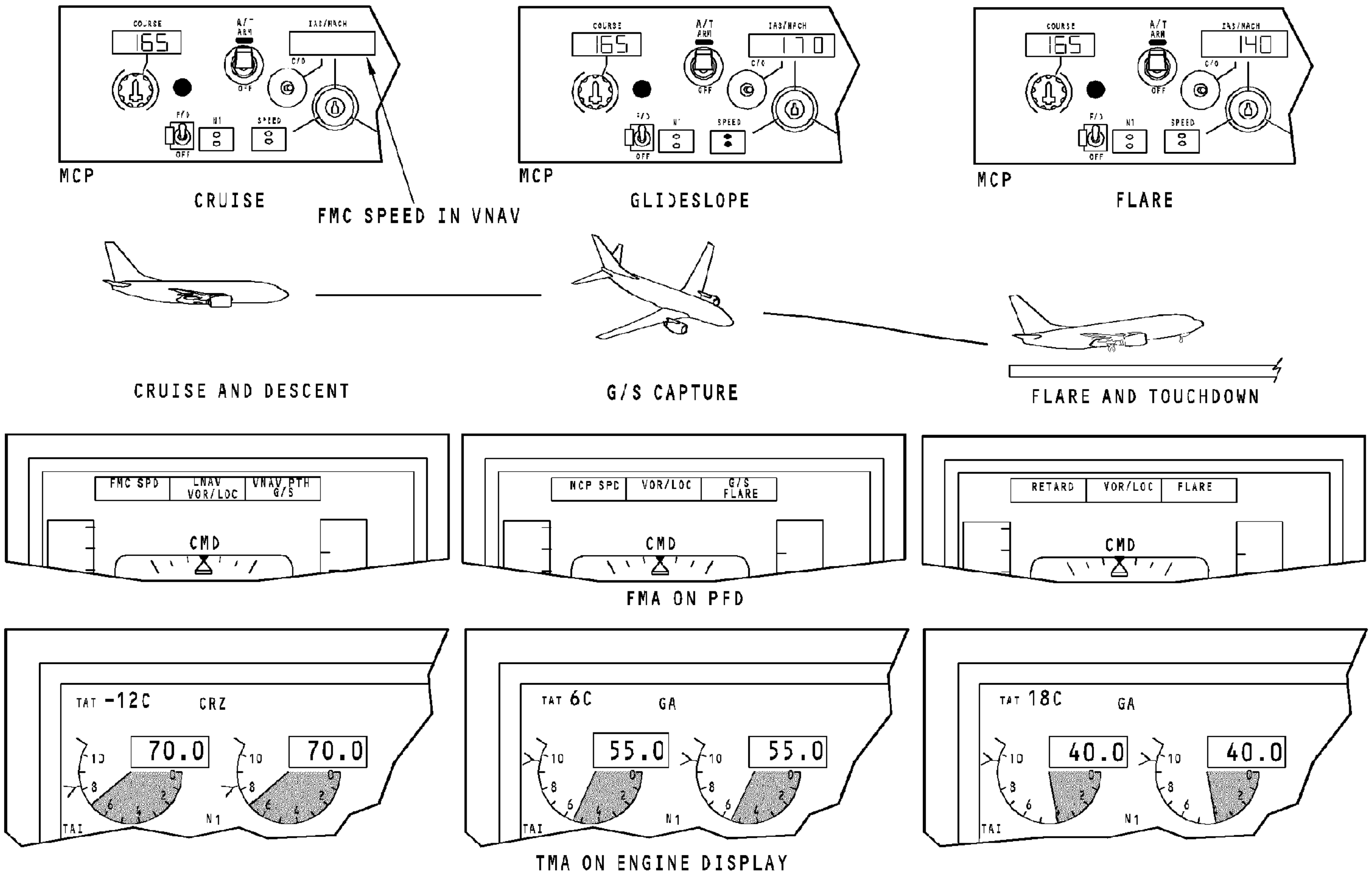
During the approach while on glideslope, the A/T mode is MCP SPD. At 50 feet radio altitude, the DFCS starts the flare maneuver to touchdown and sends a flare discrete to the A/T. FLARE shows as the active DFCS pitch mode on the FMA. During DFCS flare, the A/T stays in MCP SPD mode until 24 feet radio altitude and then commands flare retard and the T/Ls move to the aft stops. These are the indications during flare:

- A/T mode changes from MCP SPD to RETARD
- A/T mode lights are off.

If the DFCS is not engaged for the approach, the A/T goes into flare retard at 27 ft radio altitude if on glideslope in MCP SPD mode and flaps more than 12.5 degrees.

A/T SYSTEM - OPERATION - APPROACH

The A/T disengages two seconds after touchdown. The A/T mode on the FMA is blank. There are no aural or visual warnings when the A/T disengages during a normal landing.



22-31-00-024

A/T SYSTEM - OPERATION - APPROACH

A/T SYSTEM - OPERATION - GO-AROUND

General

During approach to landing while on glideslope, the A/T is in the speed mode and controls engine thrust to control to the selected MCP airspeed. The A/T arms for go-around when below 2000 feet RA. After it is armed, if you push TO/GA during the approach, the A/T goes to the go-around mode and increases thrust for go-around climb.

The A/T may be used for go-around with or without the DFCS engaged. For an autopilot go-around, both autopilots must have been engaged in command mode prior to pushing TO/GA. During go-around, the DFCS uses the elevators to control pitch to hold the airspeed selected on the MCP, while the A/T controls thrust.

Reduced Thrust Go-Around

You push a TO/GA switch to enter go-around mode. The A/T moves the thrust levers forward and engine thrust increases for the go-around climb. These are the indications for go-around:

- GA becomes the A/T mode on FMA (reduced thrust)
- T/Ls move forward for reduced thrust go-around
- GA is the FMC thrust mode
- N1 ref cursors are at FMC max go-around N1 limit.

After the first push of a TO/GA switch, the A/T commands reduced go-around thrust to achieve a nominal climb rate. The A/T calculates a thrust value to achieve an eight percent climb gradient. Normally, this will be less than the full rated go-around thrust available.

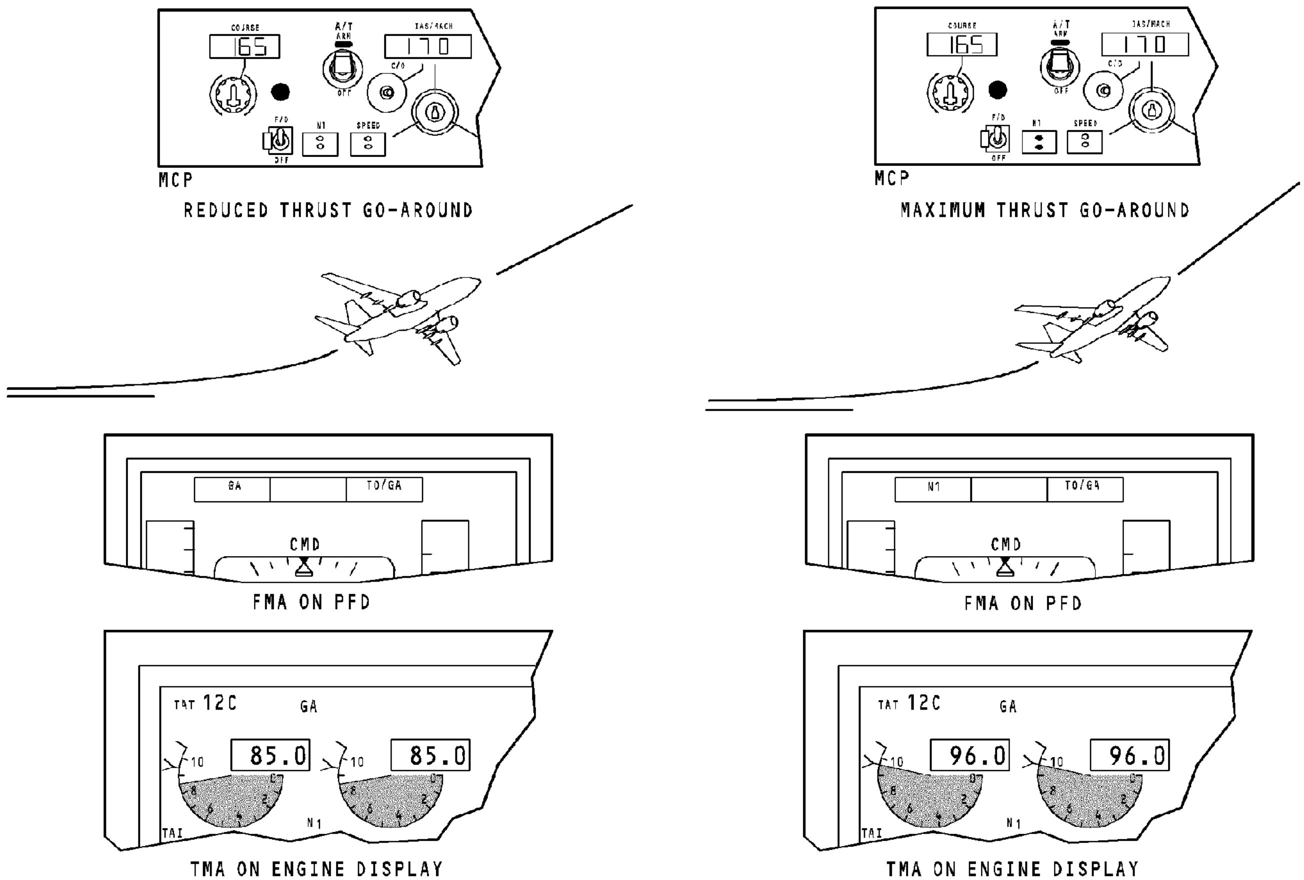
Maximum Thrust Go-Around

During go-around when you push a TO/GA switch a second time, the A/T moves the thrust levers to the full-rated go-around N1 calculated by the FMC. The A/T mode indications on the FMA and the FMC thrust mode indications on the engine display are the same as for reduced thrust go-around except for these changes:

- A/T changes from GA to N1 mode on FMA (max thrust)
- T/Ls move forward to FMC N1 limit for max thrust.

Level-Off At Altitude

During go-around, the DFCS pitch mode annunciates TO/GA on the FMA. When the airplane gets near the MCP altitude, the A/P acquires and levels off at this altitude and goes to ALT HOLD mode. The A/T mode changes from N1 (or GA) to MCP SPD as the A/T controls the thrust levers to control to the airspeed selected on the MCP.



A/T SYSTEM - OPERATION - GO-AROUND

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - A/T BITE ACCESS

General

To start A/T BITE, these conditions are necessary:

- Both EECs inactive (both start levers in CUTOFF position and both engine start switches OFF) or both engines off (N2 less than 50%)
- FMC is valid
- A/T BITE request from the CDU.

HAP 031-054, 101-999

- Autopilot not engaged

HAP ALL

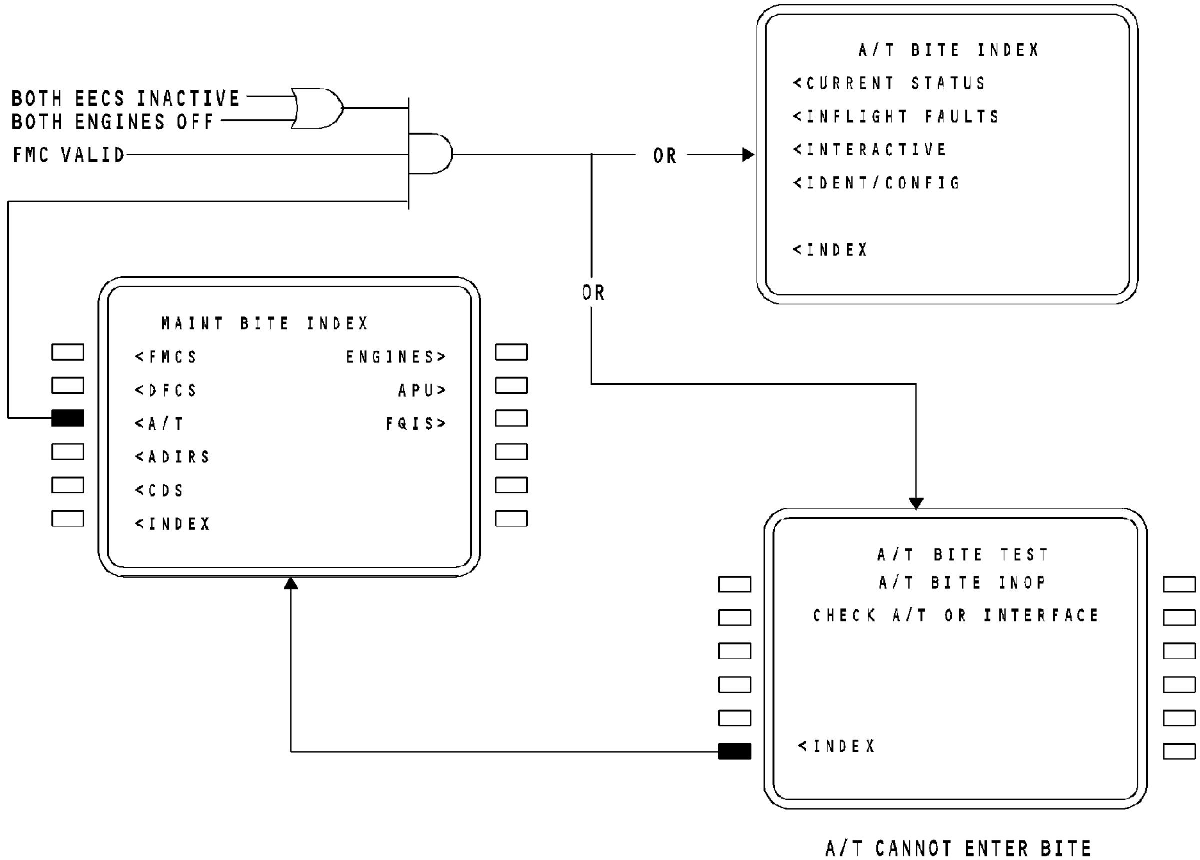
After you push A/T, LSK L3, on the maintenance BITE index page, the CDU shows one of two pages. If the A/T system starts BITE, the CDU shows the A/T BITE TEST menu and both A/T warning lights come on. If the A/T system fails to start BITE, the CDU shows the A/T BITE INOP page.

A/T BITE TEST Main Menu

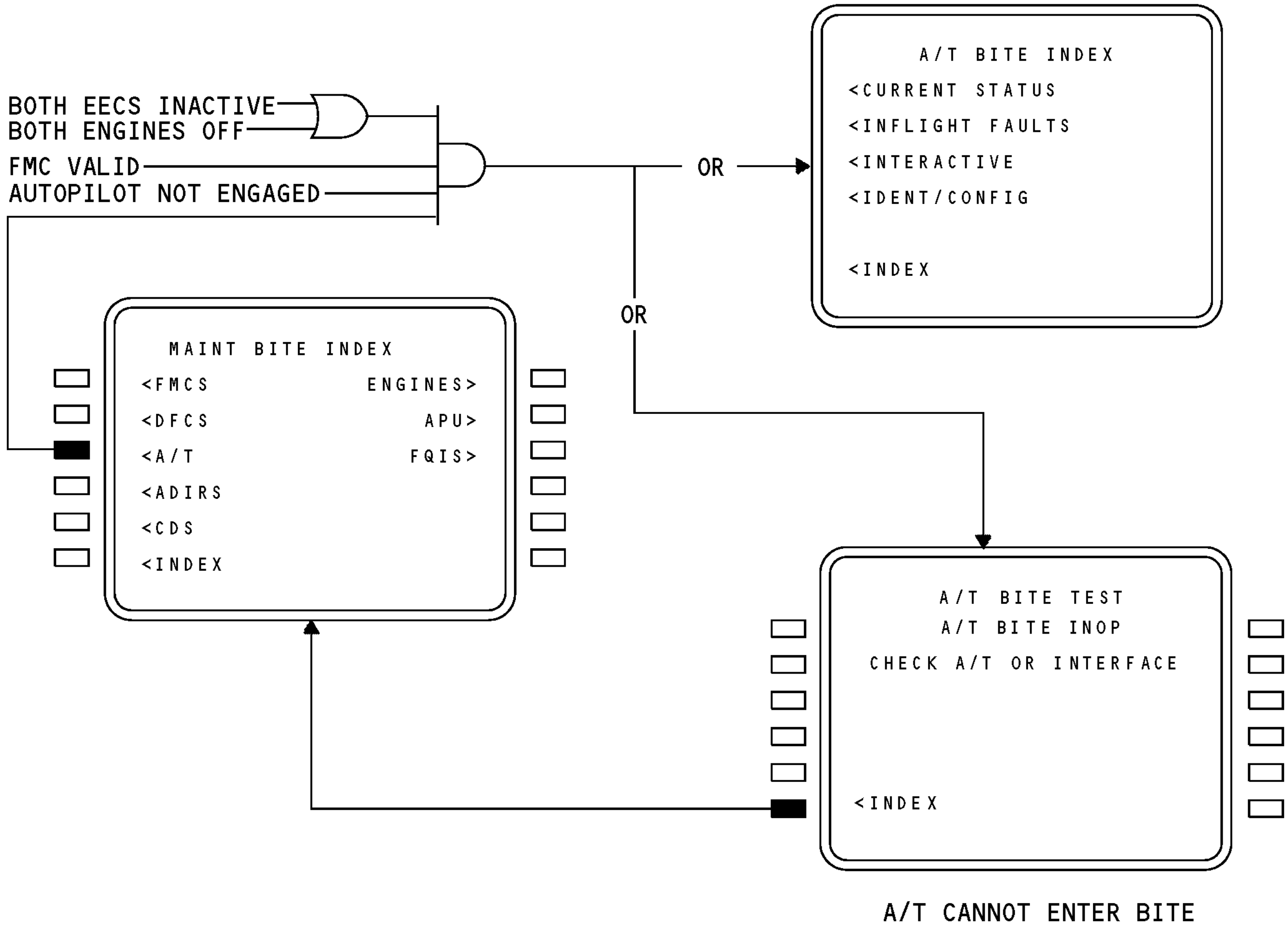
This page lets you choose a fault isolation or verification test.

A/T BITE INOP

This page shows if the A/T system fails to start BITE. If this page shows, do a check of the A/T or its interface for problems. From this page, you can exit A/T BITE and go back to the MAINT BITE INDEX page with LSK 6L.



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - A/T BITE ACCESS



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES ACCESS

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A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - CURRENT STATUS TEST

A/T BITE Main Menu Page

To do a current status test, select the CURRENT STATUS prompt on the A/T BITE main menu page. When you push the LSK 1L for current status test, the CDU gives initialization instructions.

CURRENT STATUS Initialization Page

This page gives instructions to prepare the current status test. After preparation, push LSK 6R to continue the test. The TEST IN PROGRESS page shows after you push LSK 6R. If the setup is not correct, the current status will show any failed or non-powered LRU's.

TEST IN PROGRESS Page

This page tells you that the current status tests is in progress. If there are no failures, the NO FAULTS display shows. If there are failures, the CDU shows the current status FAILURES page.

NO FAULTS Page

The NO FAULTS page shows if there are no failures. From this page, you can push LSK 6L to go back to the A/T BITE main menu.

FAILURES Page

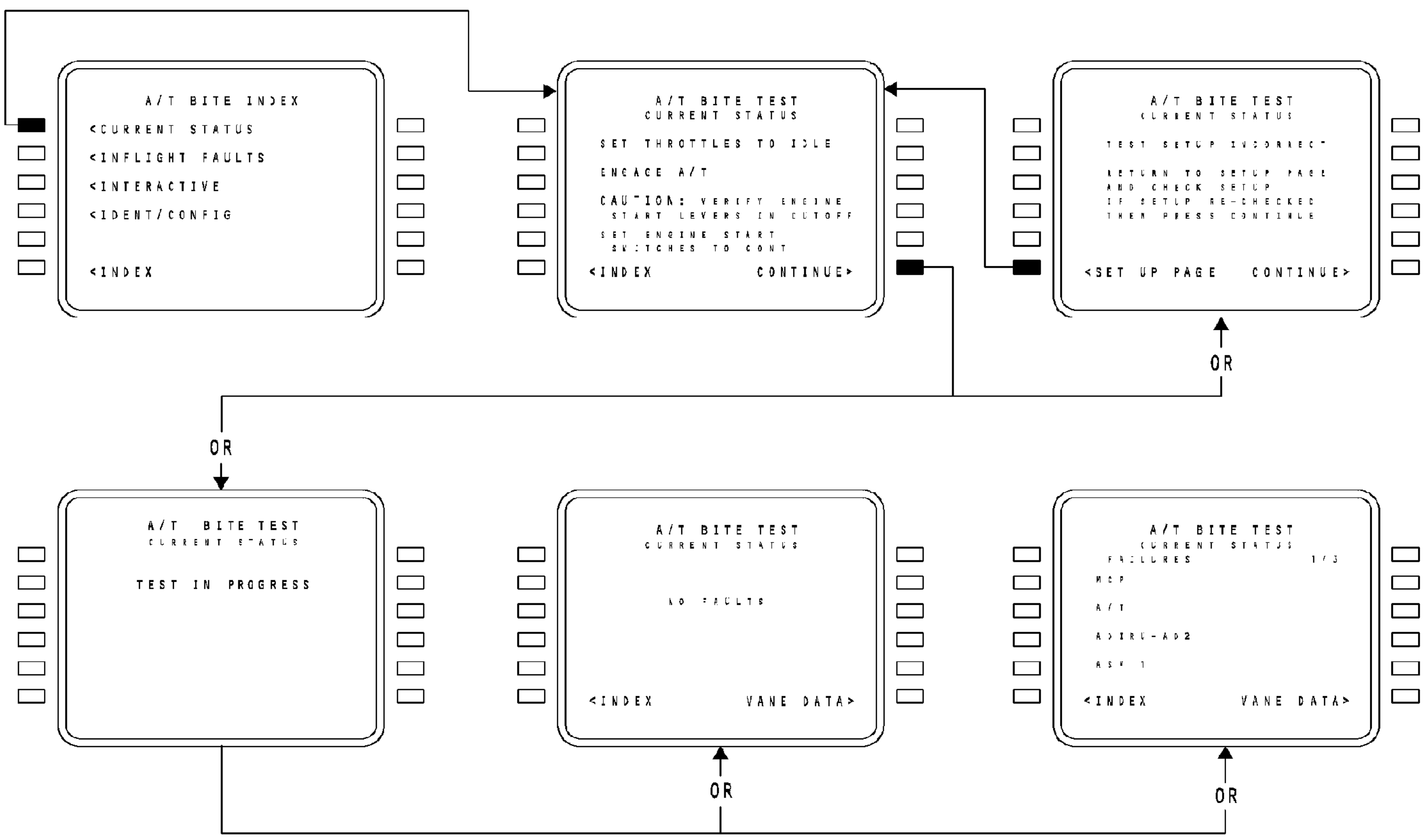
HAP 001-013, 015-026, 028-030

The failures page shows the faults found while in current status test. The left side of the display shows the LRU failures. When you push LSK 6L, the A/T BITE main menu shows.

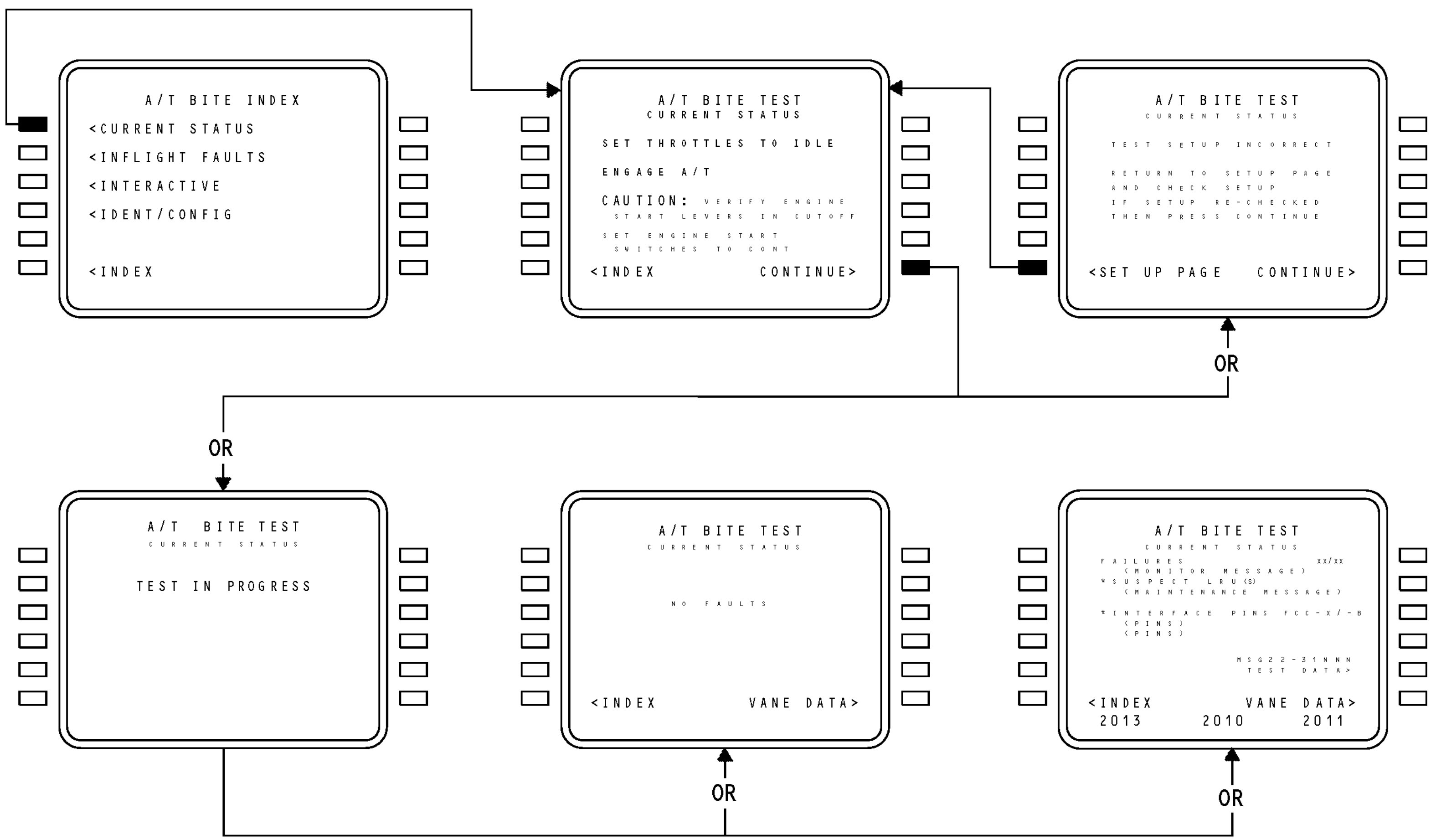
HAP 031-054, 101-999

The failures page shows the faults found while in current status test. The display shows failures, suspect LRUs and FCC interface pin status. When you push LSK 6L, the A/T BITE main menu shows.

HAP ALL



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - CURRENT STATUS TEST



A/T SYS - TRAINING INFORMATION POINT - A/T BITE PAGES - CURRENT STATUS TEST

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A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - CURRENT STATUS ENGINEERING DATA

NO FAULTS Page

To see alpha vane information, push LSK 6R.

FAILURES Page

From the CURRENT STATUS FAILURES page, you can see alpha vane information if you push LSK 6R. You can also see engineering information about the failures if you enter code 100 and push LSK 6R.

VANE DATA Page

This page shows the average vane angle difference in flight. If you push LSK 6L, the A/T BITE main menu shows.

ENGINEERING DATA Page

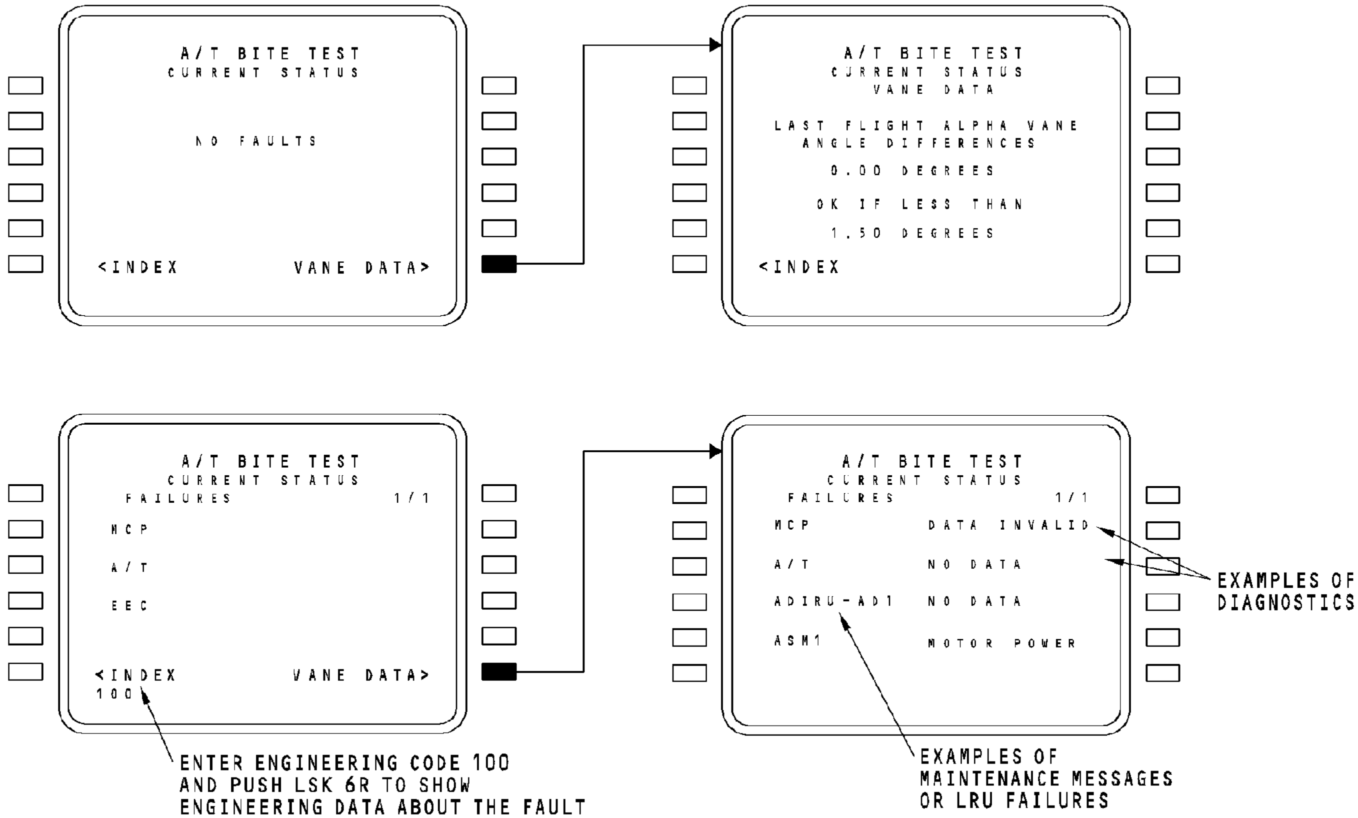
HAP 001-013, 015-026, 028-030

This page shows the engineering information of the current status failures. Enter the engineering code and push LSK 6R to show the engineering information. The failed LRU shows on the left and the diagnostic shows on the right.

HAP 031-054, 101-999

This page shows the engineering information of the current status failures. Enter the engineering code, 100, and push LSK 6R to show the engineering information. The failed LRU shows on the left and the diagnostic shows on the right. Enter 'E' and push LSK 6R to exit Engineering mode.

HAP ALL



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - CURRENT STATUS ENGINEERING DATA

22-31-00-028

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - A/T INFLIGHT FAULTS

General

To see the INFLIGHT FAULTS page, push LSK 2L on the A/T BITE main menu.

INFLIGHT FAULTS Page

This page shows you the system status during previous flights. This page shows the NONE if there are no faults. If there was a problem during a flight, the flight leg shows on this page. FLT 01 is the most recent flight. FLT 99 is the oldest flight. The flight leg field is blank if there are no faults during a flight.

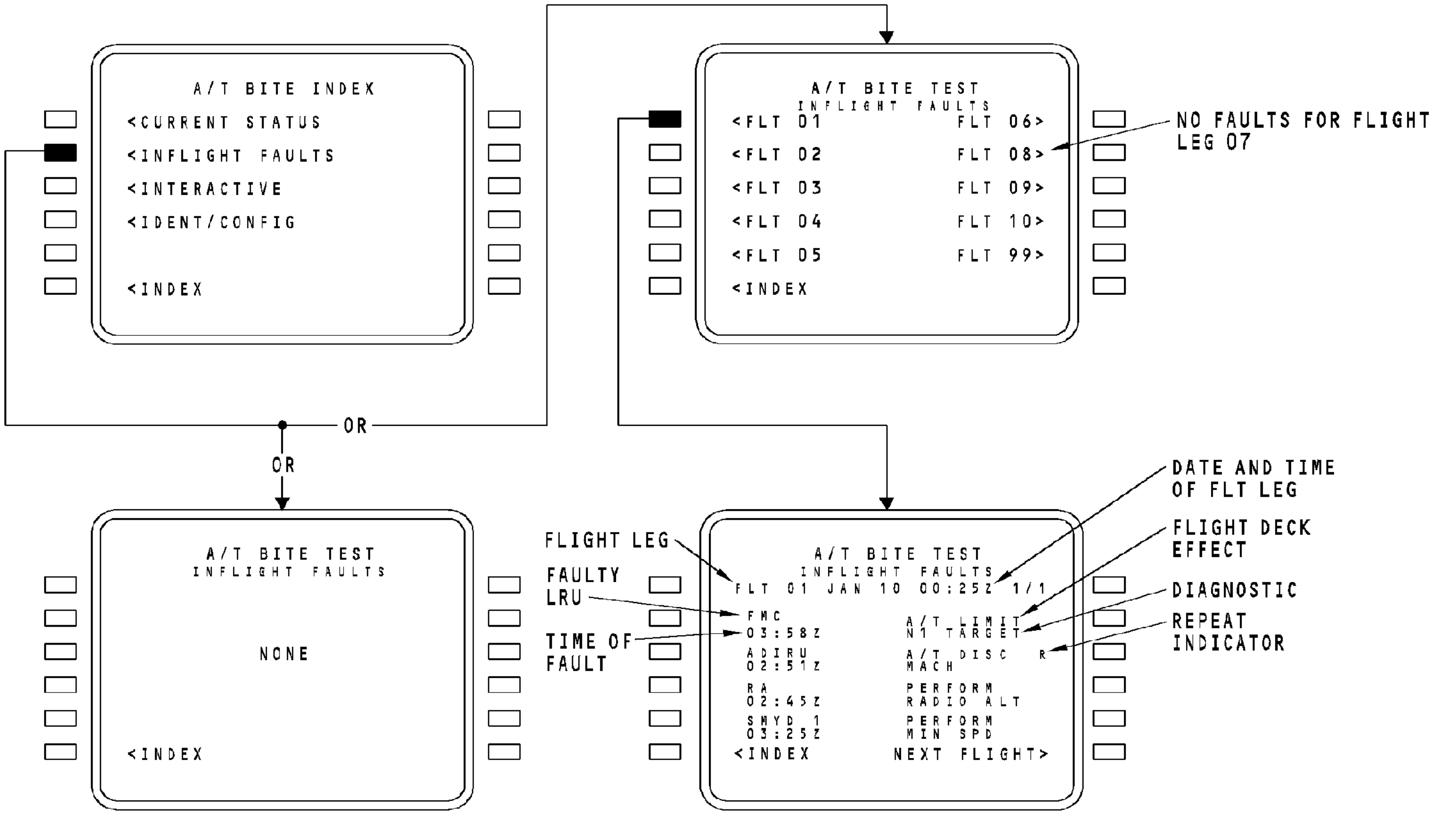
To erase the inflight faults, enter CLR/ALL on the CDU scratch and push LSK 6R. The INFLIGHT FAULTS page removes the flight legs and shows NONE.

INFLIGHT FAULTS Engineering Page

This page shows the A/T system failure information. The display shows the flight number and the date when the problem occurred. The faulty LRU shows on the left of the display and the flight deck effect shows on the right. The diagnostic is under the flight deck effect. The repeat indicator shows if the problem occurred more than once during the flight.

Push LSK 6R to see problems on the next flight.

To go back to the A/T BITE main menu, push LSK 6L.



22-31-00-029

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - A/T INFLIGHT FAULTS

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 1

INTERACTIVE Page

You select the INTERACTIVE page from the A/T BITE TEST menu when you push LSK 4L. The INTERACTIVE page lets you do interactive tests that are not in current status test. These tests are done one at a time and are selectable from a menu.

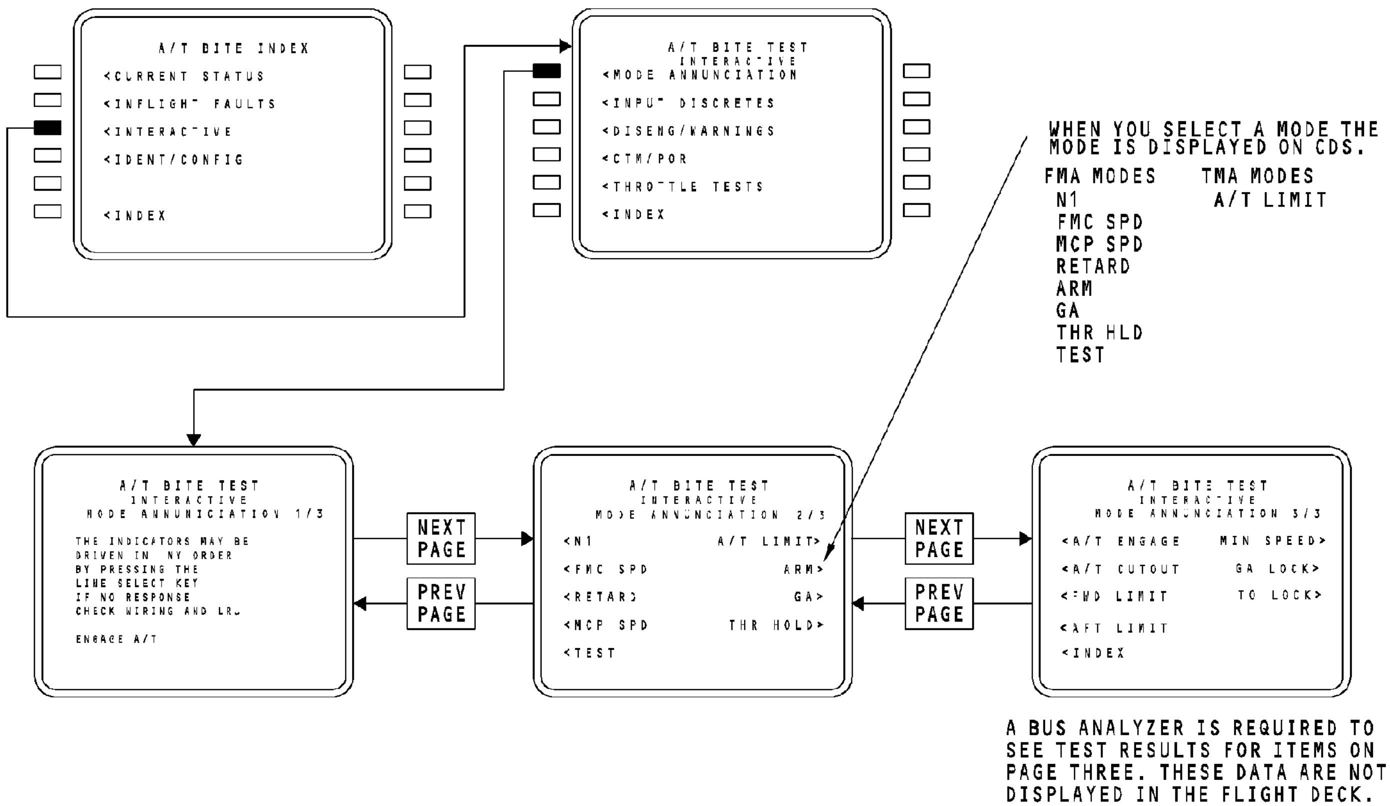
MODE ANNUNCIATION Page

From the INTERACTIVE page, push LSK 1L to start the MODE ANNUNCIATION test.

The first page of the MODE ANNUNCIATION test gives you the initialization instructions. Push the NEXT PAGE key to continue with the test.

Page 2 shows mode annunciations that you can see on the common display system. Push the LSK next to the annunciation to see the display.

Page 3 shows modes you can set but there is no annunciation on the common display system. You must connect test equipment to monitor these signals. You push the LSK next to the annunciation to set the mode.



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 1

22-31-00-030

INPUT DISCRETES Page

You select the INPUT DISCRETES page from the INTERACTIVE test menu when you push LSK 2L. The INPUT DISCRETES page lets you do interactive tests of the discrete inputs.

The first page shows general instructions for the input discretes page.

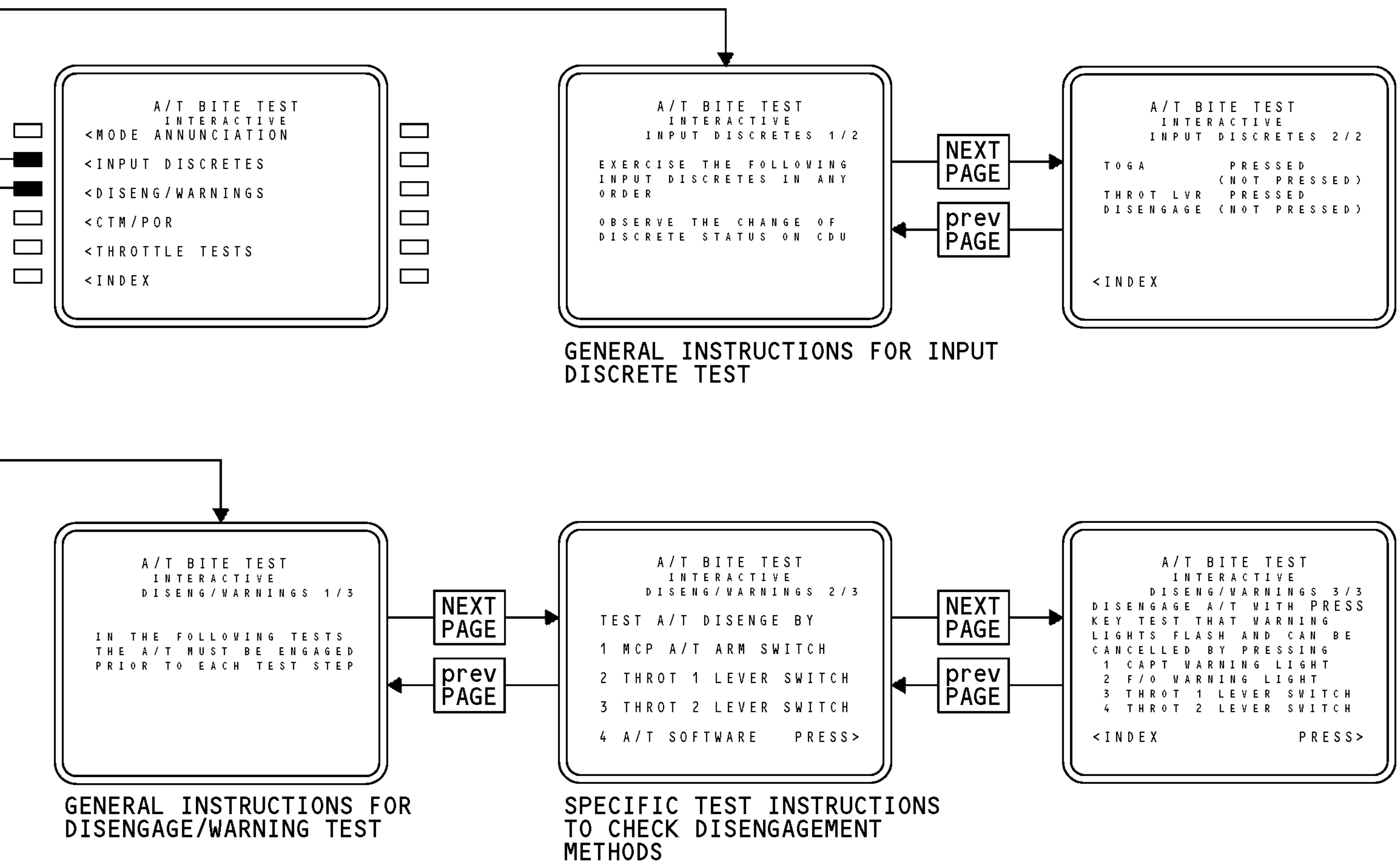
Other pages shows the current state of the input discretes.

DISENGAGE/WARNINGS Page

You select the DISENGAGE/WARNINGS test from the INTERACTIVE test menu when you push LSK 3L. The DISENGAGE/WARNINGS test lets you do interactive tests of the disengage/warning circuits.

The first page shows general instructions for the disengage/ warning test.

Other pages shows methods of A/T disengagement and methods to reset the A/T disengage warning lights.



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 2

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A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 3

CTM/POR Page

HAP 001-013, 015-026, 028-030

The Cycle Time Monitor/Power On Reset (CTM/POR) is an internal timing function that enables the A/T computer to reset itself in case an A/T malfunction is detected. A computer malfunction that manifests itself as an invalid CTM will cause the A/T computer to reset and re-initialize, causing it to disengage so as to power up again. The effect of POR is the same as starting from power off, but without the need to reset the A/T circuit breakers. The CTM/POR test is used to test this function.

HAP 031-054, 101-999

The Cycle Time Monitor/Power On Reset (CTM/POR) is an internal timing function that enables the A/T function in FCC A to reset itself in case an A/T malfunction is detected. An A/T malfunction that manifests itself as an invalid CTM will cause the A/T to reset and re-initialize, causing it to disengage so as to power up again. The effect of POR is the same as starting from power off, but without the need to reset the A/T circuit breaker. The CTM/POR test is used to test this function.

HAP ALL

You select the CTM/POR test from the INTERACTIVE test menu when you push LSK 4L. The CTM/POR page lets you do the test of the A/T cycle time monitor (CTM) and power on reset functions (POR).

The first page shows general instructions for the CTM/POR tests.

Push LSK 6R to start the test. After the test, the CDU displays the test result.

THROTTLE TESTS Page

You select the THROTTLE TESTS page from the INTERACTIVE test menu when you push LSK 5L. The THROTTLE TESTS page lets you do interactive tests to check the thrust lever performance.

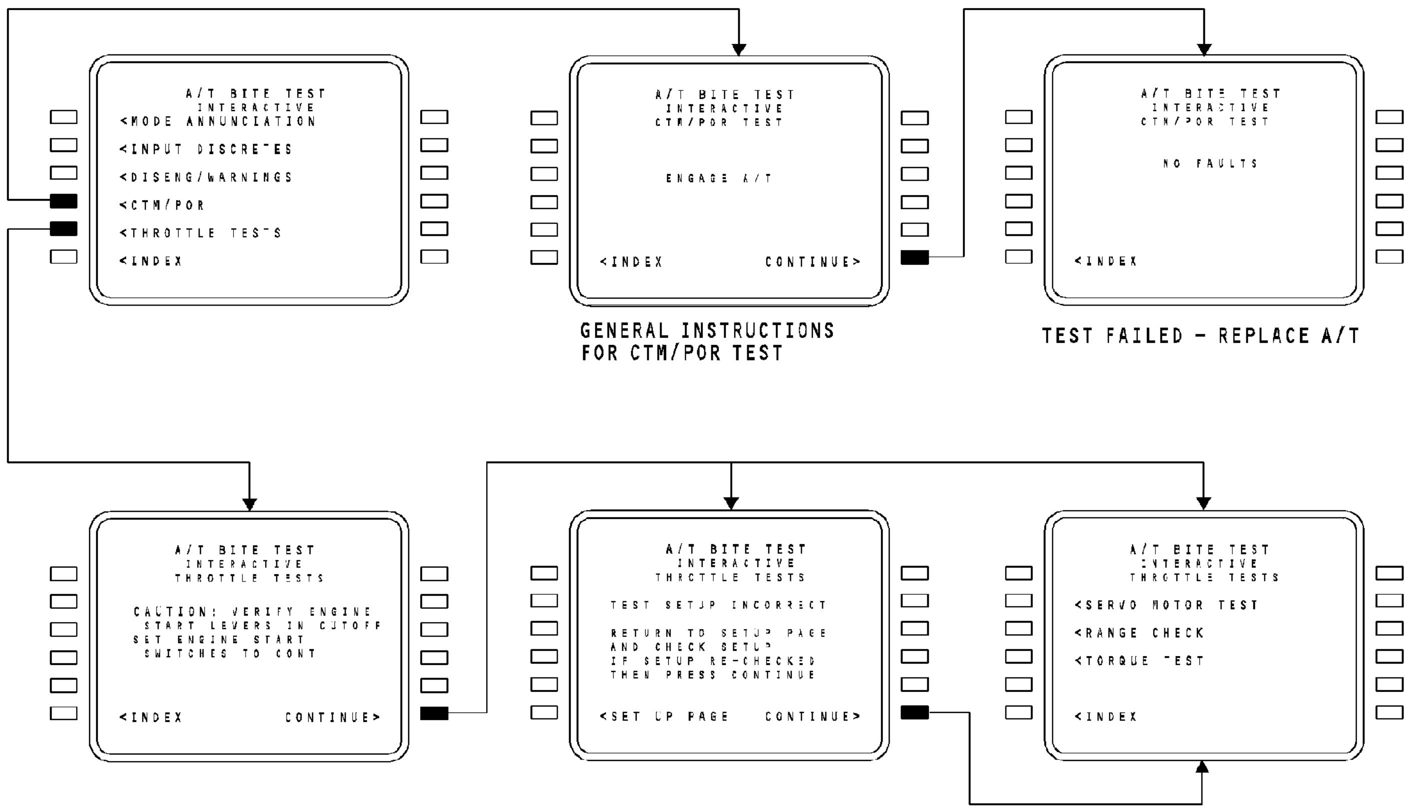
The first page shows test set-up instructions and a menu of the available throttle tests. These are the throttle tests that are available:

- Servo Motor test
- Range Check
- Torque Test

The Servo Motor Test and Torque Test check the servo motors and the torque of the gearbox friction brakes. These tests cause the A/T to drive the throttles through their full range of motion from the aft stops to the forward stops and back again to the aft stops. At the end of the test, servo motor faults will be displayed with a diagnostic code. During the test the torque values applied by the gearbox friction brakes are measured by the servo motors and sent to the A/T for display on the BITE page.

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 3

The Range Check requires operator interaction. During this test you move the throttles through their full range of motion, while observing the range values and limits on the FMC CDU.



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 3

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 4

SERVO MOTOR TEST Page

Push LSK 2L to select the SERVO MOTOR TESTS page from the THROTTLE TESTS menu. The SERVO MOTOR TESTS page shows any failures of servo motor 1 or 2.

Page 1 shows the initial test instructions. Push LSK 6R to continue the test.

Page 2 can show one of these messages:

- NO FAULTS
- A fault message
- THRUST LEVERS NOT AT IDLE.

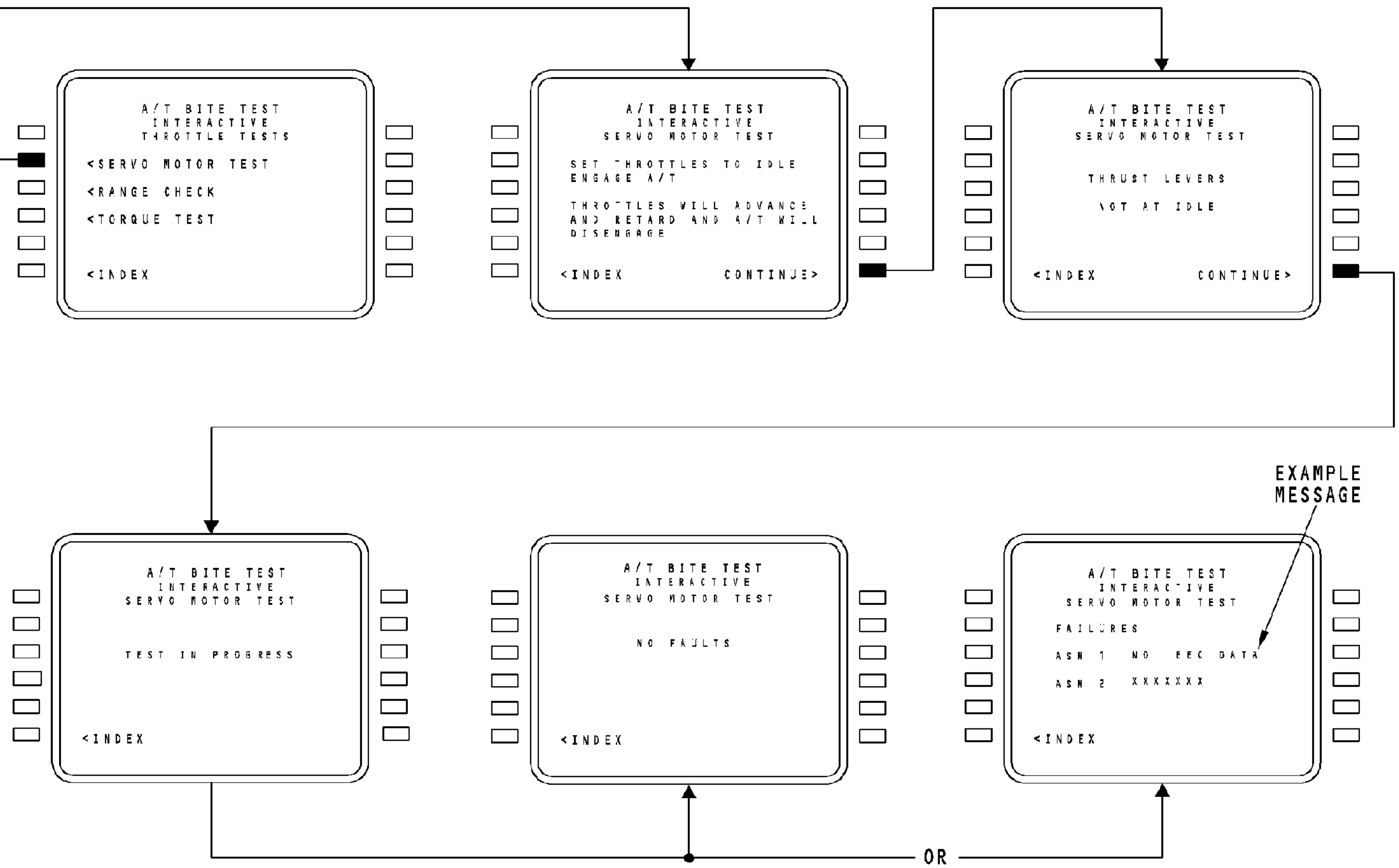
If THRUST LEVERS NOT AT IDLE shows, move the levers to the idle position and push LSK 6R to continue the test.

TORQUE TESTS Page

Push LSK 4L to select the TORQUE TESTS page from the THROTTLE TESTS menu. The TORQUE TESTS page lets you do a check of the servo torque output.

Page 1 shows the initial test instructions. Push LSK 6R to continue the test.

The thrust levers go fully forward until the clutch slips, then back to the aft stop. Page 2 shows the average torque while in test.



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 4

22-31-00-033

RANGE CHECK Page

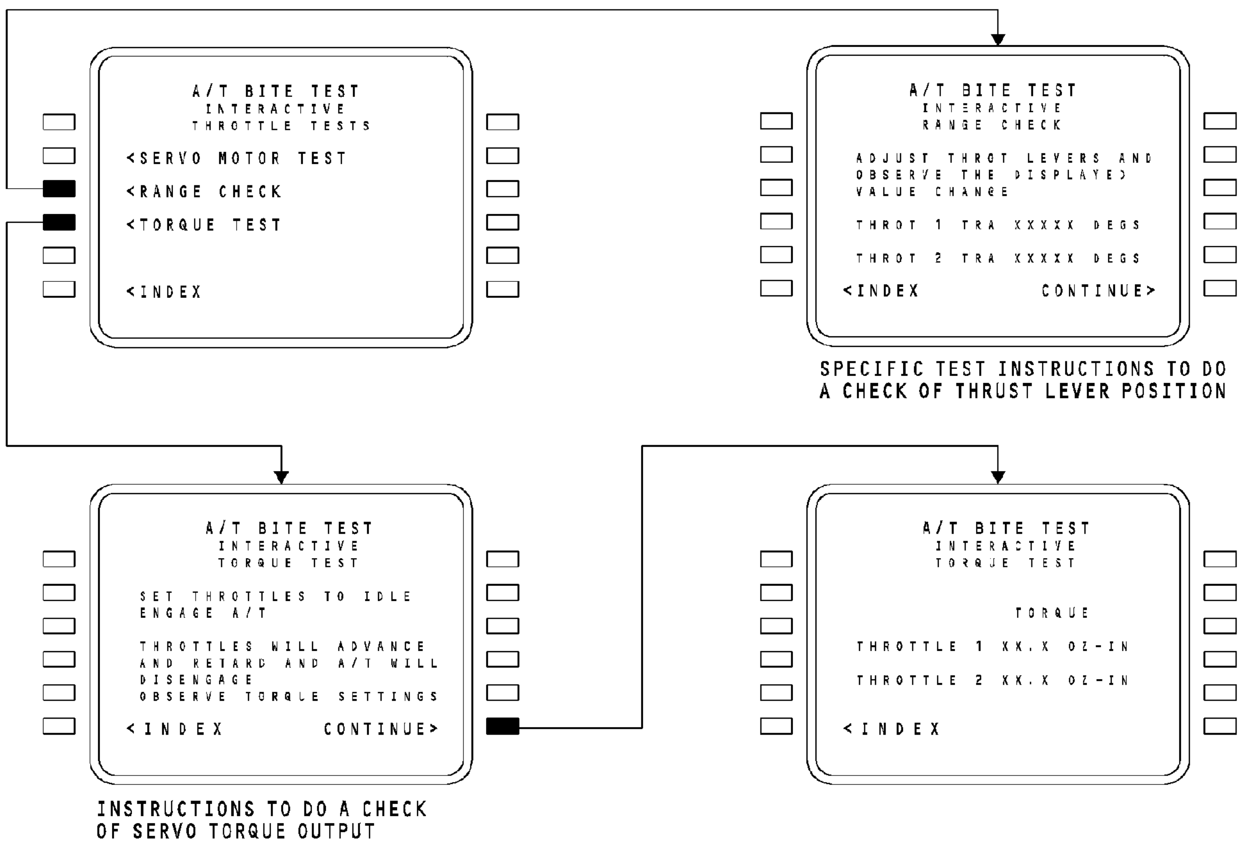
The RANGE CHECK page lets you monitor the thrust lever position as you move the thrust levers.

TORQUE TESTS Page

You select the TORQUE TESTS page from the THROTTLE TESTS menu when you push LSK 4L. The TORQUE TESTS page lets you do a check of the servo torque output.

Page 1 shows the initial test instructions. Push LSK 6R to continue the test.

The thrust levers go fully forward until the clutch slips, then back to the aft stop. Page 2 shows the average torque while in the test.



22-31-00-034

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - INTERACTIVE TEST 5

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - IDENT/CONFIG

IDENT/CONFIG Page

You select the IDENT/CONFIG page on the A/T BITE main menu page. Push LSK 4L to show IDENT/CONFIG page 1.

HAP 031-054, 101-999

The first page shows:

- Hardware part number
- Serial number
- FCC operational software part number.

HAP 001-013, 015-026, 028-030

Page 1 shows the configuration of the autothrottle computer. These are the configuration items that show:

- Noise abate option
- Fast/slow option
- Parity
- 737 model.

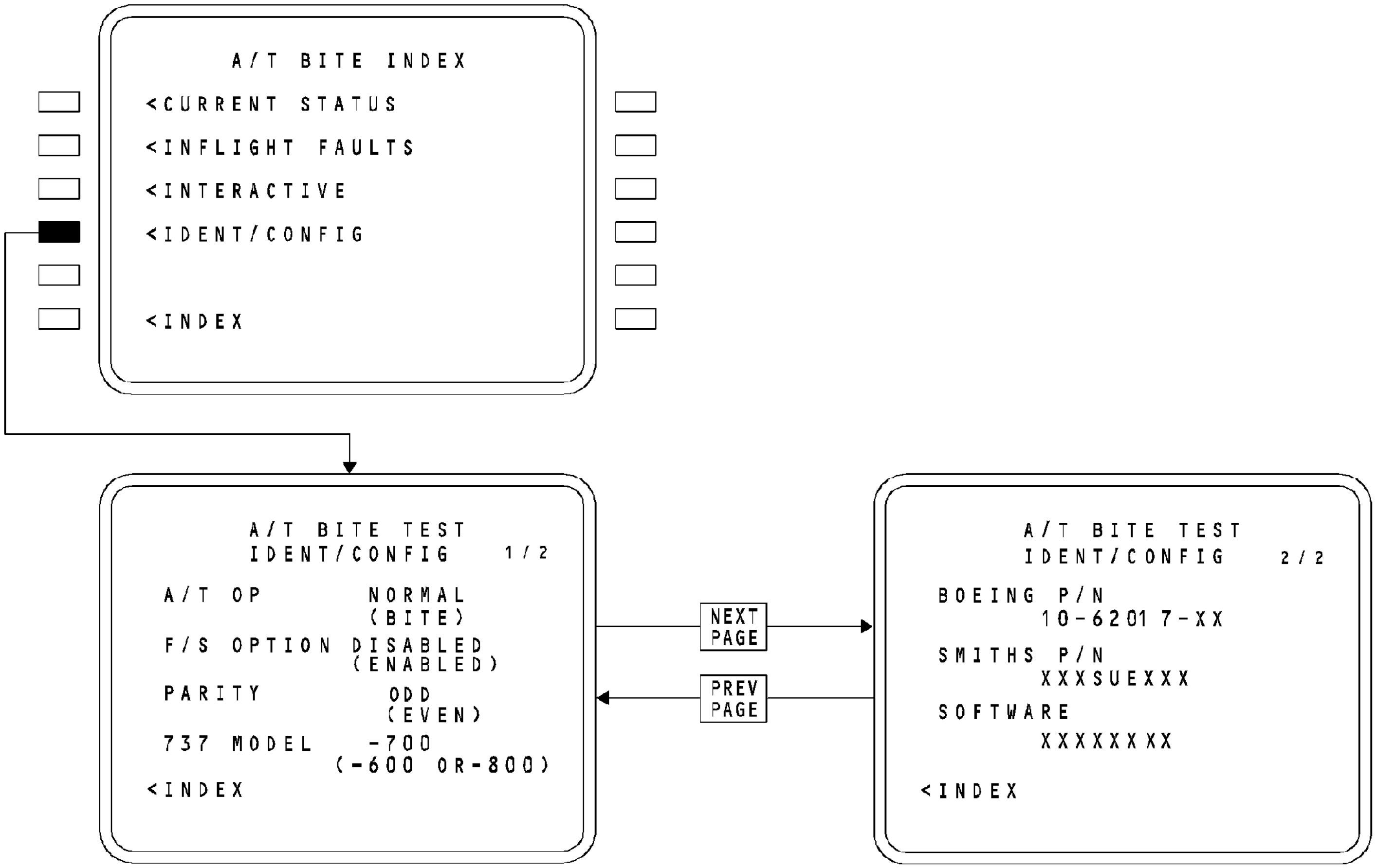
Push the next page key to move to page 2. Page 2 shows this information:

- The Boeing part number
- The Smith part number
- Software version.

HAP 031-054, 101-999

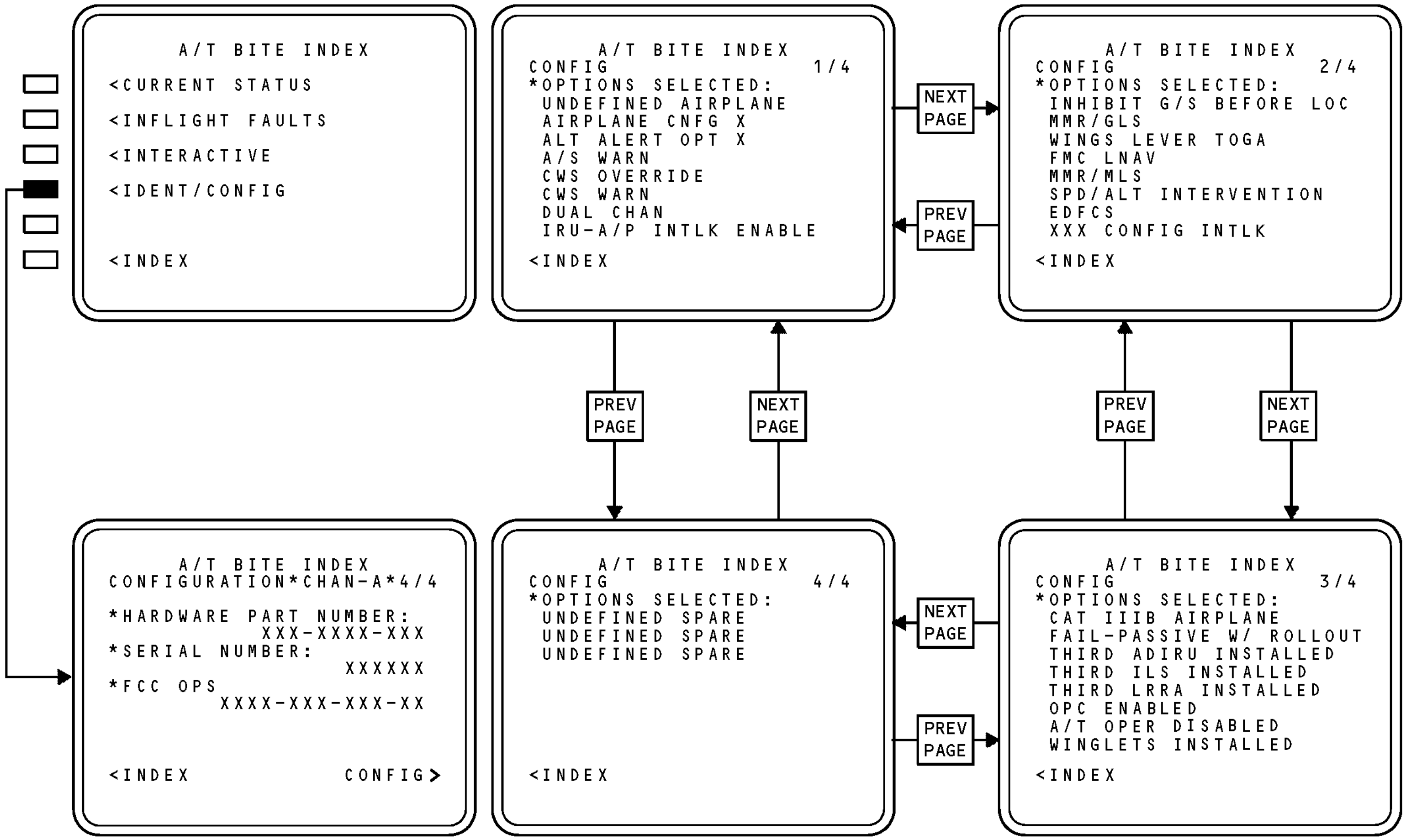
When you select CONFIG on the first page, you see the first of 4 pages that show unique airplanes option. You use the NEXT PAGE/PREVIOUS PAGE CDU keys to go to these pages.

HAP ALL



A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - IDENT/CONFIG

22-31-00-035



NOTE: OPTIONS SCREENS REPRESENT TYPICAL DATA

A/T SYSTEM - TRAINING INFORMATION POINT - A/T BITE PAGES - IDENT/CONFIG

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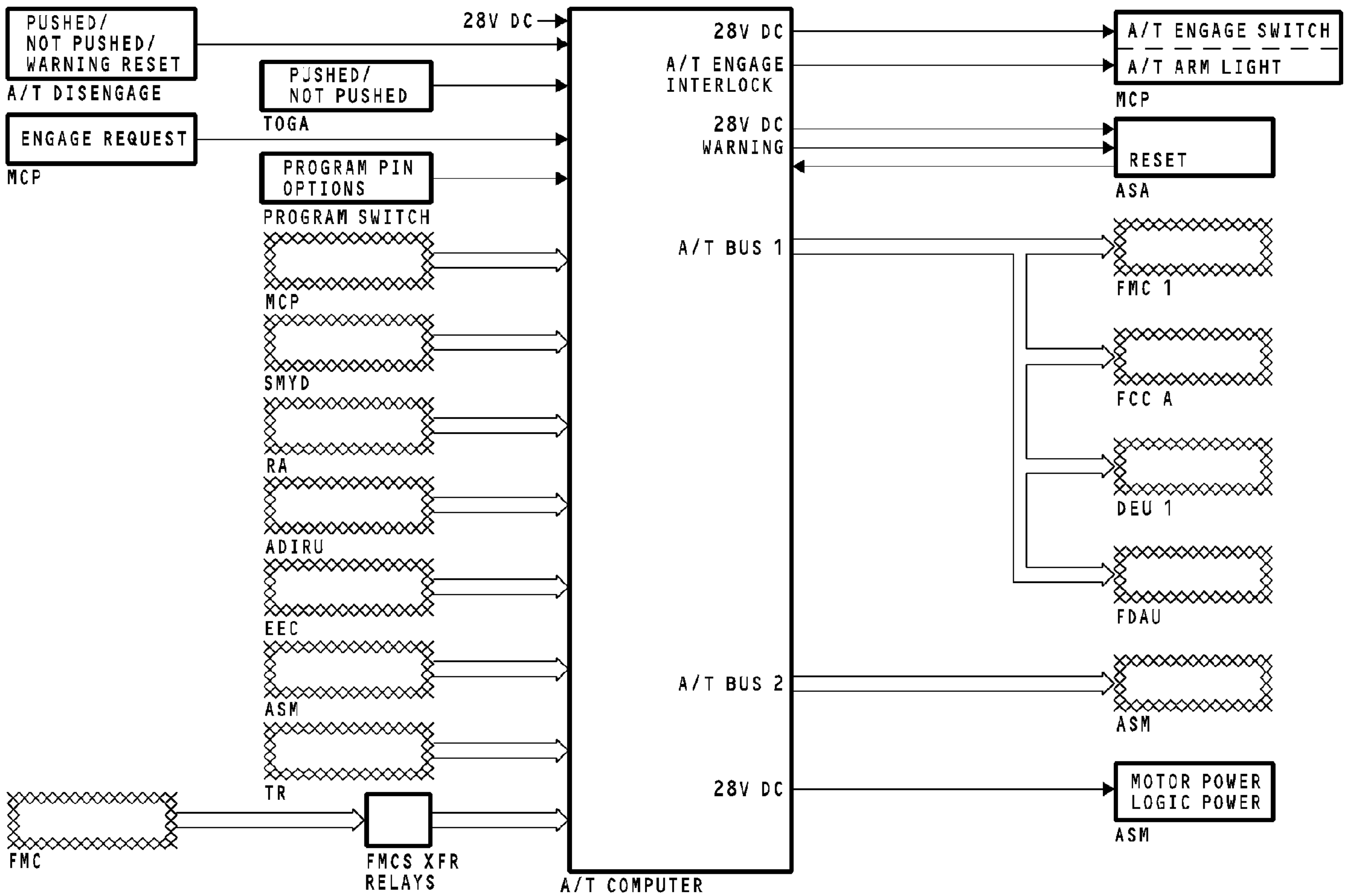
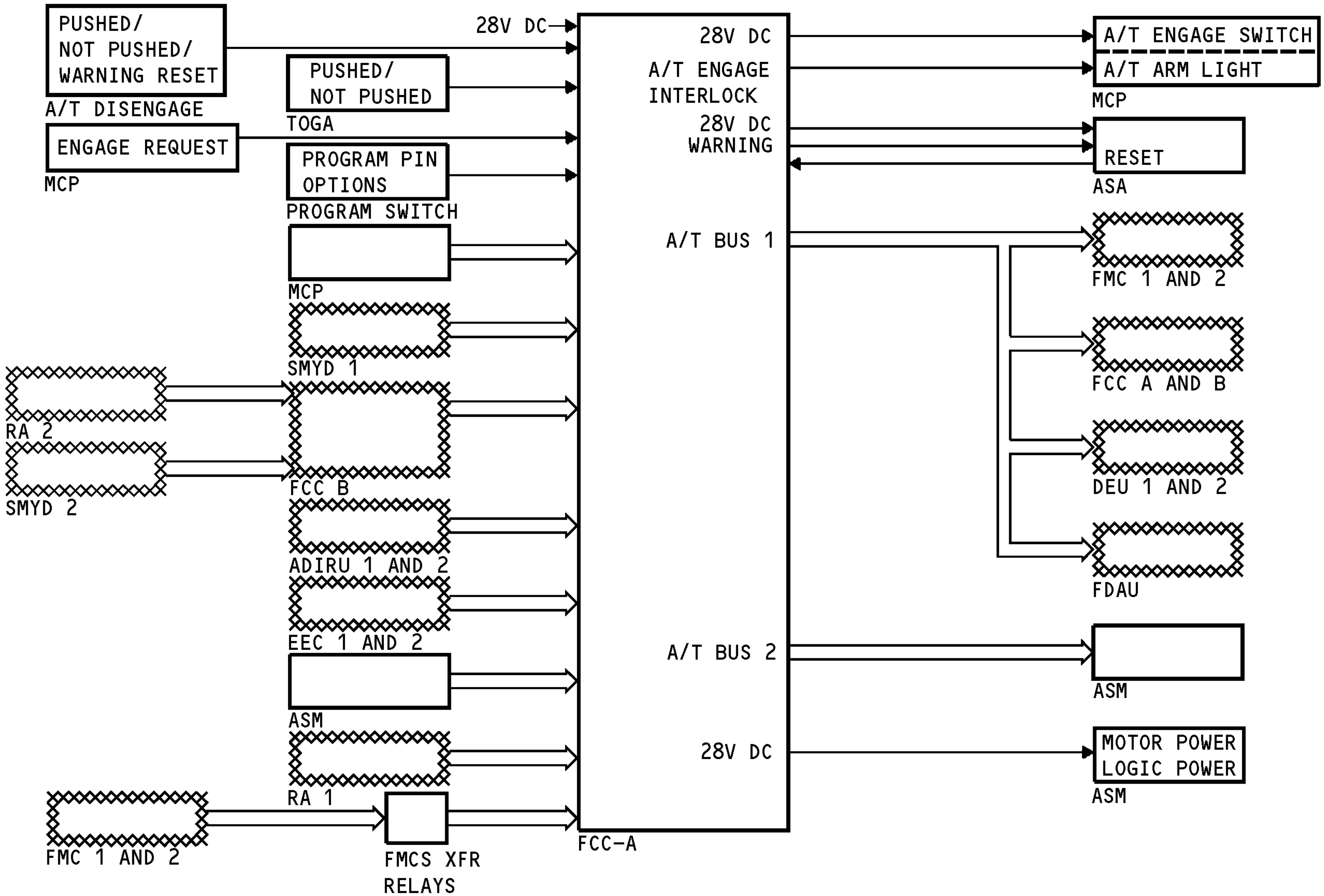
A/T SYSTEM - SUMMARY

General

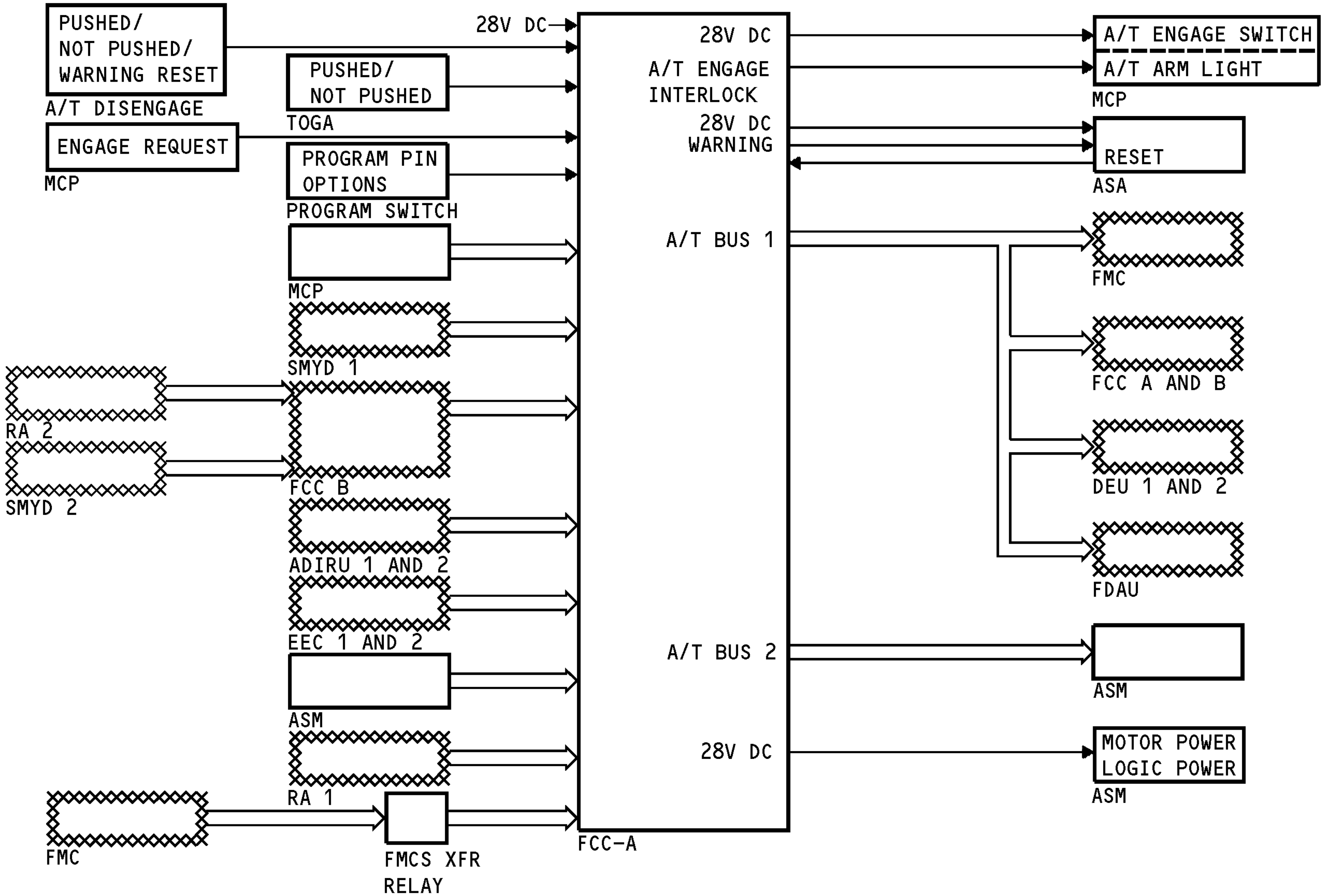
This page is for reference.



A/T SYSTEM - SUMMARY



A/T SYSTEM -SUMMARY



A/T SYSTEM - SUMMARY