KSC GP 15-30
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LAUNCH MISSION SUMMARY AND SEQUENCE OF EVENTS

TELESAT-F (ANIK-D1)

DELTA-164

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15. Abstract

This document contains a brief summary of the launch vehicle, spacecraft, and mission. Also included is information relative to launch windows, vehicle telemetry coverage, realtime data flow, telemetry coverage by station, selected trajectory information, and a brief sequence of flight events.

16. Key Words

Launch vehicle, spacecraft, mission, launch windows, telemetry, data flow, trajectory, and flight events.

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LAUNCH MISSION SUMMARY AND
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DELTA-164 LAUNCH VEHICLE

TELESAT-F SPACECRAFT

(ANIK-D1)

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TELESAT-F (ANIK-D1) SPACECRAFT DESCRIPTION

Telesat-F (Anik-D1), a 24-channel communications satellite designed for use within Canada, will be launched on a two-stage Delta 3920 launch vehicle from Launch Complex 17, Pad-B, on the Cape Canaveral Air Force Station, Fla. The Delta will place the spacecraft into a low earth-impact trajectory with an apogee of 100 nautical miles (185 kilometers).

A solid propellant motor assembly called the Payload Assist Module (PAM) will be used to raise Telesat-F from the low impact trajectory into an elliptical transfer orbit with an apogee of 19,654 nautical miles (36,366 kilometers) and a perigee of 100 nautical miles (185 kilometers), at an inclination to the equator of 24.5 degrees. The PAM, conceived and built by the McDonnell Douglas Astronautics Company, comprises three major elements; a payload attach fitting, a Thiokol developed solid rocket motor, and a spin table. The solid rocket motor has a burn time of approximately 85 seconds at an average thrust of 15,000 pounds (6672 N), capable of boosting spacecraft weights of up to 2800 lbs (1270 kg) on a Delta 3920 launch vehicle. A safe and arm device for the PAM is located on the payload attach fitting. After the solid rocket motor has completed firing, the entire assembly is separated from the spacecraft.

After Telesat-F has been injected into its transfer orbit, overall control of the spacecraft will pass to the Telesat Satellite Control Center in Ottawa, Ontario, Canada. Telesat controllers, using data from tracking stations on Guam and at Allan Park, Ontario, will evaluate the spacecraft health, commandability and attitude. At fifth apogee, an axial Reaction Control System (RCS) maneuver is performed to raise the transfer orbit perigee to 436 nautical miles (808 kilometers). Just prior to equator crossing at seventh apogee, the controllers will correctly orient the spacecraft and fire the onboard solid propellant apogee kick motor. This final burn will transfer the spacecraft into a circular drift orbit a little below geosynchronous altitude. If, for some reason, attitude dispersions still exist at seventh apogee, the above events may be delayed until ninth apogee.

A satellite which is slightly below the correct altitude for geosynchronous orbit will drift eastward or westward along the equator. It is planned for Telesat-F to drift westward at a rate of approximately 4° per day until it arrives on station at 104° west longitude. At this time the on-board RCS will be activated to halt the westward drift and raise the spacecraft to geosynchronous orbit at an altitude of 19,324 nautical miles (35,792 kilometers). To maintain this geosynchronous station, the spacecraft will have a final velocity of approximately 6,876 miles (11,066 kilometers) per hour.

The Anik-D1 spacecraft is built by Spar Aerospace Ltd. for Telesat and is designed to operate over a 10-year life span. The two main elements of the spacecraft are the spinning rotor, comprising 70 percent of the on-station vehicle weight, and the despun earth-oriented platform containing the communication repeater and its antenna. A rotating interface, consisting of ball bearings and slip rings permits signal transfers to take place, and affords an electrical path over which power from the solar panels and batteries can flow to the repeater payload. The overall spacecraft length at launch is 112 inches (284 centimeters); its maximum diameter is 85.33 inches (217 centimeters). After antenna deployment and extension of one solar panel cylinder, the overall spacecraft length is 265 inches (673 centimeters). It has an in-orbit weight of 1452 lb (659 kilograms) after consumption of apogee motor propellants.

The spinning structure is built around a central thrust tube composed of two frustrum cones, a cylinder, and five frames. The equipment shelf, attached to the thrust tube, is an aluminum honeycomb sandwich platform with aluminum facesheets. The despun compartment structure consists of a monocoque conical frustrum, annular and cylindrical honeycomb sandwich shelves, and a pair of bipods which support the antenna assembly. All communication equipment is located on the despun honeycomb sandwich shelves. Four locking devices at the spinning shelf rim join the despun and spinning sections for launch. Axial loading from the solar arrays, batteries, and the despun communication equipment is carried directly to the spacecraft base through a load path comprising the Bearing and Power Transfer Assembly (BAPTA), the spun shelf, and struts to the separation plane, while lateral loading is transferred to the central thrust cone via the spinning shelf and launch locks. Four polar mounted propulsion tanks between eight radial support struts are connected by tubular bipod/tripod structures to the central cone.

The spinning equipment shelf, supported at and near its rim by eight struts, carries earth sensors, radial thrusters and batteries on the forward face and, on the aft face, the encoders, decoders, power control electronics, and attitude control equipment. Components also are mounted to the central thrust tube cone. These include the axial thrusters, the safe and arm unit, the spacecraft/PAM interface umbilical connectors, and the bus limiters. The solar array substrate is rigidly attached to the spinning shelf via eight shear bearing fittings which minimize local substrate deformation.

Various spacecraft components are stowed in the launch position and subsequently released by firing pyrotechnic devices (squibs). Among those items restrained are the reflector and omni antennas, the despun shelf, and the aft retracted solar panel. In the stowed position, the antenna reflector is folded over the despun shelf and secured at four places. The omni antenna folds above the reflector and is retained at one point. The despun shelf is secured at four places while the aft solar panel is locked at three attach fittings. The squib driver circuits for the shelf and panel release bolt cutters are located in the squib and solenoid driver unit while the antenna releases are fired through driver circuits in the antenna positioner electronics box. All mechanisms are provided with redundant squibs.

The spacecraft configuration uses a part of the solar panel drum as a dedicated, mirrored, thermal radiator. Ninety percent of spacecraft thermal dissipation is provided by this radiator which provides a low temperature, highly stable, heat sink for battery temperature control. A small annular radiator on the substrate forward end provides equipment thermal dissipation in transfer orbit when the stowed aft panel covers the primary drum radiator. A low emittance, despun, thermal radiator barrier on the forward end helps stabilize equipment temperatures. The aft end enclosure is a low thermal barrier, black outboard that protects the interior of the spacecraft from apogee motor plume impingement and solar heat.

The Anik-D1 6/4 GHz satellite communications subsystem consists of two basic sections: a dual polarization-selective grid antenna that provides independent transmit and receive beams at both polarizations, and a communications repeater composed of broadband input and channelized output sections. The communications subsystem receives low-level signals from the transmitting ground stations, amplifies and converts these signals from 6 GHz to 4GHz, channelizes the signals for routing to the output Traveling Wave Tube Amplifiers (TWTAs) where the signals are further amplified, and then feeds them to the high gain antennafor transmission.

The telemetry, command/track, and ranging subsystem provides the ground command capability and the spacecraft performance and status information required to properly control the spacecraft. The subsystem also provides single-axis spacecraft communications antenna pointing information to the Attitude Control Subsystem (ACS) by monopulse tracking the command uplink signal (RF beacon tracking function). The subsystem can be configured as a transponder for transfer orbit tone ranging. All RF hardware is located on the despun side of the spacecraft. The baseband Telemetry and Command (T&C) hardware consists of redundant despun command decoders and telemetry encoders and redundant spinning command decoders, telemetry encoders, and squib and solenoid drivers. The baseband spinning and despun units interface through signal slip rings contained within the BAPTA.

The spacecraft telemetry subsystem gathers subsystem performance, sensor, status, and attitude information necessary for the proper operation of the spacecraft. The subsystem provides this information via an RF downlink during transfer orbit, drift orbit, and on-station operation.

A command subsystem, consisting of two identical, redundant, and simultaneously operating channels of receiving demodulation and decoding hardware, continually provides complete control capability over all spacecraft states and modes of operations; however, all commanded automatic functions can be overidden by ground command. The command subsystem is also equipped to handle baseband formats used for special functions. These are the axial thruster off-pulsing and pseudo earth formats.

The command subsystem includes a spinning squib and solenoid driver unit, and despun squib drivers located in antenna positioner electronics. The spinning unit contains squib drivers to initiate pyrotechnic devices for firing the apogee motor and for releasing the despun shelf and solar panel locks. It also contains valve drivers for the axial and radial thrusters and the latch valves. The despun squib drivers release the omni antenna mast and the communication antenna reflector. All squib firing commands are provided with separate enable commands and enable status telemetry. Solenoid drivers are used to actuate isolation latch valves and the thruster valves in the reaction control subsystem. Each solenoid driver can be actuated by either of two spinning decoders.

The ACS provides velocity control, spin axis attitude control and stabilization, and antenna pointing control throughout the spacecraft mission lifetime. Velocity maneuvers are executed by ground commanded thruster firings, while attitude maneuvers may be accomplished by either ground command or autonomous thruster pulsing. These maneuvers and the spin speed operating range are selected so that no additional spin control is required for a nominal mission, while positive spin control is provided if necessary. Data for ground attitude determination are supplied by sun and earth sensors during transfer and drift orbits.

The power subsystem consisting of solar panels, batteries, power control electronics and wiring harnesses, is designed to satisfy all spacecraft load requirements for the mission lifetime. Spacecraft power is provided by a single bus located on the spun section; power is delivered to the despun section via the BAPTA redundant power slip rings. During sunlight operation, all spacecraft loads receive power from the main solar arrays at 29.75 vdc. The main arrays consist of matrix connections of silicon solarcells. During transfer orbit, the aft cylindrical solar panel, stowed over the fixed forward cylindrical so-lar panel, provides satellite power. In synchronous orbit, the aft panel is extended to its normal position and power at initial operation of 1000 watts is supplied by both solar panels. Three 32-cell, 17.3 A-hr nickel-cadmium batteries provide electrical energy during launch, transfer orbit, and solar eclipses. The batteries are on-line during sunlight operation to supplement the solar arrays in supplying power for fault clearing or transients. The batteries are charged by charge arrays which can be commanded to achieve the desired charge rate.

The RCS performs satellite velocity and attitude control maneuvers in response to onboard and ground commands. When commanded, the thruster valve opens and hydrazine is pressure-fed to the thruster, which catalytically decomposes the hydrazine to produce thrust. The propellant is contained in two conispherical titanium alloy tanks per half subsystem. A cross-connect latch valve allows transfer of propellant between subsystem halves, making all propellant available to any thruster. Each half subsystem contains a squib valve in the gas main-fold connecting the two tanks, preventing propellant migration when the tanks are at different heights during launch operations.

There are two thrusters per half subsystem, one axial and one radial. Radial thrusters operate individually for station acquistion and spacecraft east-west station keeping. The more heavily used axial thrusters provide ANC (post-PAM separation), station acquisition, injection error corrections, attitude trim, and north-south station keeping. All thrusters are operated in the pulse mode with the axial thrusters also operating in the continuous mode. Operating requirements are derived from spacecraft attitude control and station keeping requirements.

DELTA LAUNCH VEHICLE

First launched by NASA in May 1960, the reliable Delta vehicle can be utilized in various combinations of stages and strap-on motors, sized to meet the particular requirements of individual missions. The Delta has been flown as a two- or three-stage vehicle, with zero, three, six, or nine Castor II or nine Castor IV solid propellant motors attached to the first stage. A Delta is now 116 feet (35.4 m) tall and 8 feet (2.4 m) in diameter (not including the solids). This vehicle has a gross weight of approximately 422,688 pounds (191,731 kg) at liftoff.

Stage I is a long-tank derivative of the Thor vehicle, measuring 74 feet (22.5 m) in length and 8 feet (2.4 m) in diameter. It is powered by a Rocketdyne RS-27 main engine system that burns RP-1 and liquid oxygen. The main engine, plus the two vernier engines, is rated at 207,000 pounds (920,777 N) of thrust at sea level, and has a burn time of approximately 228 seconds.

This vehicle utilizes nine Castor IV solid propellant strap-on motors for additional first stage thrust. A Castor IV is 36.9 feet (11.2 m) in length, 3.3 feet (1 m) in diameter, and weighs about 24,500 pounds (11,113 kg). Each motor delivers an average of 85,270 pounds (379,298 N) of thrust for 57 seconds. Six ignite at liftoff and three ignite after the first six burn out. Total first stage thrust averages 720,620 pounds (3,205,318 N) from liftoff to burnout of the six solids.

Stage II is approximately 21 feet (6.4 m) long and 68 inches (173 cm) in diameter. The new AJ10-118K main engine, built by Aerojet General uses nitrogen tetroxide as the oxidizer and Aerozene-50 as the fuel. It produces 9,900 pounds (44,035 N) of thrust and can burn for over 430 seconds.

The second stage has an 8-foot (2.4 m) wide and 11-inch (28 cm) high structural assembly called the miniskirt attached 3.5 feet (1 m) from its top. This miniskirt rests on an 8-foot (2.4 m) diameter interstage barrel 15.5 feet (4.7 m) high, which extends upward from the top of the first stage. A 26-foot (7.9 m) high fairing sits on top of the miniskirt and completes the exterior view of the vehicle. The second stage hangs down inside the interstage and extends up into the fairing, protected from contact with the atmosphere during first stage flight.

The Delta Redundant Inertial Measurement System (DRIMS), which controls the flight of the vehicle, is mounted in the second stage. It consists of an inertial sensor package and a digital guidance computer. The sensor package provides vehicle attitude and acceleration information to the guidance computer, which controls the sequence of operations. The guidance computer generates vehicle steering commands for Stage I and II. These steering commands correct trajectory deviations by comparing computed positions and velocities against established values. The computer also controls timing, staging, and engine restarts, including those for engineering experimental burns performed after the main mission. The PAM stage is held on a steady course by its spinning motion, and requires no guidance.

TELESAT-F (ANIK-D1) LAUNCH WINDOWS

Date			Window No. 1 Open	Close	Duration (min.)	Window No. 2 Open	Close	Duration (min.)	Window No. 3 Open	Close	Duration (min.)
August	19	EDT	1922	1926	4	2006	2011	5	2051	2143	52
		GMT	2322	2326		0006*	0011*		0051*	0143*	
	20	EDT	1922	1927	5	2007	2011	4	2051	2143	52
		GMT	2322	2327		0007*	0011*		0051*	0143*	
	21	EDT	1921	1927	6	2007	2012	5	2051	2143	52
		GMT	2321	2327		0007*	0012*		0051*	0143*	
	22	EDT	1921	1928	7	2007	2012	5	2051	2143	52
		GMT	2321	2328		0007*	0012*		0051*	0143*	
	23	EDT	1921	1928	7	2008	2012	4	2052	2142	50
		GMT	2321	2328		0008*	0012*		0052*	0142*	
	24	EDT	1920	1928	8	2008	2013	5	2052	2142	50
		GMT	2320	2328		0008*	0013*		0052*	0142*	
	25	EDT	1920	1929	9	2008	2013	5	2052	2141	49
		GMT	2320	2329		0008*	0013*		0052*	0141*	
	26	EDT	1919	1929	10	2009	2013	4	2052	2140	48
		GMT	2319	2329		0009*	0013*		0052*	0140*	
	27	EDT	1919	1929	10	2009	2013	4	2053	2140	47
		GMT	2319	2329		0009*	0013*		0053*	0140*	
	28	EDT	1918	1930	12	2009	2014	5	2053	2139	46
		GMT	2318	2330		0009*	0014*		0053*	0139*	
	29	EDT	1918	1930	12	2010	2014	4	2053	2138	45
		GMT	2318	2330		0010*	0014*		0053*	0138*	
	30	EDT	1917	1930	13	2010	2014	4	2053	2138	45
		GMT	2317	2330		0010*	0014*		0053*	0138*	

* Next day

ANTICIPATED TELEMETRY COVERAGE

It is planned that Delta-164 telemetry data will be received by TEL-IV, Merritt Island Unified S-band Station (MIL), Antigua (ANT), Dakar (DKR), Ascension - ETR (ASC), and Ascension - STDN (ACN). Anticipated coverage times during powered flight are shown on page 14. The data flow is shown on page 13. Realtime data will consist of STDN 56 kbps format, special groups as shown on pages 11 and 12, and the total data from TEL-IV, and special spacecraft circuits. DKR will support, receive, and record on an engineering basis. ARIA will not support this mission.

Antigua Retransmission

Transmit System	Vehicle VCO	Data
	High Freq Subcable	
80 khz VCO	2-G	PCM
	Low Freq Subcable	
VCO-C	2-E	PDM
-A	2-A	Triax Accelerometer, Thrust
-13	2-13	Engine Chamber Pressure
-12	2-12	Triaxial Accelerometer, Pitch
-11	2-11	Triaxial Accelerometer, Yaw
-10	3-17	Thrust Accelerometer
-9	3-16	Yaw Accelerometer
-8	2-8	Roll/Pitch Jet Actuation
-7	2-7	Pitch/Roll Jet Actuation
	Low Low Freq Subcable	
-6	2-6	Yaw Jet Actuation
-5	2-5	Control Battery Current
-4	3-15	Pitch Acceleration
-3	3-14	Roll Rate

Ascension ETR to AE/CIF

VCO	Vehicle VCO	Data
1	2G-4	Roll/Attitude Error
2	2-8	Roll/Pitch Jets
3	2-7	Pitch/Roll Jets
4	2G-5	Pitch Attitude Error
5	3-12	Yaw Rate
6	3-15	Pitch Accel
7	3-18	Motor Chamber Pressure
8	----	IPPS Time

Ascension STDN to AE/CIF Via STDN Comsat and GSFC

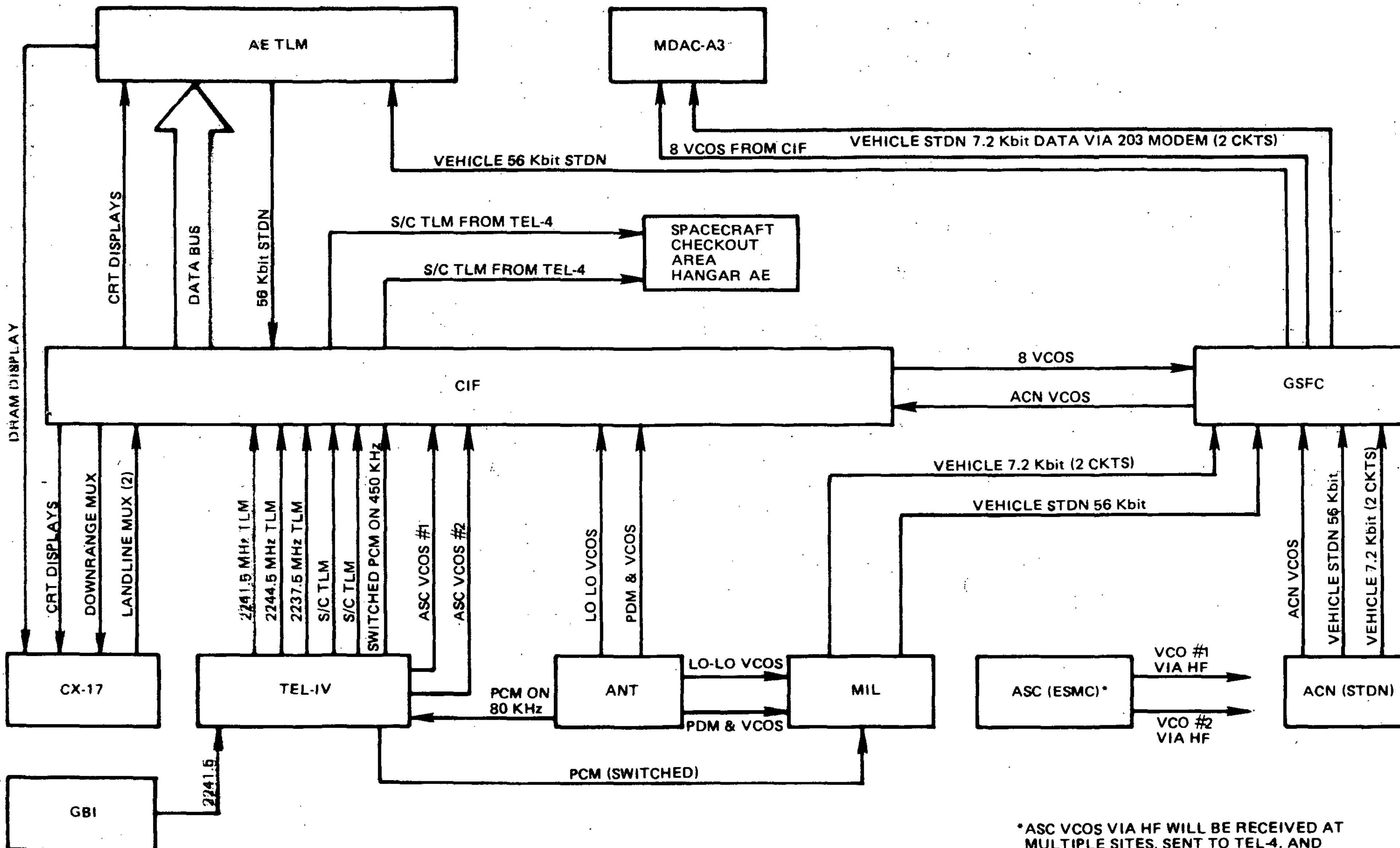
VCO	Vehicle VCO	Data
1	3-12	Yaw Rate Gyro
2	3-13	Pitch Rate
3	3-14	Roll Rate
4	3-15	Pitch Accel (Lower)
5	3-16	Yaw Accel (Upper)
6	3-17	Thrust Acceleration
7	3-18	Motor Chamber Pressure
8	----	Time

Ascension ETR to AE/CIF

VCO	Vehicle VCO	Data
1	2E-20	Control Battery Voltage
2	2E-27	Nitrogen Reg Press
3	2G-6	Yaw Attitude Error
4	2-6	Yaw Jets
5	3-13	Pitch Rate
6	3-16	Yaw Radial Accel (Upper)
7	3-17	Thrust Accel
8	----	Time

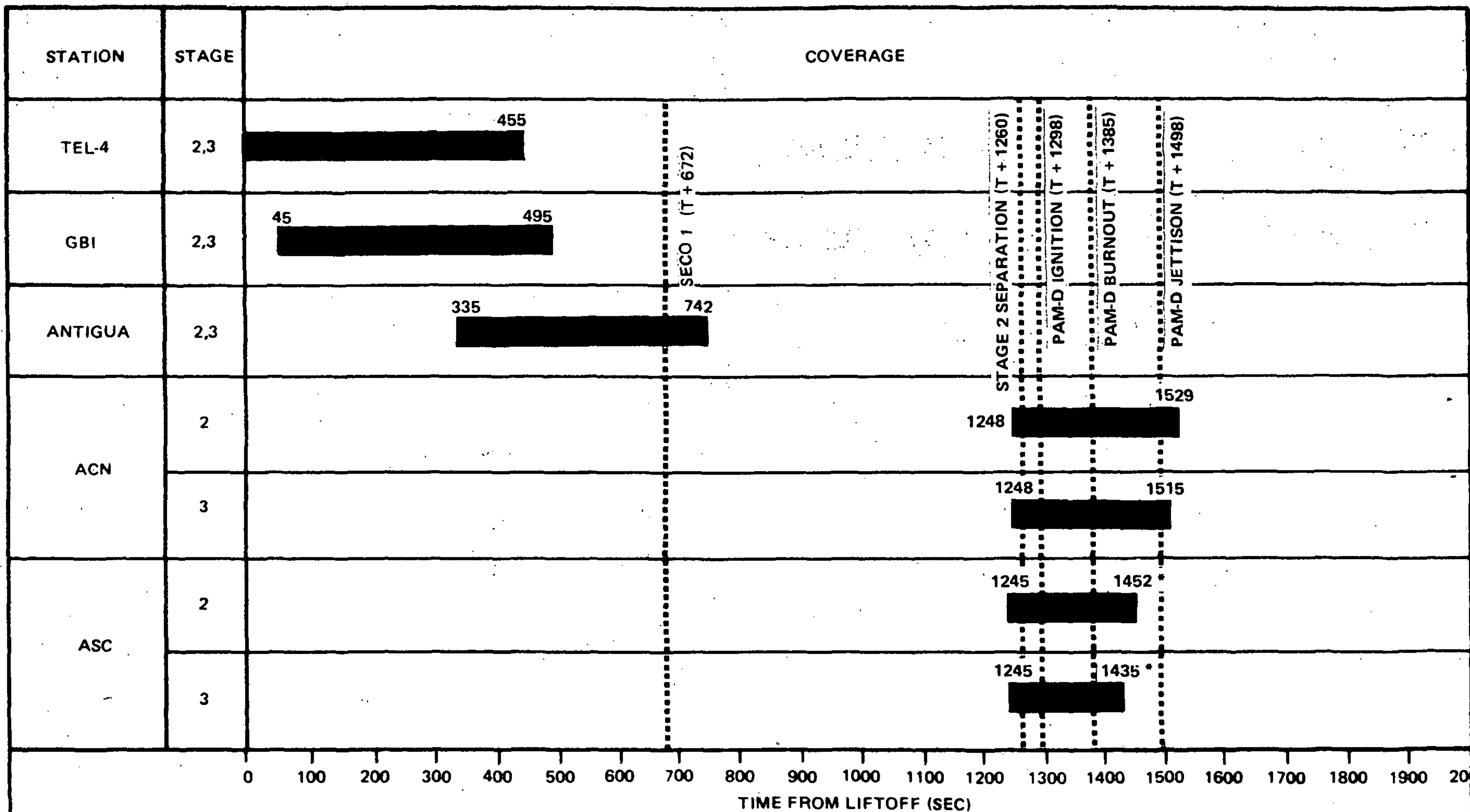
NOTE: All 2G channels to have a DAC shift of 3.

REALTIME TELEMETRY DATA FLOW



*ASC VCOS VIA HF WILL BE RECEIVED AT MULTIPLE SITES, SENT TO TEL-4, AND TEL-4 WILL SEND BEST SOURCE TO CIF.

VEHICLE TELEMETRY COVERAGE



ORBITAL SUPPORT AFTER PAM SEPARATION WILL BE PROVIDED BY HAW, GWM, WTR/NTM, MIL, TEL-4, ANT, ASC AND ACN

*CUT OFF BY GREEN MOUNTAIN

TELESAT-F (ANIK-D1) SELECTED TRAJECTORY INFORMATION

Parameter	Max Dynamic Pressure	Jettison Last Solid Motor	MECO	Stage I/II Sep	SECO	Jettison Stage II	Jettison PAM
Time (sec)	53.256	122.000	223.819	231.819	671.860	1260	1498
Surface Range (nm)	3.18	38.506	207.363	228.434	1609.743	3885.938	4969.119
Altitude (nm)	5.95	25.196	58.458	61.847	106.653	100.627	126.571
Inertial Velocity (ft/sec)	2953.026	7630.399	17,804.355	17,814.197	25,572.147	25,609.798	33,529.636
Thrust (lb)	809,902.39	229,664.44	215,905.40	0.00	7823.53	0.00	0.00
Vehicle Weight (lb)	264,352.45	114,397.31	36,313.78	24,298.89	10,169.94	10,163.79	3054.50
Vehicle Axial Accel (ft/sec^2)	84.46	64.0043	191.2914	0.00	24.72	0.00	0.00
Dynamic Pressure (lb/ft^2)	1289.89	61.17	0.03	0.01	0.00	0.00	0.00

TELESAT-F (ANIK-D1) SEQUENCE OF EVENTS

T+Sec	Min:Sec	Event
T-0.2		Solid motor ignition (1,2,3,7,8,9)
T+0.0	00:00.0	Liftoff
T+2.0	00:02.0	Begin first roll program
T+6.0	00:06.0	Stop first roll program
		Begin first pitch program
T+12.0	00:12.0	Begin second pitch program
T+13.0	00:13.0	Roll gain change
T+15.0	00:15.0	Begin third pitch program
T+20.0	00:20.0	Begin fourth pitch program
		Pitch and yaw gain change
T+30.0	00:30.0	Begin fifth pitch program
T+34.0	00:34.0	Pitch and yaw gain change
T+40.0	00:40.0	Begin sixth pitch program
		Roll gain change
T+50.0	00:50.0	Begin seventh pitch program
T+53.0	00:53.0	Pitch and yaw gain change
T+55.0	00:55.0	Continue pitch program
T+56.9	00:56.9	Solid motor burnout (1,2,3,7,8,9)
T+60.0	01:00.0	Begin eighth pitch program
		Pitch and yaw gain change
T+62.0	01:02.0	Solid motor ignition (4,5,6)
T+65.0	01:05.0	Continue pitch program
T+69.5	01:09.5	Solid motor separation (1,2,3)
T+70.0	01:10.0	Begin ninth pitch program
		Pitch and yaw gain change
T+70.5	01:10.5	Solid motor separation (7,8,9)
T+75.0	01:15.0	Continue pitch program
T+80.0	01:20.0	Begin tenth pitch program
T+90.0	01:30.0	Begin eleventh pitch program
T+100.0	01:40.0	Begin twelfth pitch program
		Roll gain change
T+110.0	01:50.0	Begin thirteenth pitch program
T+119.1	01:59.1	Solid motor burnout (4,5,6)
T+120.0	02:00.0	Begin fourteenth pitch program
T+122.0	02:02.0	Pitch and yaw gain change
		Solid motor separation (4,5,6)
T+128.0	02:08.0	Begin fifteenth pitch program
T+135.0	02:15.0	Start guidance
T+203.8	03:23.8	Switch to velocity steering
T+213.8	03:33.8	Stop stage I closed loop guidance
T+220.0	03:40.0	Stop fifteenth pitch program
T+223.8	03:43.8	MECO
		VE enable/main engine lockout
		Stage II hydraulic pump on (backup)
		Arm stage II ign and pyro pwr
T+225.8	03:45.8	Pressurize tanks
T+229.8	03:49.8	VECO
T+231.8	03:51.8	Blow stage I/II separation bolts
T+236.8	03:56.8	Start stage II engine
T+237.8	03:57.8	Remove tank pressurization
T+242.0	04:02.0	Begin sixteenth pitch program
T+244.0	04:04.0	Fairing unlatch
T+245.0	04:05.0	Fairing separation
T+260.0	04:20.0	Start guidance
T+574.3	09:34.3	Pitch and yaw gain change
T+621.9	10.21.9	Switch to velocity steering
T+668.9	11:08.9	Switch to acceleration only steering
T+670.7	11:10.7	Stop guidance
T+671.9	11:11.9	SECO 1
		Disarm stage II ign and pyro pwr
		Turn off hydraulic pump
T+723.9	12:03.9	Turn off CDRs
T+750.0	12:30.0	Begin seventeenth pitch program
T+850.0	14:10.0	Stop seventeenth pitch program
T+860.0	14:20.0	Begin first yaw program
T+900.0	15:00.0	Stop first yaw program
T+1197.0	19:57.0	Begin coast guidance No. 1
T+1247.0	20:47.0	Stop coast guidance No. 1
T+1256.1	20:56.1	Arm stage II ign and pyro pwr
T+1258.1	20:58.1	Fire spin rockets
		Start PAM CDF
T+1259.1	20:59.1	Fire stage III wire cutters
T+1260.1	21:00.1	Blow stage II/III separation bolts
T+1262.1	21:02.1	Disarm stage II ign and pyro pwr
T+1270.1	21:10.1	PAM D ignition
		Start payload separation pyro
T+1357.1	22:37.1	PAM D burnout
T+1498.1	24:58.1	Payload separation

T+Sec	Min:Sec	Event
T+1500.1	25:00.1	Release YO weight
T+4190.0	69:50.0	Begin second roll program
T+4340.0	72:20.0	Stop second roll program
T+4350.0	72:30.0	Begin eighteenth pitch program
T+4550.0	75:50.0	Stop eighteenth pitch program
T+4601.0	76:41.0	Start coast guidance No. 2
T+4651.0	77:31.0	Stop coast guidance No. 2
		Initiate ullage jets
		Arm stge II ign and pyro pwr

T+Sec	Min:Sec	Event
T+4684.0	78:04.0	Turn on hydraulic pump
T+4700.0	78:20.0	Stage II depletion restart
T+4701.0	78:21.0	Turn off ullage jets
T+4717.4	78:37.4	Stage II depletion shutdown
T+4790.0	79:50.0	Initiate ullage jets
		Turn off hydraulic pump
T+4930.0	82:10.0	Turn off ullage jets
T+4932.0	82:12.0	Disarm stage II ign and pyro pwr

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Code MV - NASA HQ Washington, DC	3
EX	1
TRW, E&O 211	4
TI	1
TI-CSD	1
TI-CSD-3	1
TI-INS	1
TI-INS-31	2
TI-INS-3	1
TI-INS-32	1
SI-SRV-1	1
SF-SEC-2	2
CV	4
SP-VSTS, KSC WSMC Opn Div P. O. Box 425, Lompoc, CA 93436	2
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