

SPACE PRODUCTS



OUR EXPERIENCE, YOUR SWITCH SOLUTION SINCE 1945



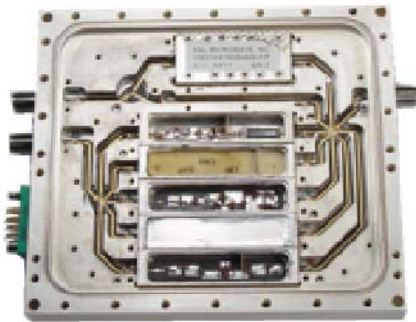
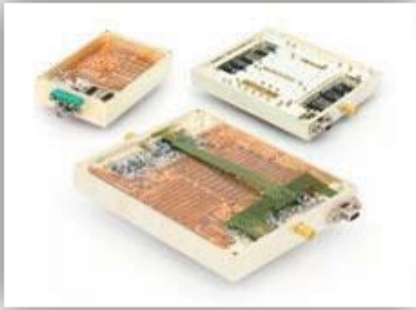
1U Model



2U Model



3U-4U Model



OUR HERITAGE, YOUR SWITCH SOLUTION

Space business experts stress the three most critical aspects of supplier selection: heritage, heritage, heritage.

Dow-Key Experience

We have been a premier supplier of space qualified coaxial and waveguide switches since 1970. Dow-Key Microwave designs, fabricates and test all integrated switch blocks assemblies and individual switches in our Ventura, California facility, about 1 hour drive north of Los Angeles international airport. Our switches have had an in-flight failure free record in over 100 different space programs using 150 different product designs. With decades of experience and knowledge we are confident in providing High Reliability solutions which can withstand the severe environments that space imposes on complex systems.

Dow-Key Space Team

We have an entire team of experts — from devoted sales and program managers, QA and procurement personnel to design, test, and manufacturing engineers — dedicated solely to space production that is supported by a well trained and certified group of technicians and production personnel. Our entire staff is fully dedicated to our customer base, with comprehensive focus on each project from the design phase through final test and beyond.

Dow-Key Facility, Quality and Equipment

Dow-Key Microwave has heavily invested in technical staff and capital equipment to provide the right environment and tools for manufacturing products of the highest quality and reliability for use in manned and unmanned space vehicles.

Facility/Test Equipment

- Two Class 7 Clean Rooms with humidity and temperature controlled environment
- Prohibited materials and screening chamber
- Three full time T-VAC test stations
- RF Power and Multipaction stations
- Vibration Room

Design Software:

- AutoCAD
- SolidWorks
- HFSS (High Frequency Structural Simulator)
- Cosmos FEA (validation and failure mode simulation)

Quality Certifications:

- Quality Management System (QMS) evolved from MIL-Q-9858A & MIL-I-45208
- DOD classified certifications
- AS9100/ISO-9001:2000 Certified through BSI Management Systems

1970-1979	
1972	
818-SPDT	SYMPHONIE
1975	
700-TRANSFER	METEOSAT
1976	
33-WAVEGUIDE	TELESTAR
300-TRANSFER	MAROTS
707-TRANSFER	SPACE SHUTTLE
1977	
700-TRANSFER	CRRES
700-TRANSFER	SCATHA
909-SPDT	SEASAT
1978	
707-TRANSFER	EXOSAT
707-TRANSFER	INTELSAT V
1979	
707-TRANSFER	SATCOM
800-SPDT	TDRSS
808-SPDT	INSAT
909-SPDT	RADARSAT

1980-1989	
1980	
909-SPDT	ANIK D
1981	
33-WAVEGUIDE	TELECOM1
305-TRANSFER	SPACE SHUTTLE
808-SPDT	NAVSTAR GPS
1982	
33-WAVEGUIDE	NATO III
33-WAVEGUIDE	ECS
406H-SPDT	IUS
1983	
33-WAVEGUIDE	TV SAT
33-WAVEGUIDE	ISPM
402H-SPDT	GPS2F
707-TRANSFER	GIOTTO
1984	
33-WAVEGUIDE	IBS
700-TRANSFER	DSP1
805-SPDT	SKYNET
909-SPDT	LSAT
909-SPDT	SKYNET IV
1985	
700-TRANSFER	TOPEX
707-TRANSFER	HIPPARCOS
707-TRANSFER	DFS
808-SPDT	SHUTTLE/ CENTAUR

1986	
707-TRANSFER	EURECA
707-TRANSFER	ERS 1
909-SPDT	SKYNET
1987	
707-TRANSFER	EUTELSAT
959-DP3T	ANIK E
1988	
33-WAVEGUIDE	EUTELSAT II
33-WAVEGUIDE	ENVISAT RA-2
707-TRANSFER	INSAT II
737-T-SWITCH	ITALSAT

1990-1999	
1990	
33-WAVEGUIDE	SPOT 4 HELIOS
737-T-SWITCH	TELCOM II
1992	
33-WAVEGUIDE	TURKSAT
33-WAVEGUIDE	AMOS
707-TRANSFER	SAX
818-SPDT	CENTAUR
1993	
401H-SPDT	EUROPEAN MOBILE SAT.
780-SP8T	INMARSAT
1994	
411H-TRANSFER	INMARSAT III
1995	
411H-TRANSFER	PANAMSAT
1996	
33-WAVEGUIDE	HOT BIRD 3
707-TRANSFER	LANDSAT VII
909-SPDT	SARSAT
1997	
33-WAVEGUIDE	SKYNET IV
818-SPDT	DELTA LAUNCH
919-SPDT	TIROS
1998	
33-WAVEGUIDE	SICRAL
406H-SPDT	METEOSAT
421H-SPST	MILSTAR
1999	
818-SPDT	ATLAS V
406H-SPDT	SAP-308

2000-2013	
2000	
406H-SPDT	ALOS
413H-TRANSFER	FOS
919-SPDT	SST
406H-SPDT	OPTUS
411H-TRANSFER	NEW SKIES
700-TRANSFER	CORIOLIS
426H-SPDT	GOES
2001	
707-TRANSFER	SMART I
707-TRANSFER	CLOUD SAT
249-SPDT	DOCOMO
2002	
33-WAVEGUIDE	DEEP IMPACT
401H-SPDT	GPS
401H-SPDT	GE 15/16
411H-TRANSFER	INMARSAT IV
511H-T-SWITCH	INSAT III
707-TRANSFER	DEEP IMPACT
2003	
401-SPDT	PEGASUSA
33-WAVEGUIDE	LRO
511H-T-SWITCH	ISRO
2004	
33-WAVEGUIDE	KEPLER
2005	
511H-T-SWITCH	MUOS
818-SPDT	ULA
2006	
406H-SPDT	ARG. GOVT
2007	
H9-SWITCH BLOCK	KOMPSAT
818-SPDT	ATLAS V
2008	
402H-SPDT	GPS-2F
401H-SPDT	LOUTCH
406H-SPDT	SOLAR SAT.
406H-SPDT	H-2A
2009	
406H-SPDT	GLONASS
H9-SWITCH BLOCK	GPS III
2010	
511H-T-SWITCH	GALILEO
700-TRANSFER	GALILEO
2013	
700C77800	GOES
461HQ-730832	AMOS IV

This represents only a fraction of the hundreds of Dow-Key switches that have been a part of space missions over the past 40 years.

2014	Program
511H-730332	WGS
511H-730332	TDRS
406HJC-730332	GPS III, SV4-8
411HQ-730832	Block 3
H9014, 6 Sw Assy*	GPS III, SV 4-8
H9016, 4 SW Assy*	GOES T
406H-730332	Classified
406HJC-730332	GPS 2F Upgrade
33C96600*	JWST
700C78800	JWST

2015	Program
707C78800-37	Solar Probe
33C51400 WR-112	Solar Probe
33C98100-2, WR-28	Block 3
33D13700-6, WR-15	Block 3
919C70200-12	Missile Defense
H9016, 4 SW Assy*	GOES U
406HJ-730332	GLONASS #2

2016	Program
509H-7311	JC17
413HCJ-730332	Galileo #2
707C78800	Galileo #2
33H-73122C32	EMM (Emirate Mars Mission)
818D30900	ULA
707C78800-43	EMM (Emirate Mars Mission)

2017	Program
H9014, 6 SW Assy*	GPS III SV 9-10
H9016, 4 SW Assy*	GOES Spare
406HJC-730332-6	GPS III SV 9-10
401H-720832	GPS III
H9056, WR-34 Assy*	JPSS II
33HJ-7351C32, WR-51	APEX
707C78800	Tenacious
33HJ-732822-1, WR-28	Block 3
707C78800-48	APEX

2018	Program
H9064, Dual 6 Sw Assy*	Dream Chaser
441HCJ-790832	ORION
33HJ-7342C32, WR-42	Zena
413HCJ-730332	Galileo #3
707C78800	Galileo #3
401H-730832	Smallsat
33HJ-7315C30, WR-15	Magnus

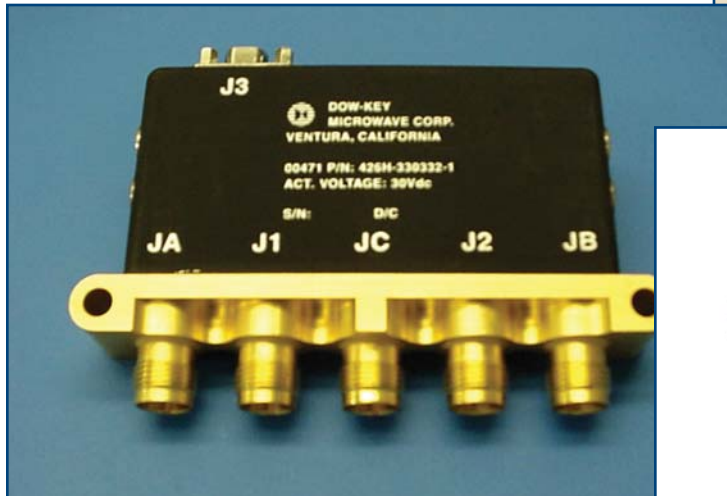
* Indicates assembly with Cables/Waveguide, Power Dividers, Circulators, Terminations & other components

SPDT

Dow-Key's innovative and proven high reliability, superior RF performance, and low current/magnetic latch SPDT switches have played a part in hundreds of successful space missions since the 1970s. Some of these missions include: GPS III (Global Positioning System), Atlas (launch vehicle), Pegasus (rocket), Milstar (satellite communication system), and Optus (leading operator of satellites in the Asia Pacific region).



421H SPDT



426H SPDT



413 SPDT Terminated

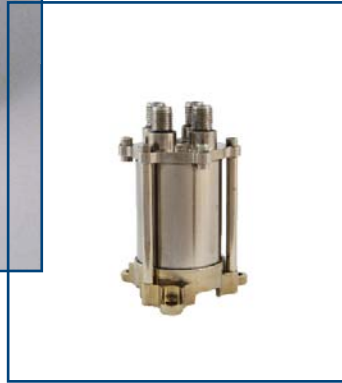
Series*	Description	Frequency GHz	VSWR (max)	Isolation dB (min)	Ins. Loss dB (max)	Weight g (max)	Life Cycles (min)	Power W CW
401H	SPDT, Low Power	DC-22	1.45	65	0.45	55	200,000	7
401HY	SPDT, Low Power	DC-27	1.45	60	0.45	55	100,000	2
401HY	SPDT, Low Power	DC-40	1.75	55	0.70	58	100,000	2
402H	SPDT, High Power	DC-10	1.50	60	0.50	130	100,000	160
406H	SPDT, Medium Power	DC-12	1.50	60	0.40	100	100,000	20
406H	SPDT, High Power	DC-10	1.50	60	0.45	115	200,000	140
421H	2/3, Low Power	DC-22	1.45	60	0.45	118	100,000	2
426H	2/3, High Power	DC-10	1.45	60	0.45	135	100,000	25
818	SPDT, High Power	DC-6	1.30	60	0.40	175	100,000	20
909	SPDT, Low Power	DC-18	1.50	60	0.50	60	100,000	4

* All listed products are Pulse Latching, except for 818-Series which is BBM Pulse Latching.

DPDT (Transfer)



707 DPDT



411HQ DPDT

Dow-Key's rigorous quality assurance processes allow transfer switches to be used in critical programs such as Inmarsat-4 satellite system, which supports Broadband and Global Area Network to deliver Internet and intranet content solutions (video, fax, email, LAN access). On other space missions like the GOES weather satellite - a telemetry system, our lightweight (less than 55 grams) and highly reliable qualified transfer switches were a perfect fit.

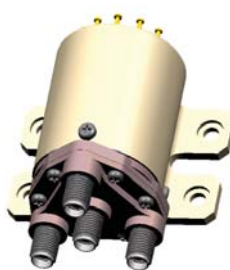
Series*	Description	Frequency GHz	VSWR (max)	Isolation dB (min)	Ins. Loss dB (max)	Weight g (max)	Life Cycles (min)	Power W CW
700	DPDT, Medium Power	DC-10	1.45	60	0.45	140	100,000	30
707	DPDT, Low Weight	DC-18	2	60	0.50	70	100,000	6
411H	DPDT, Low Power	DC-18	1.50	60	0.50	110	100,000	7
411HQ	DPDT, Low Weight	DC-27	1.45	65	0.45	55	200,000	2
4113HAC	DPDT, High Power	1.25-1.65	1.20	60	0.2	185	50,000	50

* All listed products are Pulse Latching.

T-Switch



High Power T-Switch



Medium Power T-Switch

The benefit of a T-switch over a transfer switch is that up to three combinations of RF paths are available, which is perfectly suited for space applications where more than two path combinations (DPDT) are required. In addition to superior RF performance and lightweight/high power capabilities, Dow-Key distinguishes itself from others by introducing random drive (minimizing the switching time) rather than forcing the application to switch RF paths in sequential order. These switches have been qualified in programs including MUOS (space craft), Isro (Indian Space program), and Insat-3 (multipurpose satellite design providing telecommunications, television broadcasting, meteorological, search and

Series*	Description	Frequency GHz	VSWR (max)	Isolation dB (min)	Ins. Loss dB (max)	Weight g (max)	Life Cycles (min)	Power W CW
511H	Medium Power	01.0-8.8	1.25	60	0.24	670	100,000	35
511H	High Power	0.36-0.38	1.22	60	0.10	210	100,000	200
511H	High Power	2.5-4.38	1.25	60	0.20	195	100,000	140
511H	High Power	DC-4	1.25	60	0.25	95	100,000	260

* All listed products are Pulse Latching.

Waveguides: DPDT (Transfer)



WR-15

In 1993 Dow-Key expended its involvement in Hi-Rel space programs with the acquisition of the Transco Space Qualified Products from Datron/Transco Systems in Southern California, including space programs dating back to 1968. In addition to inheriting many of the Hi-Rel (and commercial) waveguide switches, many of the veteran Transco design engineers stayed with Dow-Key and are still employed with us today. Thus, this unique combination of experience and innovation enhances our capabilities. The waveguide switches listed below were included in high profile space missions such as James Webb Telescope and most recently, NASA Parker Solar Probe .



WR-34 Assembly



WR-22

Part Number	Waveguide Size	Dimensions (inches)	Actuator Type	Voltage (Vdc)	Mass (grams)
33D13700	WR 15	2.225 x 3.765 x 1.850	Latching	28	180
33C98100	WR 28	2.045 x 3.035 x 2.045	Latching	28	158
33C96600	WR 34	1.510 x 2.510 x 1.510	Latching	28	150
33C96100	WR 42	2.042 x 3.424 x 2.042	Latching	28	135
33C96000	WR 62	1.810 x 3.414 x 1.810	Latching	28	150
33C94100	WR 75	2.640 x 4.060 x 1.880	Latching	28	140
33C51200	WR 90	2.637 x 3.900 x 1.875	Latching	28	360
33C51400	WR 112	2.173 x 4.400 x 2.175	Latching	28	490
33C13200	WR 15R	2.225 x 3.765 x 1.850	Latching	28	180
33HJ-7351C30	WR 51	2.04 x 3.37 x 1.48	Latching	28	160

Note: Other configurations are available including "R"

Switch Block

Over the years, Dow-Key's outstanding Hi-Rel track record has generated interest in combining space qualified switches and other components such as power dividers in a block of switches to achieve the matrix complexity needed in programs such as GPS-3, Kompsat-3 (satellite), Inmarsat-4, and other classified programs. Experience gained in over 150 years of combined knowledge and practice in design, test, and manufacturing of Hi-Rel products, makes Dow-Key a perfect investment for custom and complex switching needs.



222D50600



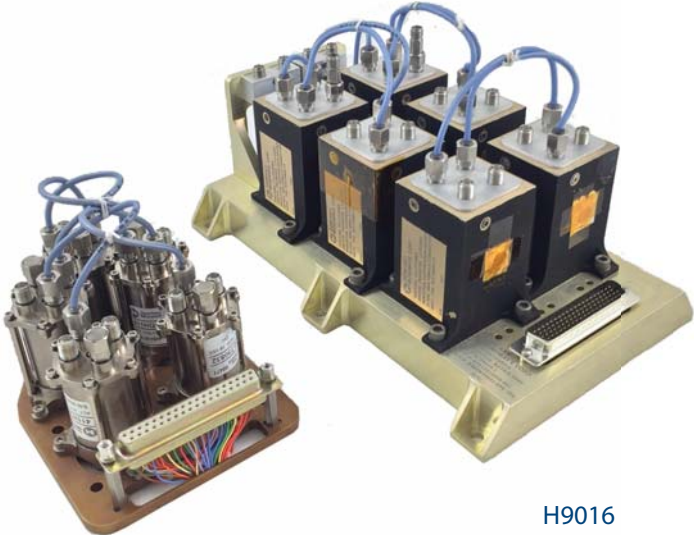
H9010 Switch Block

Series*	Description	Frequency GHz	VSWR (max)	Isolation dB (min)	Ins. Loss dB (max)	Weight g (max)	Life Cycles (min)	Power W CW
H9001	(5) Multi-throw Switches	L-band	1.24	55	0.15-0.25	670	100,000	15
H9010	(8) C-switches, (2) Power dividers	S-band	1.45	60	0.15-4.50	2,660	100,000	7
H9014	(6) C-switches, (2) Power dividers	L/S-band	1.45	60	4.28	2,190	100,000	7
H9016	(2) C-switches, (1) SPDT	X-band	1.45	60	0.60	840	100,000	15
222D50600	WR-51 Waveguide R-Switch Block	Ka-band	1.10	60	0.08	480	100,000	100

* All listed products are Pulse Latching.



H-TBD



H9014

H9016



Facility

Our facility includes two 400 square foot Class 7 clean room with controlled humidity and temperature that are allocated for the most critical assembly processes and in-process testing. Our Environmental Lab is fully equipped with three Thermal Vac chambers as well as a sophisticated vibration table that is fully equipped to perform random and sine vibration, in addition to limited levels of mechanical shock.



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