

# QubeFlex

CubeSat/SmallSat/LEO Satellite Transceiver/Modem



Compliant with CCSDS  
& Intelsat Standards

## Overview

The **QubeFlex™** software defined modem has been specifically designed to provide high performance and reliable reception of transmissions from low-earth orbit Cubesat and smallsat devices. Growing commercial applications demand fast time to market and dependable comms.

The **QubeFlex** modem supports CCSDS telemetry, Intelsat and other common space transmission and packet standards. Forward error correction ensures data is protected against transmission loss. High data rates ensure maximum data can be received on each satellite pass.

The **QubeFlex** demodulator will acquire and remain locked to the signal even when faced with the largest Doppler frequency shifts caused by fast-moving low-earth orbit satellites. Demodulator output is formatted for convenient onward computer processing and storage.

In addition to supporting the standard carrier roll-off factors, the **QubeFlex** modem supports larger than normal roll-off factors to allow users to minimise the peak-to-average-power ratio of the generated waveform. This minimises distortion of the transmitted signal and thereby relaxes the design constraints for the smallsat transmission system, which are typically subject to extreme size, weight and power limitations.

The **QubeFlex** modem includes powerful onboard test equipment (spectrum analyzer and a constellation monitor), and is also capable of detecting satellite beacon transmissions, which removes the need for a separate beacon receiver.

## Markets and Applications

- CubeSat & smallsats
- Low-earth orbit (LEO) satellites
- Earth & weather observation
- LEO space research projects
- Intelligence gathering
- Space telemetry

## Features

- Data rates up to 50Mbps (CCSDS maximum is 50Mbps)
- Support for CCSDS telemetry & Intelsat standards including Viterbi/Reed-Solomon error correction & scrambling
- Modem is protocol agnostic but includes explicit support for CCSDS.
- Modulation includes 2.2 to 2.45 GHz S-band
- Supports other bands (including X) when used with external frequency conversion
- Doppler limits:  $\pm 700\text{kHz}$ ,  $\pm 9\text{kHz/s}$
- Demodulator output options: Ethernet (with optional timestamps & metadata) & EIA-530
- Q-NET™ Navigator network control application included as standard
- Our partners provide fully compatible onboard CubeSat transmission systems - please contact us for details

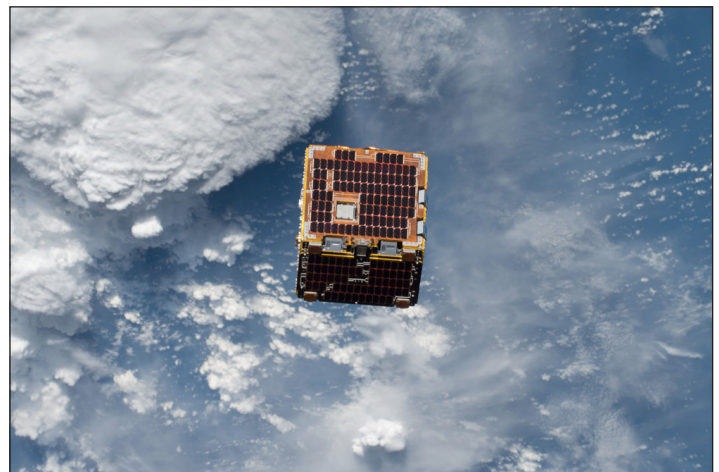


Photo courtesy of NASA

**LEO/SmallSat Application:** The QubeFlex modem may be used to communicate with LEO satellites such as the one pictured above, which was deployed by the International Space Station.

## Why QubeFlex?

Our Flagship Software Defined Modem is Paradise Datacom's most innovative and flexible Satellite Modem to date

### STATE OF THE ART

- Extended roll offs, up to 60%
- Modulation includes 2.2 to 2.45 GHz S-Band

### SECURE

- SCPC is both secure, and with Paradise Modems, easy to provision

### COMPATIBLE

- Supports CCSDS telemetry
- CCSDS compliant Viterbi & Reed-Solomon
- Compatible integrated Tx channel for test purposes
- Supports IF and L-band in one unit.



### CONVENIENT

- Optional BUC power Supply reduces need for external equipment
- Built in Beacon Receiver, Spectrum Analyser and Constellation monitor

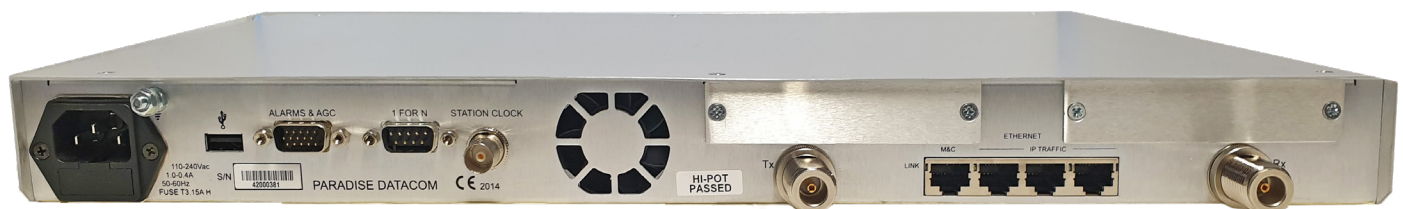
### PRACTICAL

- 1U rack mount chassis
- Simple front panel control with back-lit LCD
- Intuitive web browser and Q-NET compatible
- Built in test tools, no need for expensive test equipment

### EFFICIENT

- 5% spectral roll off, saving 15% bandwidth over the standard 20%
- Extended Doppler limits:  $\pm 700\text{kHz}$ ,  $\pm 9\text{kHz/s}$

## WELL EQUIPPED



### Transmitter

#### Fast:

- Up to 50Mbps CCSDS
- Output power: IF 0 to -25dBm; Standard L-Band 0 to -40dBm

### Interface Ports

#### Convenient:

- 4 GB Ethernet ports, Layer 2 Bridge, Layer 3 router.
- Optional Serial EIA-530 interface
- Optional High-speed LVDS serial interface

### RF Stages

#### Future Proof:

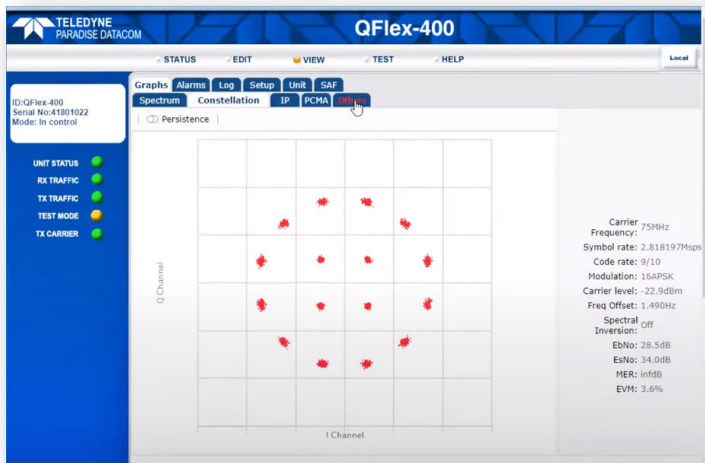
- Transmit and Receive speeds field upgradeable, only pay for the capacity you need now
- Extended L-Band Transmit coverage from 950 to 2,450 MHz
- Wideband IF 50 - 180MHz

### Receiver

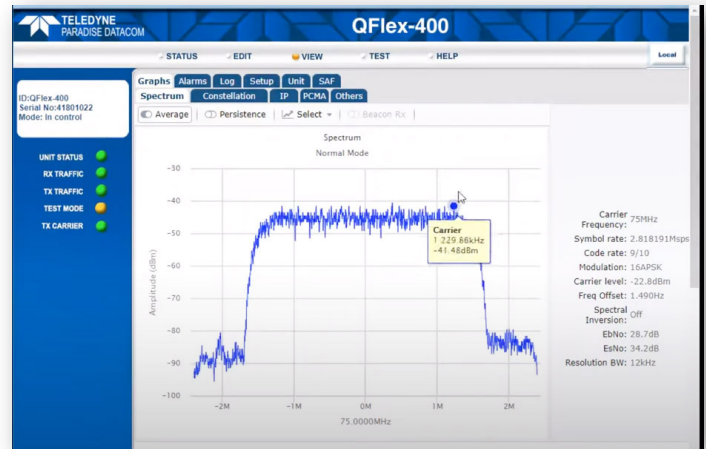
#### Fast:

- Up to 50Mbps
- Extended L-Band receive coverage from 950 to 2,450MHz

## Powerful Onboard Test Equipment



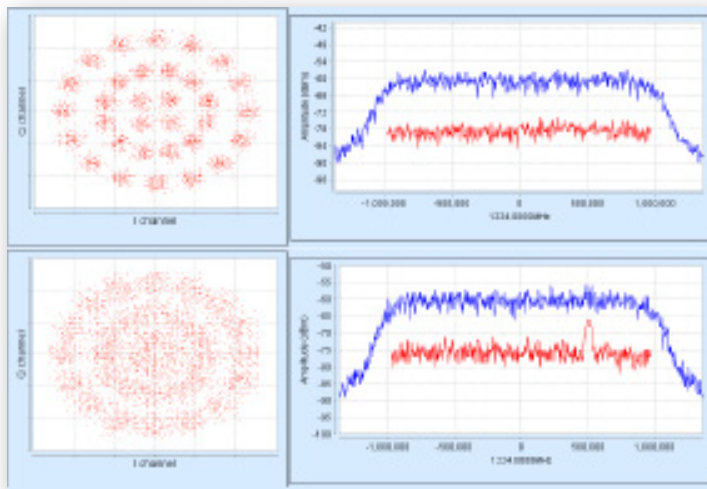
**Constellation view:** The Rx Constellation Monitor can be used to check for correct modem operation including checking for signal distortion and phase noise. The persistence mode is useful for showing any long-term effects due to phase noise and interference.



**Spectral view:** The Rx Spectrum Monitor is a powerful real-time spectrum analyser within the modem that is used to view the received signal spectrum. The monitor can not only display the wanted carrier but a Super Wide view allows checking for adjacent interfering carriers.

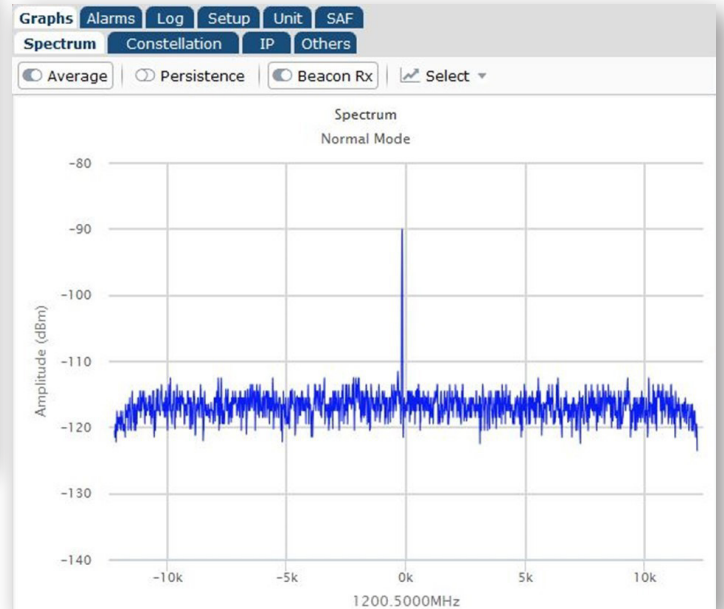
## LinkGuard™ Interference Detection

Built-in Spectrum Analyser showing LinkGuard™ Signal-Under-Carrier interference detection without/with interferer present.



## Beacon Receiver Function

**QubeFlex** detects satellite beacon transmissions down to very low signal levels. This helps with automatic antenna pointing and removes the need for a separate beacon receiver.

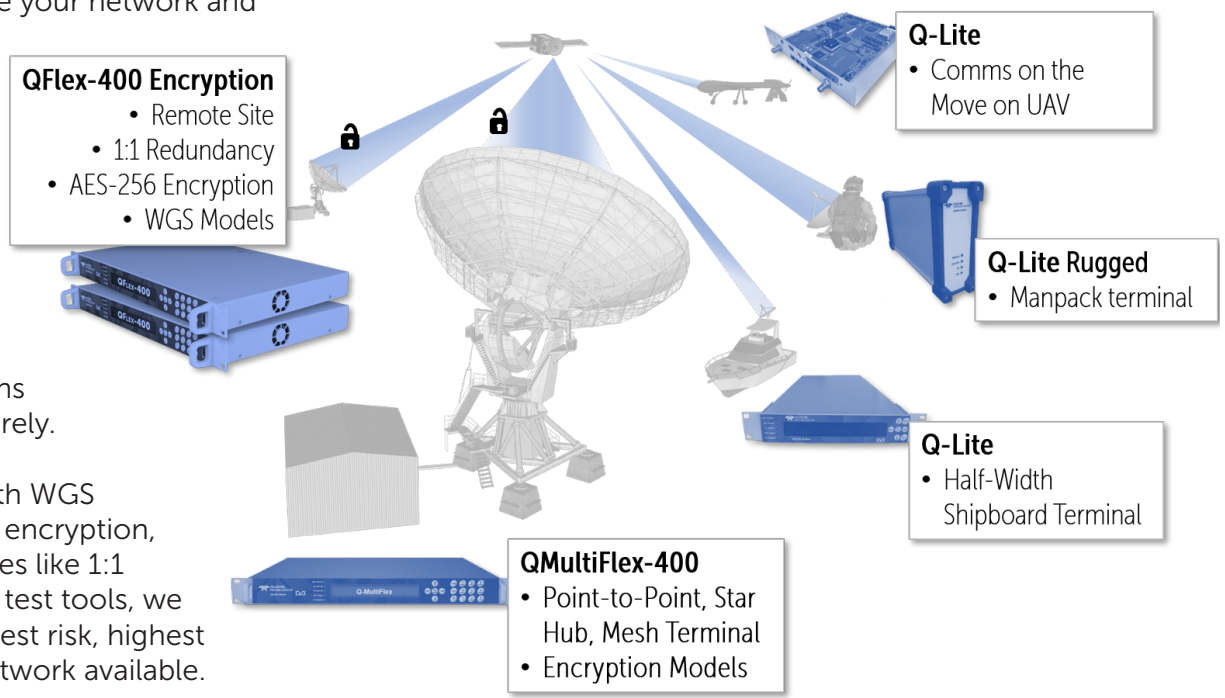


## The Q-Net Family

Q-Net is a fabric that allows each of the Q-Series modems to seamlessly interoperate giving you the ability to upgrade your network and re-use assets at will.

The different models have been thoughtfully designed to cover a wide variety of network situations flexibly and securely.

From models with WGS certification and encryption, to built-in features like 1:1 redundancy and test tools, we give you the lowest risk, highest return secure network available.



## The Paradise Family of Secure SCPC Modems



Paradise SCPC Modems			Point-to-Point	Mesh	Point-to-MultiPoint, Star, Hybrid		Features of Note
					Hub	Remote Site	
Standard	1U 19" Rack	QFlex-400	✓			✓	PCMA+ enhanced carrier overlay available
		QMultiFlex-400	✓	✓	✓	✓	Optional Embedded Hub Canceller
		QFlex-400 P2MP	✓			✓	Configured remote
		QubeFlex	✓				Small Sat/LEO - support for CCSDS
		AXIOM-N	✓			✓	IP-centric modem
Small Form Factor	Rack Mount Half Width	Q-Lite Half Width	✓			✓	Mountable side-by-side in 1U rack space
		AXIOM-C	✓			✓	Compact IP-centric modem
	Rugged	Q-Lite Rugged	✓			✓	IP65 weatherproof outdoor modem
		AXIOM-R	✓			✓	IP67 IP-centric modem
OEM Card	Q-Lite Card	✓			✓	For OEM integration	
	AXIOM-X	✓			✓	Our smallest modem	

All modem models except QubeFlex are also available as **encrypted models**, capable of TCP/IP packet payload encryption using symmetric AES with 256-bit keys. Note that these models are export controlled. The QFlex-400, Q-Lite, Q-Lite Half Width and Q-Lite Rugged models are also available as **WGS-certified** models.

## Main Specifications

Frequency	<b>L-band (standard):</b> 950 to 2,450MHz (covering lower S-band also) (resolution 1Hz) <b>IF (standard):</b> 50 to 180MHz (resolution 100Hz) N-type connectors for Tx & Rx
Data Rates	<b>Standard:</b> 2.4kbps to 2,048kbps <b>Options:</b> 5, 10, 25, 50Mbps (CCSDS maximum is 50Mbps)
Symbol Rate Limits	2.4ksps to 40Msps (CCSDS Tx Max: 24.9Msps Viterbi +RS)
Operating Modes	<b>CCSDS</b> (CCSDS 131.0-B-1) Viterbi & Reed-Solomon <b>Intelsat</b> (IESS-308) Viterbi & Reed-Solomon
Scrambling	<b>CCSDS</b> (CCSDS 131.0-B-1) scrambler <b>Intelsat</b> V.35 scrambler
Impedance	50Ω
Return Loss	<b>L-Band:</b> 950MHz to 2GHz >16dB; 2GHz to 2.45GHz > 12dB <b>IF:</b> > 18dB

## Traffic Interfaces

Standard	4-port Gigabit Ethernet switch for IP traffic and user control of the modem); Automatic conversion of all demodulated data to UDP unicast/multicast packets, with optional timestamp and link metadata. Includes explicit handling of CCSDS, these and all other formats can also be output in a 'pass through' mode as generic IP. Output is compatible with various off-the-shelf IP packet capture tools for onward computer processing and storage
Serial EIA-530 Interface 	RS422, X.21, V.35 & RS232; 25-pin D-type female connector; maximum data rate for RS232 is 100kbps and for all the others is 10Mbps
High-speed Serial LVDS Interface 	In serial mode, the demodulator acts as a transparent pipe, with no attempt being made to interpret the data following the error correction stage. 25-pin D-type female connector; maximum data rate is 50Mbps

## Test Facilities & Alarm Outputs

Built-in Test Tools	As part of built-in web server: Rx constellation monitor; Rx spectrum analyser; <b>LinkGuard™</b> Signal-Under-Carrier interference detection; beacon receiver function that provides automatic detection of satellite beacon transmissions; time graphs for key performance indicators (IP throughput, Eb/No, etc.)
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## Mechanical/Environmental

Size	1U chassis, 285mm deep excluding front panel handles and rear panel connectors and fans
Weight	3kg
Power Supply	90 to 264VAC, 1A @ 100V, 0.5 A @ 240V, 47 to 63 Hz Fused IEC connector (live and neutral fused); 48V DC option
Compliance	FCC, CE and RoHS compliant
Safety Standards	EN 62368-1:2014
Emissions & Immunity	Emissions: EN 55032:2015 Class A Immunity: EN 55032:2017
Operating Temperature	0°C to +55°C
Storage Temperature	-20°C to +70°C (limits must not be exceeded)
Humidity	95% relative humidity, non-condensing
Design & Production Facility Certification	Both the design and production facilities are ISO9001 certified; the production facility is additionally AS9100 certified (giving parts traceability)

## Modulator

<b>Description</b>	An integrated CCSDS TM (Telemetry) modulator - useful for bench/satellite test purposes.
<b>Output Power</b> (0.1 dB steps)	<b>IF:</b> 0 to -25dBm (0.1 dB steps) <b>L-Band</b> (0.1 dB steps): <ul style="list-style-type: none"> <li>0 to -40dBm (950 to 2,150MHz)</li> <li>0 to -30dBm (2,150 to 2,450MHz)</li> </ul>

## Demodulator

<b>Input Range</b> (dBm)	<b>IF minimum:</b> -130 + 10 log (symbol rate) <b>L-band minimum:</b> -140 + 10 log (symbol rate) <b>IF/L-band maximum:</b> -68 + 10 log (symbol rate)
<b>Doppler Limits</b>	<b>Frequency shift:</b> up to $\pm 700$ kHz <b>Rate of change:</b> up to $\pm 9$ kHz/s
<b>Frequency Sweep Width</b>	$\pm 1$ kHz to $\pm 255$ kHz (1kHz steps)
<b>Maximum Composite</b>	+10dBm
<b>Wanted-to-Composite</b>	<b>L-band:</b> -102 + 10 log (symbol rate)
<b>Rx Spectral Roll-off</b>	Root-raised cosine filter provides choice of 5% , 10%, 15%, 20%, 25%, and 35-60% in 1% steps.  Larger roll-offs reduce the carrier peak-to-average power ratio, which reduces signal distortion, thereby substantially easing smallsat transmitter size, weight and power design constraints
<b>LNB 10MHz Reference</b>	Via IFL cable; 10MHz $\pm 0.01$ ppm; 2dBm $\pm 2$ dB (complies with both 0dBm $\pm 3$ dB and 3dBm $\pm 3$ dB)
<b>LNB Voltage</b>	Programmable 13V, 15V, 18V, 20V or 24V DC to LNB via IFL cable; maximum 0.75A

## Included Network Management

Web browser user interface support provided standard. SNMP & command line interfaces support development of third-party user interfaces. The following network control application options is available

<b>Q-NET™ Navigator</b>	A simple interface to allow all Q-series modems in a network to be monitored and controlled from a single desktop application. Provided as standard, free of charge.
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## Ethernet: Standard Features

<b>IPv4/IPv6</b>	Dual IPv4/IPv6 TCP/IP supporting IPv4/ IPv6 bridging and routing
<b>DHCP</b>	DHCP client for automatic allocation of M&C IP address
<b>SNMP</b>	SNMP v1, v2c & v3
<b>Web Server</b>	Modem web server M&C interface (including built-in tools listed under Test Facilities)
<b>IP Metrics</b>	Tx, Rx throughput (bps, pps) graphs; dropped, errored packet counts
<b>Ethernet MTU Size</b>	All packets generated by the demodulator will conform to the standard MTU of 1500 bytes

## Forward Error Correction

**Note:** Viterbi & Reed-Solomon can be used independently of each other as required

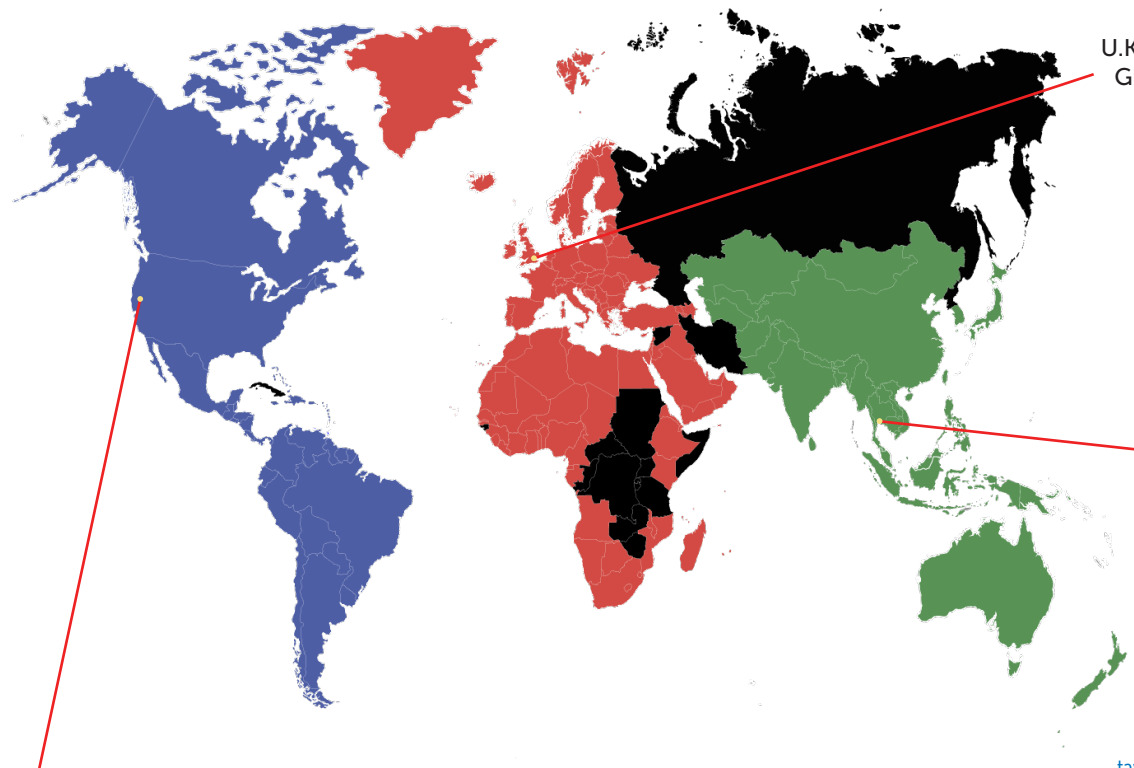
<b>CCSDS-compliant Viterbi &amp; Reed-Solomon</b>	<b>Viterbi:</b> BPSK, QPSK & OQPSK 1/2, 2/3, 3/4, 5/6, 7/8 <b>Reed-Solomon:</b> <b>Symbols per codeword:</b> 255 <b>Error correction values:</b> 8 & 16 Codes include (255, 223) & (255, 239) plus shortened codeblocks <b>Interleaver depth:</b> 1
<b>Intelsat-compliant Viterbi &amp; Reed-Solomon (including custom settings)</b>	<b>Viterbi:</b> BPSK, QPSK & OQPSK 1/2, 3/4, 7/8 <b>Reed-Solomon:</b> A codeword consists of k data symbols + (n - k) parity symbols, where (n - k)/2 symbol errors per codeword can be corrected. <b>Value of n:</b> 60 to 255 symbols <b>Value of k:</b> 40 to 253 symbols in steps of 2 where the current range is restricted to between n - 2 and n - 20 <b>Interleaver depth:</b> 4 & 8

## Ordering: QubeFlex Satellite Modem

Standard Features	Description
Base Modem	<input checked="" type="checkbox"/> 2.4kbps to 2.048Mbps Tx/Rx CCSDS/Intelsat modem 4-port Gigabit Ethernet switch for modem control and satellite traffic; includes all features described under Ethernet Standard Features CCSDS & Intelsat Forward Error Correction as described under Forward Error Correction IF operation: 50 to 180MHz L-band/S-band operation (standard): 950 to 2450MHz; high-stability 10MHz reference Doppler limits (standard): $\pm 255\text{kHz}$ , $\pm 2.1\text{kHz/s}$ Carrier roll-offs (standard): 5%, 10%, 15%, 20%, 25%, 35% Test facilities: includes all features described under Test Facilities AC mains input
Optional Features	
Extend Data Rate	<input type="checkbox"/> 5Mbps data rate: Extends base operation to 5Mbps (CCSDS Viterbi/Reed-Solomon) <input type="checkbox"/> 10Mbps data rate: Extends 5Mbps operation to 10Mbps (CCSDS Viterbi/Reed-Solomon) <input type="checkbox"/> 25Mbps data rate: Extends 10Mbps operation to 25Mbps (CCSDS Viterbi/Reed-Solomon) <input type="checkbox"/> 50Mbps data rate: Extends 25Mbps operation to 50Mbps (Supports CCSDS Viterbi/Reed-Solomon to 50Mbps)
Terrestrial Interfaces	<input type="checkbox"/> Serial EIA-530 interface: Supports RS422/X.21/V.35/RS232; 25-pin D-type female connector; maximum data rate for RS232 is 100kbps and for all the others is 10Mbps <input type="checkbox"/> High-speed LVDS serial interface: 25-pin D-type female connector; maximum data rate is 50Mbps
Extended Doppler	<input type="checkbox"/> Extends base modem Doppler limits from $\pm 255\text{kHz}$ , $\pm 2.1\text{kHz/s}$ to $\pm 700\text{kHz}$ , $\pm 9\text{kHz/s}$
Extended Roll-offs	<input type="checkbox"/> Extends base modem carrier roll-offs to include up to 60% roll-off (selectable in 1% increments)
DC Input	<input type="checkbox"/> 48V DC: K3025 48V DC primary power input (in place of 100 to 240V AC input)



## Global Sales Offices



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Refer to the website or contact Sales or Customer Support for the latest product information. The modem is classified ECCN 5A991.b.4 and is subject to U.S. Department of Commerce export control. Export, re-export or diversion contrary to U.S. law is prohibited.