

Operational Guide

Q330 Telemetry & Parameter Adjustments

Introduction:

The Quanterra Q330 Data Engine uses UDP/IP protocol to send data to Data Processors (DP's). Incorporated in the exchange are parameters the applications use on each end of the link to guarantee reliable, efficient transfer of data. This document describes the function of the telemetry link parameters and some strategies for tuning the link for the best performance in different conditions and using different types of connections, for example ethernet, radio or VSAT.

For an ethernet connection, a large window size, no grouping and quick ACK timeout is preferred since there is ample bandwidth and little penalty for resending data. The maximum bandwidth on the ethernet interface can be regulated by a software setting to ensure other hosts can utilize the segment as well.

A radio connection might increase the timeout to some seconds and shorten the window size to a medium value.

A VSAT connection typically employs a grouping concept to bunch up a number of small packets into a payload appropriate to fill a time-domain slice of satellite bandwidth when it becomes available. The group is dispatched when the number of packets reaches the group size or after waiting until the group timeout is reached.

Link tuning strategies often enable the "Link Flooding" feature when adjusting the link parameters. This feature causes extra packets to be added over and above the data packets so as to fill the output link to maximum. By observing the throughput, one can determine which parameters have the greatest benefit. The flood packets are counted and then discarded by the receiving software. Several diagnostic status screens for data port (packets sent, packets resent, flood packets and resend time) and for an interface (CRC errors, total rate, ...) allow measurements of link capability while parameters and hardware (radio antennas) get adjusted.

Getting Started:

Each of the four available Data Ports can be separately configured for packet exchange with the corresponding destination system. The parameters selected depend on the interface in use and communication link traversed. The Willard application, "Configuration | Data Port" displays the adjustable parameters as slider bars, which help identify the range of acceptable values. Several checkboxes allow setting options to adjust the link without affecting the slider settings. For instance, you can switch off data from this data port if you want to transfer other IP packets on the link for a short period, such as to download a data file from a Baler or transfer a system software update at maximum speed. The amount of 8Mb packet memory allocated to this Data Port is also

set in this panel as a percentage of the total and governs how much data will be queued when transmission is not proceeding. Finally, it is possible to prevent certain categories of data from being sent on the link by checking one of the boxes in the bottom section.

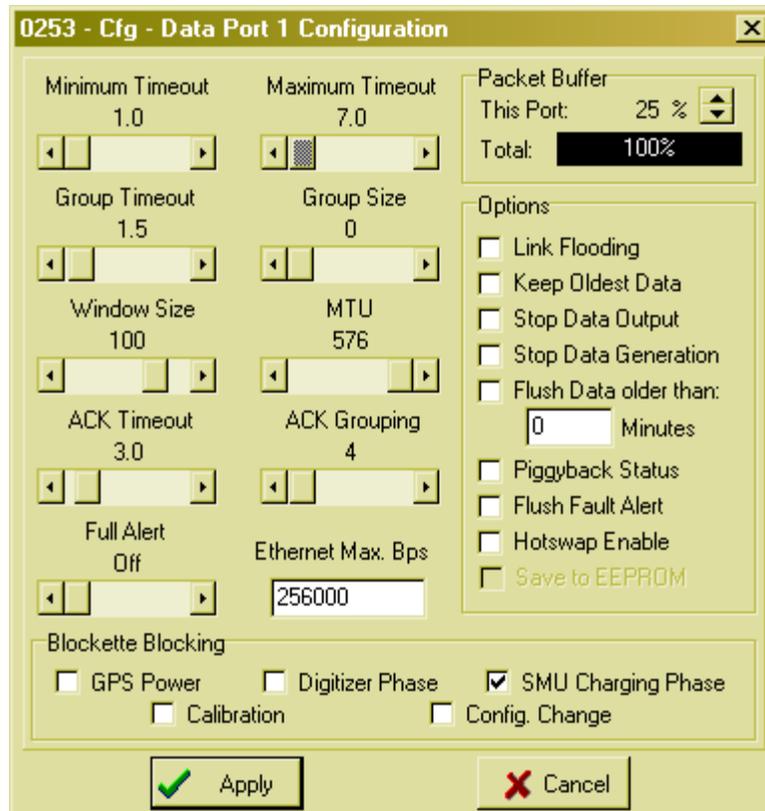


Figure 1: Typical Data Port Configuration Panel for a Radio Link

Description of parameters

A **Data Port** is a logical collection of channels and sample rates (defined in Willard's Data Recording Panel) that is delivered to a receiver called a Data Processor. Four Data Ports are available. Information about the receiver system such as IP address and UDP port number are established on connection and not stored as any Data Port parameter.

Packet Buffer percentage: A Q330 has a total of 8Mbytes that is shared between the four Data Ports in 1% increments. Data for each Data Port will accumulate in the queue and when full, overwrite older data or discard the most recent data if the checkbox "Keep oldest data" is checked. As a practical matter, when deploying a 330 decide how to apportion the packet queue percentage between Data Ports based on the intended use of each Port. Larger queue for a Baler will result in less frequent powerups, reducing the overall power consumption. Larger queues on telemetry links will result in continuous data delivery spanning brief link outages or Data Processor reboots. When a link goes down for days, it may be more appropriate to retrieve selected SEED channels from a

local storage such as the Packet Baler. Typical proportions of packet buffers for a telemetered station with Baler are; DP1 25%, DP2 15%, DP3 5%, DP4 (Baler) 60%. An autonomous station (with no telemetry) might allocate; DP1 5%, DP2 0%, DP3 0%, DP4 (Baler) 95%, where 0% means the Data Port is disabled.

See the theory of operation section below for more information about the dialog between Q330 and receiver works. For more information about packet construction and data structure formats consult the "Q330 Communication Protocol". The Q330 accepts an IP socket connection for each Data Port after the requestor successfully negotiates authentication, a process referred to as "registering". The receiver sends a command to commence data transfer using a sliding window. That is, the 330 sends a sequence of packets and waits for an acknowledge from the receiver before sending additional packets. The receiver's acknowledge identifies the last contiguous data packet, and a mask of subsequent valid packets. The Q330 resends any packet if it has not been acknowledged within the timeout period. The resend timeout is dynamically adjusted by the 330 but limited to the range specified by the maximum and minimum timeout parameters.

Window Size: Number of packets in the sliding window. The Q330 will send up to this number of packets and then wait for acknowledgement. As any packets are acknowledged, additional packets are sent, up to a total number of "in the air" packets matching the window size value. This technique avoids overrunning data buffer storage in downstream devices (such as a frame relay device with an ethernet interface to the Q330 but a 56Kbps telephone circuit to the receiver). For links with long transit times, a larger window (and longer maximum timeout) will allow more packets to be "on the way" while waiting for an acknowledgement from the first departing packets.

Maximum Timeout / Minimum Timeout: The timeout out is how long the Q330 will wait for acknowledge before resending a packet. The resend timeout is dynamically adjusted but limited to the range between the maximum and minimum value, in seconds.

ACK timeout: How long the receiver should wait before sending the Q330 an acknowledgment. Sending an acknowledge for every packet generates large amount of back traffic to the Q330, waiting too long may result in the 330 resending a packet.

ACK grouping: How many packets the receiver should accumulate before sending the Q330 and acknowledge. The receiver should dispatch an acknowledge when it has received the "ACK grouping" number of valid packets or after "Ack timeout". Typically the "ACK grouping" is 4 packets and the timeout is $((\text{ACK timeout} / \text{typical packet rate}) + 1 \text{ second})$

Group Size / Group Timeout: Data packets are held from transmission until the number of packets reaches the group size or the Group timeout has been reached. This mechanism operates within the constraint of the window size. For example, if the group size is ten, the Q330 must have received acknowledgment for at least ten packets before adding any new packets in the sliding window. For most links the Grouping is disabled (Group Size =0), meaning dispatch each packet when ready. Grouping is helpful for time domain multiplexing common in VSAT communication links.

MTU: Maximum transmission unit, the maximum number of bytes in a UDP packet. The highest MTU supported is 576 which allows for a 20 byte IP header, 8 byte UDP header, 12 byte QDP

header, and up to 536 bytes of data. The MTU can be reduced down to a minimum of 276 should packets require further processing, such as the addition of authentication codes.

Ethernet Max. Bps: A software throttle that will restrict data from this data port to a maximum number of bytes per second over the ethernet interface. Used to ensure that one data port does not monopolize the interface at the expense of other data ports or configuration functions.

Full Alert: Defines the percentage of packet buffer for this data port that will cause the "DATACOM" fault LED on the front panel of the Q330 to illuminate. The LED illuminates on the logical OR of the Full alert from all four Data Ports. Typically the full alert is set to 0% (disabled) for telemetry links and a few percent higher than the dump threshold for a Baler. Hence the DATACOM LED illuminates only if the Baler has not collected data. The assumption here is that LEDs visible only locally are helpful for assessing local storage, while a failed telemetry link is usually apparent to the receiver.

Theory of Operation

The Q330 produces data in one second packets and relies on a DP (Data Processor) to convert these packets into SEED records for storage and retrieval, along with any detection facilities.

The Q330 system has 4 serial interfaces and a 10Base-T Ethernet interface. Serial interface 4 is used internally for the GPS Engine, Serial interface 3 (CONSOLE) is multi-purpose, supporting either configuration or CNP, but is switched to "virtual interface mode" if a connection is made to the DB9 connector, or infrared if such signals are detected. Serial 1 and Serial 2 and the Ethernet interface are available exclusively for telemetry. The three serial interfaces support RS-232 single ended with full modem control lines. Each physical interface has it's own IP address, but the system does not require you to use a different IP address on each interface. The Serial 3, CONSOLE (front panel DB9/Infrared) does not have an IP address and so will respond to any address.

The Q330 supports up to 4 "logical" telemetry ports, called data ports. An 8MB packet buffer is shared between the data ports in 1 percent increments. The basis for communications on all ports is the same - UDP/IP with a QDP (Quanterra Data Packet) header for reliable transport. ICMP Echo is also implemented so a Q330 can be "pinged". SLIP is used as a packet framing protocol on the serial lines. Data and Control streams are handled on two separate UDP ports.

The Q330 port numbers are (assuming the Base Port is set to the default of 5330) :

5330 - Configuration

5331 - Special Functions

5332 - Control on data port 1

5333 - Data on data port 1

5334 - Control on data port 2

5335 - Data on data port 2

5336 - Control on data port 3

5337 - Data on data port 3

5338 - Control on data port 4

5339 - Data on data port 4

The data ports use a sliding window to increase throughput. Each data port has 128 window buffers available, with the actual number in use at any one time being determined by window size parameter. Packet "grouping" is provided for use over VSAT links. The system used is modeled on the "dacommo" protocol that has developed over many years on existing Quanterra equipment. "Partial Window Acknowledgment" is added on the telemetry data port to improve throughput by reducing resends of valid, but out of order packets. Each UDP packet incorporates a CRC value to validate the contents. IP routers may discard UDP packets with invalid CRC's. The delivery of the UDP packet follows IP routing protocol.

Each data packet incorporates a DRSN and a PSN. The Data Record Sequence Number is related to the absolute time of the data within the packet. The Packet Sequence Number is a sequential index of the packets sent by this data port. A packet resent will have the same DRSN but new PSN.

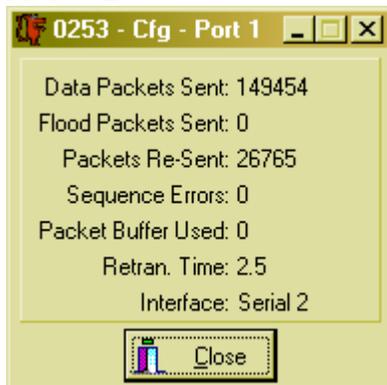
Examples of tuning

The Willard and Palm Applications report transmission statistics of each Data Port and each Interface that can be viewed from the Q330 end of the link. The Data Processor receiving application such as Socorro or MountainAir also calculate statistics for data packets and flood packets.

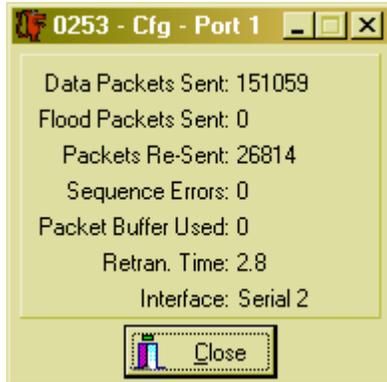
One simple method is to take a snapshot of the data port status screen (Alt-Printscreen and paste the bitmap into Word), and note the time. Then after some time, say ten minutes to a day, take another snapshot and calculate the transfer rate.

For example;

At 15:32

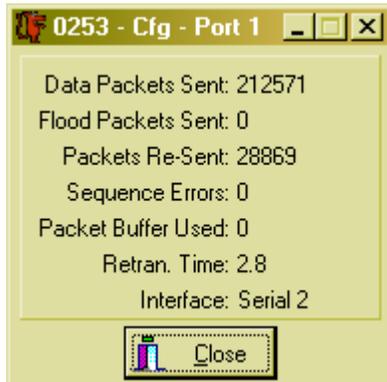


at 15:42



1605 data packets in interval
49 resend packets in interval, interval = 600 seconds
using 5380 bits/packet
14.8kbps total 3% resend

at 3/25 21:25



61512 data packets in interval
2055 resend packets in interval, interval is 20580 seconds
using 5380 bits/packet
16.62kbps 3.3% resend

Additional References:

Q330 Communication Protocol - <http://www.q330.com>

Q330 DP Writer's Guide - <http://www.q330.com>

RFC's - <http://www.ietf.org/rfc>

- IP 791 no IP fragmentation
- IP subnets 950 the device performs no routing and references only host addresses
- IP bcast 919 reference to BOOTP

- IP bcast+subnets 922
- ICMP 792 selected functions supported
- TCP 793
- UDP 768
- SLIP 1055
- ARP 826
- PPP 1661, 1662
- PAP 1334
- NCP/PCP 1332