

Guidance Notes for Using Double Precision Floating Point Numbers In DeltaV

A vital piece of the jigsaw





1.1 DeltaV IEEE 754 Double Precision Processing and DeltaV

Floating point numbers within DeltaV controllers are of the single precision format (32 bit IEEE 754 format) which is only able to represent 7 significant figures. Therefore you have a problem when interfacing to high precision computing controllers such as oil and gas industry flow metering computers which have to represent huge flow totalisation values with many more significant figures. This is typically achieved by use of double precision (64 bit IEEE 754 format) numbers that support 15 significant figures.

The standard DeltaV Serial interface card (with Modbus) also only supports floating point numbers of the 32 bit format. Therefore to read in 64 bit double precision values from such a device it is necessary to read in the raw 64 binary bits through the DeltaV serial card using multiples of 16 bit words (Modbus holding registers or Input register types). These multiple values then have to be recombined for representation/reporting or further calculation within the DeltaV environment.

As DeltaV controllers only supports single precision floating point numbers it isn't possible to perform further mathematics on these numbers within the controller without losing precision. Typically though within the DeltaV environment it is only necessary to display these values on operator displays or for onward reporting purposes, therefore no further manipulation is necessary (at least within the DeltaV environment).

Fortunately DeltaV Operate and the VBA it implements does support the 64 bit double precision number format. Therefore Intuitive have developed a streamline approach to achieving the recombination of the 64 bits of a double precision number for display on DeltaV operate graphics. From these it can be passed onward to reporting packages if necessary as either a double precision format floating point number if further processing is necessary, or as a simple string for basic display purposes.



1.2 The Basics of Double Precision 64 bit floating point number format

A double precision floating point number is held in a computer's memory as a group of 64 binary digits (bits).

1 bit represents the sign bit.

11 bits represent the exponent.

52 bits represent the fraction.

Graphically represented here

Sign	Exponent											Fraction																																																			
63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

If you have an interest the following web page provides more details on the format and how it is able to represent a decimal floating point number.

http://en.wikipedia.org/wiki/Double_precision_floating-point_format

At this stage it is worth taking a look at the following web page which provides a useful 64 floating point to 64 bit number converter. Have a play and see what results you get.

http://www.binaryconvert.com/convert_double.html

This page is very useful when proving an interface to a device that uses double precision numbers, enabling you to determine the bit pattern and numbers you should be expecting and allowing you to determine where and how the numbers are received by the DeltaV datasets.

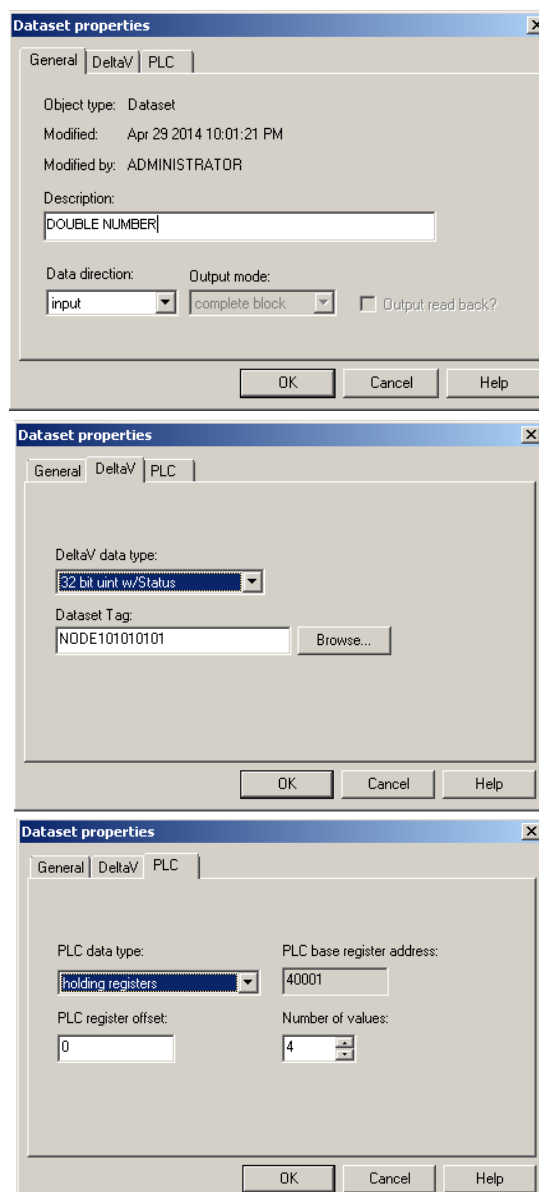
A couple of examples from this converter

1. You will see that a floating point value of 1.0 is represented by 0x3FF0000000000000 (that's a hexadecimal value) and in this case the most significant 32 bits (bits 32 to 63 bit have a value of 3FF00000 hexadecimal which is 1072693248 decimal. (Note each hex digit represents 4 bits). The next 32 bits (bits 0 to 31) have a value of zero.
2. You will see that a floating point value of 12345.67891 is represented by 0x40C81CD6E685DB77
Bits 32 to 63 = 40c81cd6 hex = 1086856406 decimal
Bits 0 to 31 = e685db77 hex = 3867532151 decimal
These are the data values you'll see on the registers read from the serial device.

1.3 Example of DeltaV Serial Card Configuration

Presented here is the serial device dataset configuration to read one double precision number by reading 4 x 16 bit holding registers. This could also be 4 x 16 bit Input registers. (Note the 4 holding registers would typically be contiguous within the serial device memory range). These 4 holding registers are taken into the DeltaV controller as two unsigned 32 bit integer values.

This configuration could be extended to read in upto 25 double precision numbers (100 values / 4)



The image displays three sequential screenshots of the 'Dataset properties' dialog box, showing the configuration steps for a DeltaV serial card.

First Screenshot (General tab):

- Object type: Dataset
- Modified: Apr 29 2014 10:01:21 PM
- Modified by: ADMINISTRATOR
- Description: DOUBLE NUMBER
- Data direction: input
- Output mode: complete block
- ☐ Output read back?

Second Screenshot (DeltaV tab):

- DeltaV data type: 32 bit uint w/Status
- Dataset Tag: NODE101010101
- Browse... button

Third Screenshot (PLC tab):

- PLC data type: holding registers
- PLC base register address: 40001
- PLC register offset: 0
- Number of values: 4



The screenshot shows the Intuitive software interface. On the left is a hierarchical tree structure representing the system configuration. On the right is a table displaying data for a specific node.

Tree Structure:

- Library
 - System Configuration
 - Recipes
 - Setup
 - Control Strategies
 - Unassigned I/O References
 - External Phases
 - Equipment Trains
 - AREA_A
 - DYNAMO_UPDATE
 - HOLDING
 - POC_TEST
 - REACTORS
 - SEQUENCE
 - Physical Network
 - Decommissioned Nodes
 - Control Network
 - PURGESTILL-PP
 - NODE1
 - Assigned Modules
 - Hardware Alarms
 - I/O
 - C01
 - P01
 - DEV01
 - D501
 - NODE101010101
 - P02
 - SIS Network

Table Data:

| Node | Device Tag | Parameter | Value | Description |
|---------------|------------|-----------|-------|----------------------|
| NODE101010101 | | | | |
| R40001 | Parameter | 0 | | 32 bit uint w/Status |
| R40003 | Parameter | 0 | | 32 bit uint w/Status |

You'll need to set a reference value in the serial device computer such as 12345.67891 as in the examples 2 above and confirm which register represents which group of bits. It is to important to know this as you don't want to confuse bits 0-31 with bits 32 to 63

After configuring and downloading the serial card you should see the two values as per example two in registers R40001 and R40003.

Bits 32 to 63 = 1086856406 decimal

Bits 0 to 31 = 3867532151 decimal

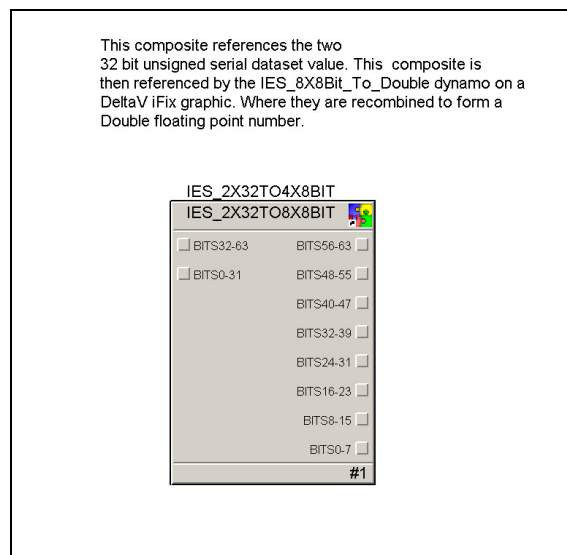
From this you can determine which register represents Bits 32 to 63 and which represents Bits 0 to 31. You'll need this information in the next step of the process.

1.4 DeltaV Control Module Configuration

Intuitive have developed a library composite and associated DeltaV Operate dynamo to simplify the process of recombination of the two 32 bit unsigned numbers back into a double precision number in the DeltaV operate environment.

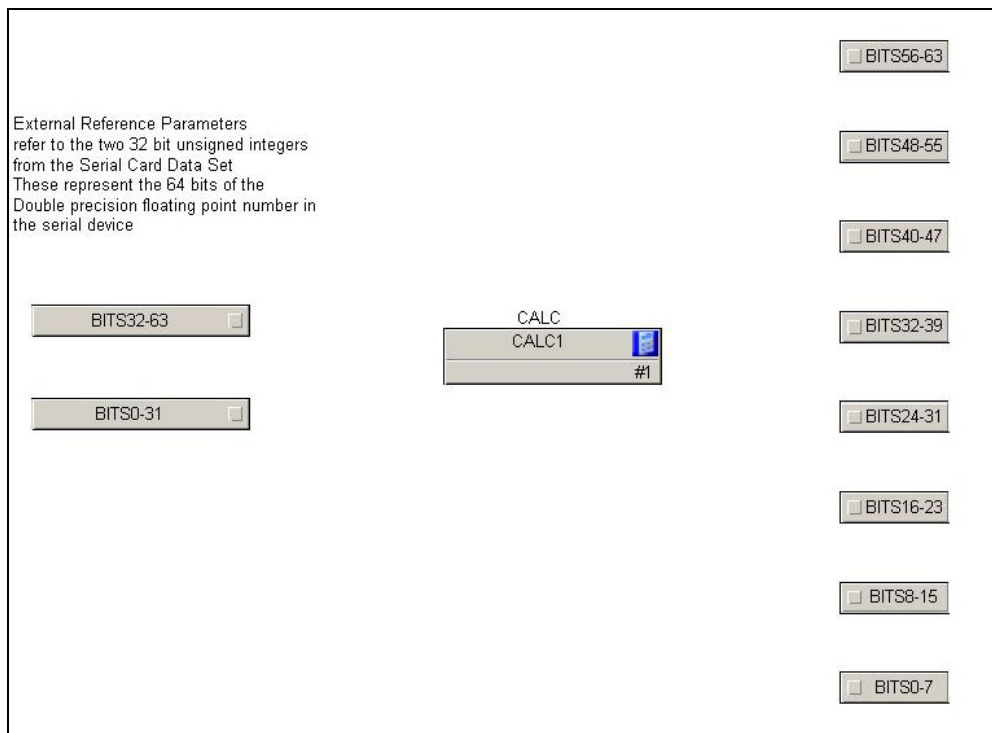
It may appear odd that we cut the 64 bits up into 8 x 8 bit unsigned (byte) numbers but this is to maintain unsigned numbers throughout the transfer process, and because of the fact that VBA in DeltaV operate does not support an unsigned integer data type greater than a byte (8 bits). The VBA integer data types of Integer and Long are both signed representations.

The composite used within a control module is shown here.





The composite internals are shown here.

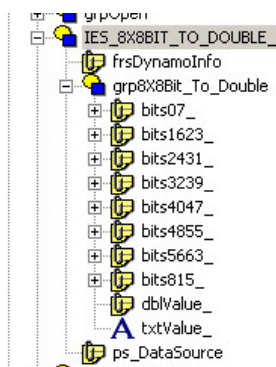
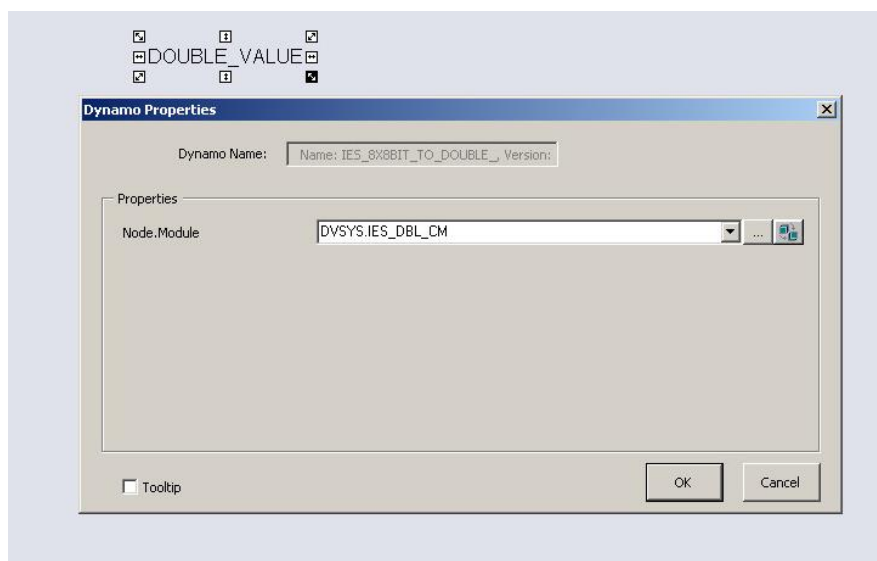


1.5 The DeltaV Operate Dynamo

The dynamo recombines the eight x 8 bit unsigned bytes provided on the outputs of the composite back into a double precision number and displays this as a string on the DeltaV Operate display. The dynamo also contains an iFix double precision variable that could be used for further mathematics within the DeltaV Operate environment or for passing on to reporting/MES packages.

An adaption of the dynamo could also be implemented within a foreground or background iFix schedule to ensure double number processing continues regardless of a specific DeltaV operate graphic being open or DeltaV Operate even running on a workstation or application station.

Rather than being a complete solution the IES_8X8BIT_TO_DOUBLE dynamo provides the framework on which further application development can be made, essentially it provides the simple recombination mechanism. Typically the units of the value would be shown on a dynamo along with alarm and status conditions associated with the value. These could be added with little extra effort.



Head Office +44 (0)161 928 8239
 email info@intuitive.uk.com
 web www.intuitive.uk.com

Post Caspian House
 Caspian Road
 Altrincham
 Cheshire
 WA14 5HH
 United Kingdom

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