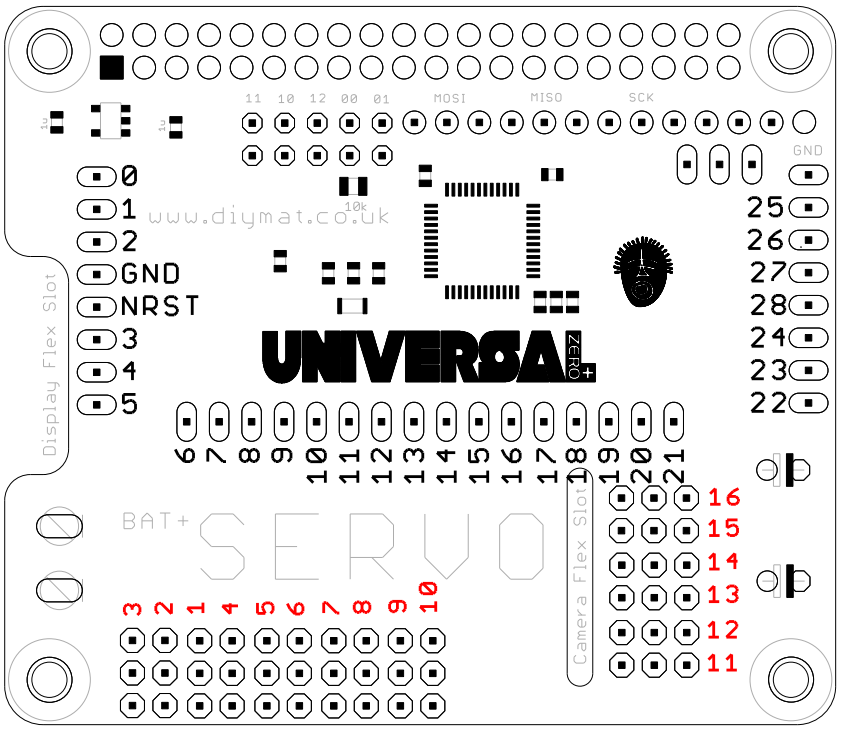
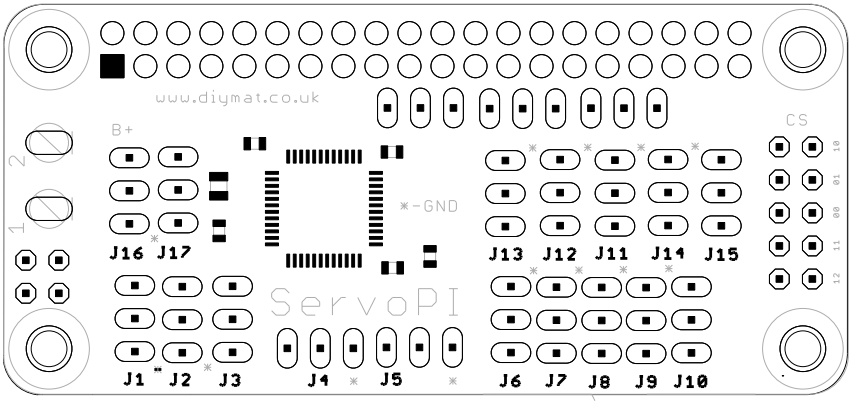
UNIVERSLA ZERO PLUS / UNIVERSAL ZERO PLUS – SERVO / UNIVERSAL PLUS Datasheet

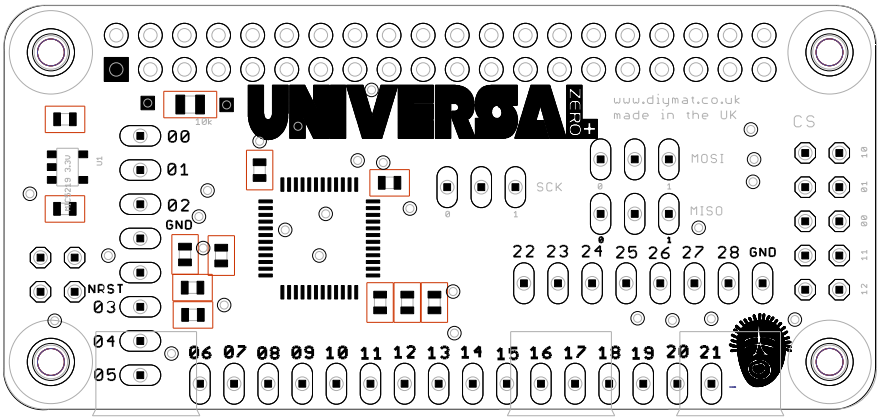
UNIVERAL ZERO



UNIVERSAL PULS ZERO SERVO



UNIVERSLA PLUS ZERO



PORT NUMBERS

GPIO ports are numbered from zero. ADC, PWM, SERVO & DAC from 1. Table below shows the ports numbers.

GPIO	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ADC				1	2	3	4	5	6	7	8	9	10	11	
DAC								1	2						
SERVO /PWM				1	2	3	4	5		6	7	8	9		10

GPIO	15	16	17	18	19	20	21	22	23	24	25	26	27	28
ADC		12	13	14	15									
DAC														
SERVO /PWM				11	12	13			14	15	16	17	18	19

The hat has 4 ADC converters. ADC1 and ADC2 or ADC and ADC3 and ADC 4 share the same sample trigger ratio in batch (DSP) mode. Channels map:

ADC1	ADC2	ADC3	ADC4
1	5	9	12
2	6	10	14
3	7	13	15
4	8		
	11		

PWM ports are grouped in the 8 groups. Channels in the group share the same frequency, but ca have different duty ratios

GR 1	GR 2	GR 3	GR 4	GR 5	GR 6	GR 7	GR 8
12	1	5	14	16	3	15	7
13	2	6	17		11		
	4	8	18				
	10	9	19				

SPI Communication:

Hat is configured as a slave device with the hardware CS signal. It uses 16bit word size. For details please refer to the SPI standard documents. Zeroes are ignored. In the command sequence zeroes are not allowed. MSB first. Little endian. Max speed -16000000

Common data format:

Ports:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
1	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
b16	b17	b18	b19	b20	b21	b22	b23	B24	B25	B27	B28	B29	B30	B31	B32
1	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	X

bx – bit number
Px – port number (GPIO numbers)

Two 16 bits words. [PORTS]

Commands:

NOP (0x00):
Does nothing

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x00															

SAFE_MODE (0xc8): (one word)
In the safe mode send 0xdf45 word when the command has finished execution. No data from other operations will be sent before it.

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0xc8															

GPIO_INIT_L (0x02): (three words)
Inits the GPIO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x02								M	T	S	S	P	P	V	L

M (mode) - 0 – input, 1 – output
T (type) – 0 – push/pull, 1 open drain
SS (speed) – 00- slow, 01 – medium, 11 – fast
PP (pull) – 00 – no push/pull, 01 – pull-up, 10 – pull-down
V – initial state (1 - high / 0 –low)
L – port lock – unused in the current version

[PORTS] (see page 3)

GPIO_SET_L (0x03): (three words)

In the safe mode send 0xdf45 word when the command has finished execution. No data from other operations will be sent before it.

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x03								V	x	x	x	x	x	x	x

V –state (1 - high / 0 –low)

[PORTS] (see page 3)

GPIO_TOGGLE_L (0x0c): (three words)

Toggle ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x0c								x	x	x	x	x	x	x	x

[PORTS] (see page 3)

GPIO_READ_L (0x0a): (three words)

Read input ports. Ignores reads from the ports not configured as GPIO inputs

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x0a								x	x	x	x	x	x	x	x

[PORTS] (see page 3)

Return value: two words in the same format as [ports]

DAC_INIT (0x32): (two words)

Initialises the DAC port

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x32								B	G	D	x	x	x	x	x

B – output buffer on/off

G – Generator mode (refer to the instruction manual)

D – DAC number (0 – DAC1, 1 – DAC - 2)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Initial value (0 – 4095)															1

DAC_WRITE (0x33): (two words)

Set DAC output voltage

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x33								x	X	D	x	x	x	x	x

D – DAC number (0 – DAC1, 1 – DAC - 2)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
voltage value (0 – 4095)															1

DAC_PERIOD (0x34): (four words)

Set the period of the DAC in the generator mode. Unit ns (nano second)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x34								x	X	D	x	x	x	x	x

D – DAC number (0 – DAC1, 1 – DAC - 2)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Reserved															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

DAC_GENERATE(0x35): (four words + data)

Set DAC in the generator mode. Load samples

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x35								x	X	D	x	x	x	x	x

D – DAC number (0 – DAC1, 1 – DAC - 2)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Number of samples (Max 4096 / channel)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Sample 0 (0 -4095)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Sample 1 (0 -4095)															1

•••

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Sample n – 1 (0 -4095)															1

DAC_START (0x37): (one words)

Start the DAC waveform generation

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x37								x	X	D	x	x	x	x	x

D – DAC number (0 – DAC1, 1 – DAC - 2)

DAC_STOP (0x38): (two words)

Stop waveform generation. Set the output voltage.

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x38								x	X	D	x	x	x	x	x

D – DAC number (0 – DAC1, 1 – DAC - 2)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
voltage value (0 – 4095)															1

PWM_INIT_L (0x46): (three words)

Toggle ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x46								x	x	x	x	x	x	x	x

[PORTS] (see page 3)

PWM_FREQ_DUTY_L (0x4b): (six words)

Set the period and duty ratio of the selected channels

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x4b								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Duty ratio in the range 0 (0%) 0x7fff (100%) Resolution depends on the frequency															1

PWM_FREQ _L (0x55): (five words)

Set the period of the selected channels

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x55								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

PWM_DUTY_L (0x4d): (four words)

Set the period and duty ratio of the selected channels

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x4d								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Duty ratio in the range 0 (0%) 0x7fff (100%) Resolution depends on the frequency															1

PWM_START_L (0x50): (three words)

Start PWM generation on the selected ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x50								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

PWM_STOP_L (0x53): (three words)

Stop PWM generation on the selected ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x53								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

SERVO_INIT (0x64): (twelve words)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x64								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Minimum impulse width in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Minimum impulse width in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Centre point impulse width in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Centre point impulse width in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Maximum impulse width in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Maximum impulse width in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Servo Exponent ratio in percents (integer only)															1

For servo exponent ratio explanation please follow the link:

https://www.desmos.com/calculator/x3utvihals

SERVO_SET (0x67): (four words)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x67								X	X	X	x	x	x	x	x

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Servo position.															1

Servo position is calculated the following way:

0x000 – minimum servo impulse width (-90 degrees)

0x3fff – centre point impulse width (0 degrees)

0x7fff – maximum servo impulse width (90 degrees)

To calculate the actual impulse width exponential ratio formula will be applicable.

If exponent rate = 0 the linear function is used

ADC_INIT_L (0x1e): (three words)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x1e								s	s	s	s	s	s	s	S

S = sample time:

0	23.4ns
1	39.1ns
2	70.3ns
3	117.2ns
4	304.7ns
5	960.9ns
6	2835.9ns
7	9398.4ns
0xff (dflt)	117.2ns

[PORTS] (see page 3)

ADC_READ_VREF (0x23): (one word)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x23								x	x	x	x	x	x	X	x

S = sample time:

Return Value:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Vref in milivolts												1	1	1	1

ADC_READ_L (0x21): (three words)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x21								s	s	s	s	s	s	s	S

S = sample time: see ADC_INIT_L

[PORTS] (see page 3)

Return values:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
NCH - Number of channels read												1	1	1	1

NCH words of ADC DATA:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
ADC value – 12 bit resolution												c	c	c	c

C - channel number

ADC_READ_FAST (0x22): (three words)

Initialise SERVO ports

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
0x22								s	s	s	s	s	s	s	S

S = sample time: see ADC_INIT_L

[PORTS] (see page 3)

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Period in ns (31 bits)															
b16	b17	b18	b19	b20	b21	b22	b23	b24	b25	b26	b27	b28	b29	b30	b31
Period in ns (31 bits)															1

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Number of convesions (Max 2048 / ADC channels in the conversion) per ADC															1

Return values:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
NCH - Number of channels read												1	1	1	1

Number of samples * number of ports

NCH words of ADC DATA:

b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
ADC value – 12 bit resolution												c	c	c	c

C - channel number

For DAC & ADC period is the time where all samples are send to the DAC or all ADC channels in the single conversion are read.

Example – to generate sine wave with 1kHz frequency * 128samples per one period set period of 1000000ns and 128 samples

To read 128 conversions (conversion can have up to 15channels) in 1 second – set period to 1000000000 and number of conversions = 128. If there are 10 channels in the conversion, 1280 reads will be returned.

The time granulation is 1/64e6.