HDS Series I²C Application Notes

I²C Bus Interface Introduction

The I²C interface of the HDS series of power supplies allows remote control and monitoring and provides the following features:

1) Retrieving of manufacturing related data (Eg. model name, serial number, etc...)
2) Reading of output voltage, output current and internal temperature.
3) Status and fault indication of the unit.
4) Setting of output voltage and output current, and ON/OFF control of the unit.

Serial Clock (SCL)

This is an input signal that is used to strobe all data in and out of the unit. An external 2kOhm pull up resistor must be connected from SCL to +5V. Serial clock speed is 100kHz.

Serial Data (SDA)

This is a bi-directional signal comprising of the send and receive data to and from the unit. This signal is an open drain output that may be wired-ORed with other open collector signals on the bus. An external 2kOhm pull up resistor must be connected from SDA to +5V.

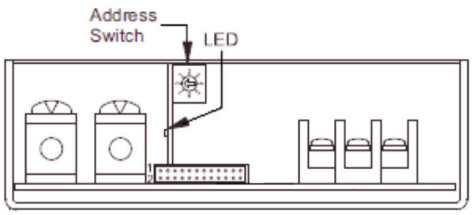
Addressing:

The slave address for each unit is set by a combination of fixed device type bits (bit 7 – 4) and floating address bits (bit 3 – 0) by adjusting the Address Switch on the rear panel. Up to eight units can be addressed.

	Fixed Device				Floating Address			R / $\overline{w}$
Bit	7	6	5	4	3	2	1	0
Level	H	L	H	L	Set by address switch			x

x = H or L

Location of the Address Switch is shown below:

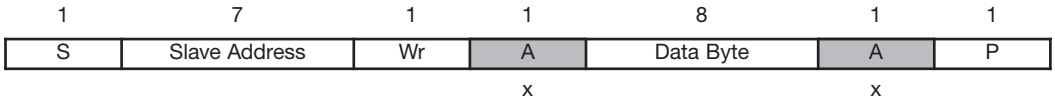


The table below shows the Address Switch position with the respective unit address accordingly.

Address Switch Set to position	Unit Address on I^2C
0	A0
1	A2
2	A4
3	A6
4	A8
5	AA
6	AC
7	AE

Supported I²C Bus Protocol

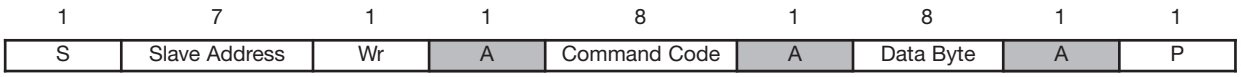
The I²C Bus slave interface supports Read/Write Byte protocols as defined in the I²C bus specification. The figures below are from the I²C Bus specification.



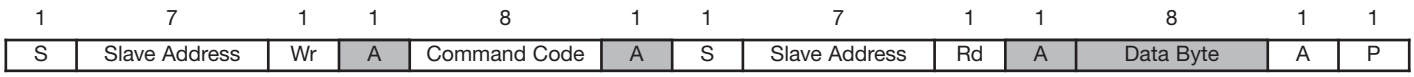
Key

S	Start Condition	A	Acknowledge (this bit position may be '0' for an ACK or '1' for a NACK)
Sr	Repeated Start Condition	P	Stop Condition
Rd	Read (bit value of 1)	PEC	Pecket Error Code
Wr	Write (bit value of 0)		Master-to-Slave
x	Shown under a field indicates that the field is required to have the value of 'x'		Slave-to-Master
		...	Continuation of Protocol

Write Byte Protocol



Read Byte Protocol



Function Description Table

Function	Address (Hex)		Number of Bytes	Protocol Type	Remarks
	Start	End			
Unit Manufacturer	00	0F	16	Read	Refer to ASCII table
Unit Series Name	10	1F	16	Read	Refer to ASCII table
Unit Model Number	20	23	4	Read	Refer to ASCII table
Unit Revision	24	27	4	Read	Refer to ASCII table
Manufacturing Date	28	2F	8	Read	Refer to ASCII table
Unit Serial Number	30	3F	16	Read	Refer to ASCII table
Country of Manufacture	40	4F	16	Read	Refer to ASCII table
Rated Output Voltage	50	51	2	Read	Unit in Volt
Rated Output Current	52	53	2	Read	Unit in Amp
Max. Output Voltage	54	55	2	Read	Unit in Volt
Max. Output Current	56	57	2	Read	Unit in Amp
Output Voltage Measurement	60	61	2	Read	Unit in AMP
Output Current Measurement	62	63	2	Read	Unit in Volt
Internal Temperature Measurement	68	68	1	Read	Unit in Degree Celsius
Unit Status	6C	6C	1	Read	Refer to Status Register table
Unit Status	6F	6F	1	Read	Refer to Status Register table
Output Voltage Setting	70	71	2	Read/Write	Unit in Volt
Output Current Setting	72	73	2	Read/Write	Unit in Amp
Unit Control	7C	7C	1	Read/Write	Refer to Control Register table

ASCII Table: Decode Value in address 00 to 4F to know the meaning

Hex	Char	Hex	Char	Hex	Char	Hex	Char	Hex	Char	Hex	Char
20		30	0	40	@	50	P	60	`	70	p
21	!	31	1	41	A	51	Q	61	a	71	q
22	“	32	2	42	B	52	R	62	b	72	r
23	#	33	3	43	C	53	S	63	c	73	s
24	$	34	4	44	D	54	T	64	d	74	t
25	%	35	5	45	E	55	U	65	e	75	u
26	&	36	6	46	F	56	V	66	f	76	v
27	‘	37	7	47	G	57	W	67	g	77	w
28	(	38	8	48	H	58	X	68	h	78	x
29	)	39	9	49	I	59	Y	69	i	79	y
2A	*	3A	:	4A	J	5A	Z	6A	j	7A	z
2B	+	3B	;	4B	K	5B	[	6B	k	7B	{
2C	,	3C	<	4C	L	5C	\	6C	l	7C	|
2D	-	3D	=	4D	M	5D	]	6D	m	7D	}
2E	.	3E	>	4E	N	5E	^	6E	n	7E	~
2F	/	3F	?	4F	O	5F	_	6F	o		

Status Register Table - Convert value in address 6C to binary to decode the meaning

Address (Hex)	Bit	Function	Status
6C	0	OVP shutdown	‘0’ is normal, ‘1’ is OVP shutdown
	1	OCP shutdown	‘0’ is normal, ‘1’ is OCP shutdown
	2	OTP shutdown	‘0’ is normal, ‘1’ is OTP shutdown
	3	FAN fail	‘0’ is normal, ‘1’ is fan fail
	4	AUX or SMPS fail	‘0’ is normal, ‘1’ is unit fail or power shutdown
	5	Hi-Temp alarm	‘0’ is normal, ‘1’ is detect high internal temperature
	6	AC input power down*	‘0’ is normal, ‘1’ is Vin <100VAC for HDS1500 & HDS3000 or <180VAC for HDL3000 or power shutdown
	7	AC input failure	‘0’ is normal, ‘1’ is Vin <85VAC or power is off
6F	0	Inhibit by VCI/ACI or EN	‘0’ is normal, ‘1’ is inhibit by EN signal, ACI, VCI
	1	Inhibit by Control Register	‘0’ is normal, ‘1’ is inhibit by control register (I^2C)
	2 -7	Not Used	

*This function is only for HDS1500 and HDS3000 series.

Control Register Table - Convert value in address 7C to binary to decode the meaning

Address (Hex)	Bit	Function	Meaning
7C	0	Power Control	0: Power Off, 1: Power On
	1	- Not Used	
	2	Command Update	0: Completed, 1: Required
	3	Command Error	0: Valid, 1: Error
	4	- Not Used	
	5	- Not Used	
	6	- Not Used	
	7	Remote Control	0: Control by VCI, ACI, INHI, 1: Control by I^2C Command

Reading Data from the Power Supply

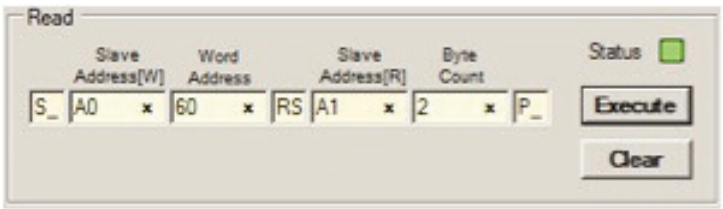
A HDS800PS24 is used for the example below with address set to $A0^h$. The Interface equipment is PICkit serial analyzer firmware version: 0x0305 from Microchip.

Output Voltage & Current Measurement

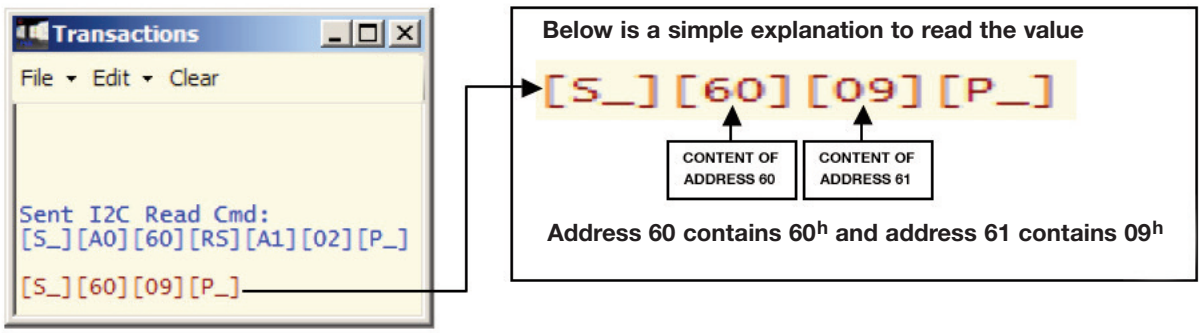
To read the output voltage and current, refer to the previous Function Description Table on page 3 and enter the address and the number of bytes accordingly to the I^2C software.

Function	Address (Hex)	Byte	Remarks
Output Voltage Measurement	60	2	Unit in Volt

The screen shot below shows how the addresses and byte count are entered.



Below is the screen shot of the transaction window. The blue statement is the instruction sent, and the brown statement is the reading. The reading is the Hexadecimal data values located in address 60 follow by 61. Note that it is a coincidence that the content of address 60 is 60).

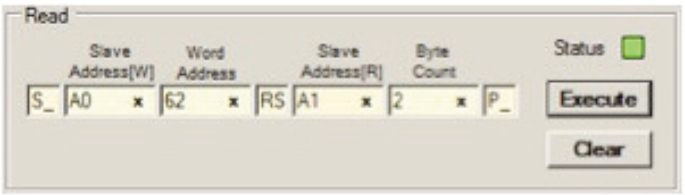


It is then required to convert the hexadecimal data into decimal and insert a decimal place in the appropriate place to get the actual voltage measured. Follow the conversion steps below:

Step	Description	Value
1	Get the contents of address 61 followed by 60	0960^h
2	Convert Hex to decimal	2400^d
3	Divide decimal by 100 to get the voltage measured	24.00V

Repeat similar steps for the current measurement using the address and number of bytes shown in the function description table.

Function	Address (Hex)	Byte	Remarks
Output Current Measurement	62	2	Unit in Amp

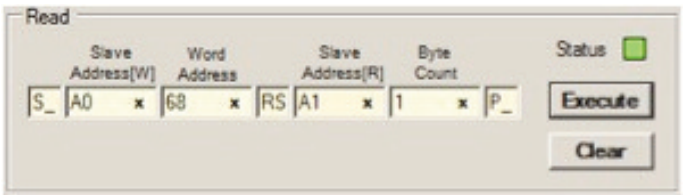


Converting 01F7^{h} into decimal gets 0503^{d}, and dividing by 100 as previous, and the resulting current measurement is 5.03A.

Below is the actual measurement captured on a meter.

Internal Temperature Measurement

Enter the I^{2}C command using the address and number of bytes shown in the function description table as shown below, and convert the Hexadecimal value to decimal to get the temperature information.



Step	Description	Value
1	Retrieve value in address 68	21^{h}
2	Convert Hex to decimal	33°C

Controlling the Power Supply

A HDS800PS24 is used for the following example with address set to A0^{h}. The example below is to set the output voltage to 10V and the output current limit to 11A using the same firmware kit mentioned earlier.

Output Voltage & Current Setting

To set the output voltage and current limit to the required setting, firstly convert the target voltage and current to Hexadecimal values. Then enter the unit address (A0^{h}), function addresses (70^{h} and 71^{h}), and value (10V converted to Hex value 03E8^{h} , and it will be stored in the appropriate address accordingly). Finally enter the execution command to address 7C by using the Control Register function. Refer to the steps below:

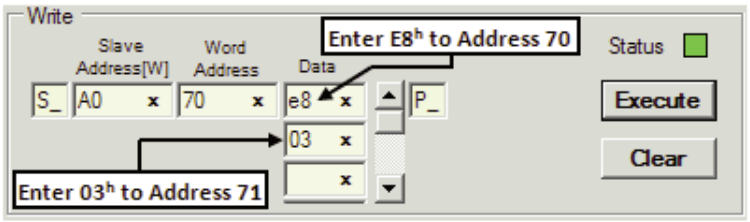
Conversion of Desired Voltage & Current Limit:

Step	Description	Value
1	Determine the voltage to be set, eg. 10V	10.00V
2	Multiply by 100 to get the decimal value	1000^{d}
3	Convert to Hex value	03E8^{h}
4	Determine the current to be set, eg. 11A	11.00A
5	Multiply by 100 to get the decimal value	1100^{d}
6	Convert to Hex Value	044C^{h}

Refer to Function Description Table and enter accordingly to set the voltage and current.

Function	Address (Hex)	Byte	Remarks
Output Voltage Setting	70	2	Unit in Volt
Output Current Setting	72	2	Unit in Amp

Send voltage setting instruction to HDS800 as shown below.



To execute the setting, an instruction (85^h) must be sent to the Control Register.

Control Register Setting

Function	Remote Control	-	-	-	Error	Update	-	Power Control
Bit	7	6	5	4	3	2	1	0
Binary	1	0	0	0	0	1	0	1
Hex	8				5			

Enter the instruction to unit to set the voltage as shown below.

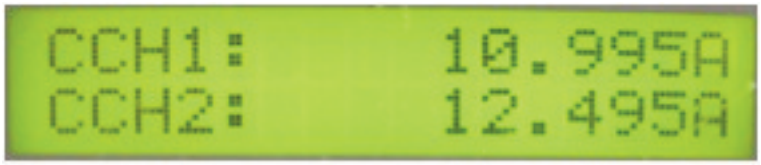
Repeat the same method for current setting.

Send current setting instruction to HDS800 as shown below.

Enter the instruction to unit to set the current as shown below.

Below are screen shots of the load display to check that the voltage and current settings have been received and stored correctly by the power supply.

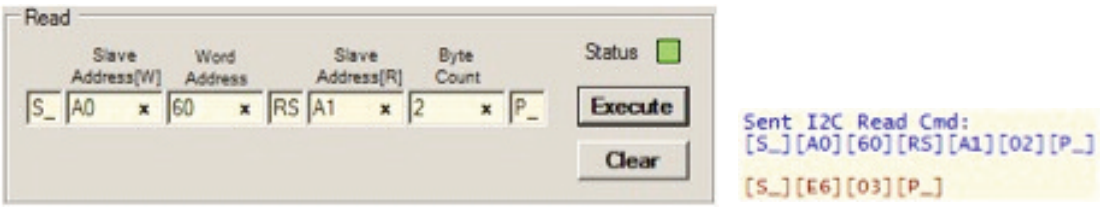
Channel 1 of the electronic load is set to 11.0A and channel 2 is set to 12.5A.



Below are the voltage and current measurements captured with channel 1 loading:

Below are the voltage and current measurements captured with channel 2 loading. The output current is maintained at 11A as set by I²C. The unit is operating in constant current mode and hence output voltage reduces.

Output voltage will recover when load reduces back to 11A or below. Below is the reading taken from the power supply.



Convert $03E6^{h}$ to decimal is 0998^{d}, and divide the decimal value by 100 to get the output voltage measured which is equivalent to 9.98V.