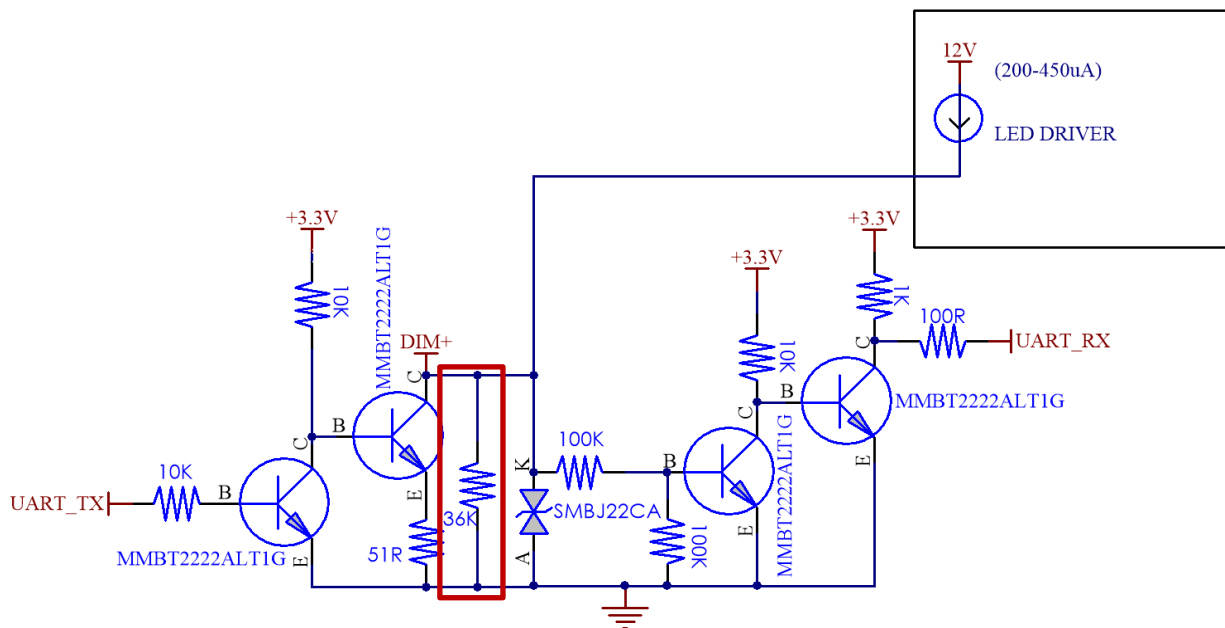


Inventronics Digital Dimming V2.0 Communication Protocol

I. Hardware Interface Design

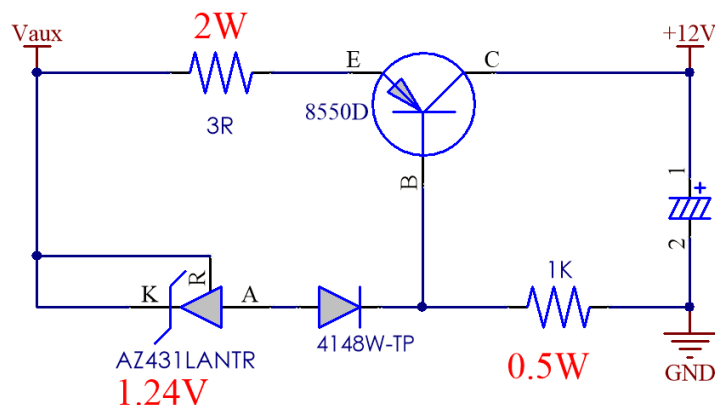
- Digital Dimming utilizes a Master-Slave single line UART communication bus
- To communicate with the driver via UART_TX and UART_RX, a conversion circuit is needed
- DIM+ is internally pulled high by the 12V auxiliary supply, which regulates a 200-450uA constant current supply on the DIM+ line.
- To ensure the reliability of communication, a 36kΩ resistor is required, paralleled between DIM+ and GND.

Reference design shown below:



- For NB-IOT, GPRS, and 4G systems, a current limiting circuit to the controller is required with the current limited to 400mA.

Reference design shown below:



II. Data and Frame Definition

- A standard UART interface is utilized
- Each byte data is consisted of 1 start bit, 8 data bits and 1 stop bit
- The Baud rate is 9600
- The Interval between data frames is a minimum of 120ms with a recommendation of over 150ms. (Including intervals between send-frame and send-frame, send-frame and receive-frame)

III. Software Protocol Definition

- A Data frame includes head, command, offset address, data length, data, checksum, and two ends.
- Checksum = command + offset address + data length + data

Available Commands:

- **Set Max Current**
 - Allows user to set output current as a percentage of the maximum current
- **Read Output Current**
 - Returns actual current in DC mA
- **Read Output Voltage**
 - Returns actual voltage in Vdc
- **Read Digital Dimming Level**
 - Read Digital Dimming brightness level, returns value between 0-200
 - Value = dim percentage * 200
- **Read LED Output Power**
 - Read Active Power for Driver LED Output in Watts
- **Read Driver Input Frequency**
 - Read driver input frequency (Hz)
- **Read Driver Input Current**
 - Read driver input current in AC mA
- **Read Driver Input Voltage**
 - Read driver input voltage in Vac

- **Read Driver Input Power**
 - Read driver input active power in Watts
- **Read Total Lamp-On Time**
 - Read Total Lamp-On Time in hours.
 - Lamp on time is defined as the time that the driver has been powered and not in a dim-to-off state.
- **Read Driver Active Energy**
 - Read driver active energy in Watt Hours
- **Read Internal Temperature**
 - Reads AD value of driver internal NTC, see Appendix 1 for corresponding AD and temperature values
- **Read External Temperature**
 - Reads AD value of driver external NTC, see Appendix 2 for corresponding resistance, AD, and temperature values
- **Read Driver Operating Time**
 - Reads driver operating time, or time that the driver has been powered, without consideration to the dim level
- **Read Driver Power Failure Mode**
 - Detects short or open circuit on driver output
- **Digital Dimming**
 - Allows for dimming of driver over Digital Dimming bus
- **Read Model Information**
 - Returns driver model and rated power level
- **Read Current Ratio**
 - Returns the programmed output current as a percentage of the maximum output current
- **Set Driver Dimming Mode**
 - Allows user to change the driver dimming mode
 -
- **Reset**
 - Power cycles the driver. This is required if the dimming mode is changed when the driver is connected to AC Power.

Information Update Rate:

Without considering UART timing, the driver updates variables approximately every 150ms. If the dimming command or set max current command are used It can take up to 2 seconds for the current and voltage readings to move to their final state. If read before 2 seconds, an intermittent state will be reflected.

Compatible Drivers:

Digital Dimming V2.0 is available on all EUM and ESM drivers ending in Lx.

IV. Command List

Checksum = Command + Offset Address + Data Length + Data Bit

Header	Command	Offset Address	Data Length	Data	Checksum	End	End	Definition	
0x3A	0x31	0x00	0x00	0x00-0x64		0x0D	0x0A	Set Maximum Current as percentage	
	0x32	0x00	0x01	If right, return 0x55, if wrong, no return				Response to command 0x31	
	0x3A	0x3A	0x00	0x01	0x02			0x3D	Read Output Current
			0x01	0x01	0x02			0x3E	Read Output Voltage
			0x05	0x01	0x01			0x41	Read Digital Dimming brightness level 0-200 (percentage * 200)
			0x06	0x01	0x02			0x43	Read LED Output Power (W)
			0x0B	0x01	0x01			0x47	Read driver input frequency (Hz)
			0x0C	0x01	0x01			0x48	Read driver power factor
			0x0D	0x01	0x02			0x4A	Read driver input current (AC mA)
			0x0E	0x01	0x02			0x4B	Read driver input voltage (Vac)
			0x0F	0x01	0x02			0x4C	Read driver input power (W) (Active Power)
			0x10	0x01	0x03			0x4E	Read Total Lamp On-Time (h)
			0x11	0x01	0x05			0x51	Read driver active energy (Wh)
			0x12	0x01	0x01			0x4E	Read driver internal temperature (NTC) (°C)
			0x13	0x01	0x01			0x4F	Read external temperature (NTC) (°C)
			0x14	0x01	0x03			0x52	Read total driver operating time (h)
			0x15	0x01	0x01			0x51	Read digital LED power failure mode bit0=1: short circuit, bit1 = 1: open circuit

Header	Command	Offset Address	Data Length	Data	Checksum	End	End	Definition
0x3A	0x3C	0x00	0x01	0x00 - 0xC8		0x0D	0x0A	Digital Dimming, (dims the driver, Percentage * 200)
	0x35	0x0B	0x01	0x05	0x46			Read model information
	0x36	0x0B	0x05	5 Bytes				Return model information
	0x37	0x34	0x01	See Definition				Set dimming mode
	0x38	0x34	0x01	0x55 (If successful)	0xC2			Dimming Mode Response
	0x39	0x00	0x01	0x00	0x3A			After setting the mode, the reset must be sent to take effect

V. Command Definition

- **Command 0x31 - Set Constant Power Max. Current**

Set constant power maximum current to fit for LED applications. This data exists in the EEPROM and is not recommended for frequent use. To dim the driver, please use the 0x3C dimming command.

Example: Set constant power maximum current to 70% of current output (70=0x46)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x31	0x00	0x01	0x46	0x78	0x0D	0x0A

- **Command 0x32 - Response of Command 0x31**

If data received successfully, reply is 0x55. If not, there is no reply.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x32	0x00	0x01	0x55	0x88	0x0D	0x0A

- **Command 0x3C - Digital Dimming Command**

- Data from 0-200 corresponds to 0-100% dimming level.
- To dim driver off, send command 0. If driver does not support Dim-to-Off, 0 is the minimum dimming level.
- If the minimum dimming level is 10%, then all levels between 0-20 are 10%.
- All values over 200 are 100% dimming level.

Example: dimming to 50% ($50\% * 200 = 100 = 0x64$)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3C	0x00	0x01	0x64	0xA1	0x0D	0x0A

- **Command 0x3D - Response from Digital Dimming Command 0x3C**

If data received successfully, reply is 0x55; if not, no reply.

- **Command 0x3A - Query Command**

The query command requests driver data registers pertaining to driver health and diagnostic information.

- **Read Current:**

Actual current value = Return current value (mA)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x00	0x01	0x02	0x3D	0x0D	0x0A

- **Read Voltage:**

Actual voltage value = Return voltage value (Vdc)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x01	0x01	0x02	0xA1	0x0D	0x0A

- **Read Dimming Level:**

Actual Dimming Level, 0-200

Diming Level = Dimming Percentage * 200

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x05	0x01	0x01	0x41	0x0D	0x0A

- **Read LED Output Power**

Actual Active Power for Driver Output, in Watts

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x06	0x01	0x02	0x43	0x0D	0x0A

- **Read Driver Input Frequency**

Actual driver input frequency, in Hertz.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x0B	0x01	0x01	0x47	0x0D	0x0A

- **Read Driver Power Factor**

Read driver power factor.

Driver power factor = response / 100

Example: a power factor of .98 will read as 0x62; 0x62 = 98, 98/100 = .98

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x0C	0x01	0x01	0x48	0x0D	0x0A

- **Read Driver Input Current**

Actual current value = Return voltage current (AC mA)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x0D	0x01	0x02	0x4A	0x0D	0x0A

- **Read Driver Input Voltage**

Actual voltage value = Return voltage value (Vac)

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x0E	0x01	0x02	0x4B	0x0D	0x0A

- **Read Driver Input Active Power**

Actual Driver Active Power, in Watts

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x0F	0x01	0x02	0x4C	0x0D	0x0A

- **Read Total Lamp-On Time**

Actual Lamp-on Time = Return Time Value, in Hours

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x10	0x01	0x03	0x4E	0x0D	0x0A

- **Read Driver Active Energy**

Driver active energy, measured in Watt Hours

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x11	0x01	0x05	0x51	0x0D	0x0A

- **Read Internal Temperature**

AD value of internal driver NTC. See Appendix 1 for correlation between AD value and temperature values in °C.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x12	0x01	0x01	0x4E	0x0D	0x0A

- **Read External Temperature**

AD value of external driver NTC. See Appendix 2 for correlation between resistance, AD value, and temperature values in °C.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x13	0x01	0x01	0x4F	0x0D	0x0A

- **Read Total Driver Operating Time**

Total driver operating time, in hours. Total driver operating time is defined as time that the driver has been energized, without regard to the status of the driver output.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x14	0x01	0x03	0x52	0x0D	0x0A

- **Read Failure Mode**

Reads driver failure mode.

For short circuit, reply is 0x01

For open circuit, reply is 0x02

If driver is not in failure mode, reply is 0x00

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3A	0x15	0x01	0x01	0x51	0x0D	0x0A

- **Command 0x3B - Query 0x3A Command Response**

Example: Receive response from Query Current Value

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x3B	0x00	0x02	0x04, 0x12	0x53	0x0D	0x0A

The data 0x04 0x12 = 0 x0412 = 1042, is the actual current value (mA)

- Command 0x35 - Read LED driver information**

Reads the information of the current model, including the rated power and the maximum rated current lomax.

Example: Read LED Driver Information

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x35	0x0B	0x01	0x05	0x46	0x0D	0x0A

Driver will return 3A36 0B 05 **01 00 96 00 69** 46 0D 0A

01 00 96 Expresses EUD150SxxxDTA, 0096 expresses power is 150W.

00 69 express Max current is 105, lomax is 1.05A.

See data format below:

Data Format:

Byte	Bit								Value
	7	6	5	4	3	2	1	0	
0x0B	x	x	x	x	x	x	x	x	Suffix
0x0C	x	x	x	x	x	x	x	x	Prefix
0x0D	x	x	x	x	x	x	x	x	Power Level
0x0E	x	x	x	x	x	x	x	x	Model Current
0x0F	x	x	x	x	x	x	x	x	

Data	Bit								Hex
	7	6	5	4	3	2	1	0	
Suffix (0x0B)									
xxxSxxxD(T/V)	0	0	0	0	0	0	0	0	0x00
xxxSxxxD(T/V)A	0	0	0	0	0	0	0	1	0x01
xxxSxxxL(G/T/B)	0	0	0	0	1	1	1	1	0x0F
xxxSxxxM(G/T/B)	0	0	0	1	0	0	0	1	0x11
Prefix									
High 5 bits of 0x0c									
EUD	0	0	0	0	0				
EUM	0	1	0	0	1				
ESM	0	1	0	1	1				
EBM	0	1	1	0	1				

- Command 0x35 - Read the Maximum Current Setting loset**

Example:

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x35	0x20	0x01	0x01	0x57	0x0D	0x0A

LED driver returns 3A 36 20 01 **50** A7 0D 0A

0x50 expresses that the maximum current of the driver is 80% of the maximum rated current, ie loset = lomax * % = 1.05 * 80% = 840mA

- **Command 0x37 - Set Dimming Mode**

This command sets the dimming mode for a Digital Dimming compatible Inventronics driver. Please note that only one dimming mode can be selected at a time. However, OLC is not considered a dimming mode, and can be used in conjunction with any other dimming mode.

The dimming mode Data Bit encoding is as follows:

Dimming Mode Data Bit			
Bit	Setting	1	0
7	OLC	Enable	Disable
6	Set to 1	1	x
5	Set to 0	x	0
4	Digital Dimming	Enable	Disable
3	0-10v/0-5v	0-5v	0-10v
2	PWM	PWM	0-10v/0-5v
1	Timer	Enable	Disable
0	Set to 1	1	x

Example: Set driver dimming mode to Digital Dimming:

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x37	0x34	0x01	0x51	0xBD	0x0D	0x0A

- **Command 0x38 - Response of Command 0x37**

If data received successfully, reply is 0x55. If not, there is no reply.

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x38	0x34	0x01	0x55	0xC2	0x0D	0x0A

- **Command 0x39 – Reset Command**

This command must be sent after the dimming mode is changed

Head	Command	Offset Address	Data Length	Data bit	Checksum	End	End
0x3A	0x39	0x00	0x01	0x00	0x3A	0x0D	0x0A

Appendix I:

Internal OTP: AD value corresponds to temperature

AD value	T °C	AD value	T °C	AD value	T °C	AD value	T °C	AD value	T °C	AD value	T °C
15	125	55	76	95	54	135	38	175	23	215	4
16	123	56	75	96	54	136	38	176	22	216	4
17	121	57	74	97	53	137	37	177	22	217	3
18	118	58	74	98	53	138	37	178	22	218	2
19	116	59	73	99	52	139	37	179	21	219	2
20	114	60	72	100	52	140	36	180	21	220	1
21	112	61	72	101	52	141	36	181	20	221	0
22	111	62	71	102	51	142	36	182	20	222	0
23	109	63	71	103	51	143	35	183	20	223	-1
24	107	64	70	104	50	144	35	184	19	224	-2
25	105	65	69	105	50	145	34	185	19	225	-2
26	104	66	69	106	50	146	34	186	18	226	-3
27	103	67	68	107	49	147	34	187	18	227	-4
28	101	68	68	108	49	148	33	188	17	228	-5
29	100	69	67	109	48	149	33	189	17	229	-5
30	98	70	66	110	48	150	33	190	17	230	-6
31	97	71	66	111	47	151	32	191	16	231	-7
32	96	72	65	112	47	152	32	192	16	232	-8
33	95	73	65	113	47	153	31	193	15	233	-9
34	94	74	64	114	46	154	31	194	15	234	-10
35	93	75	64	115	46	155	31	195	14	235	-11
36	91	76	63	116	45	156	30	196	14	236	-12
37	90	77	63	117	45	157	30	197	13	237	-13
38	89	78	62	118	45	158	29	198	13	238	-14
39	88	79	62	119	44	159	29	199	13	239	-15
40	88	80	61	120	44	160	29	200	12	240	-16
41	87	81	61	121	44	161	28	201	12	241	-17
42	86	82	60	122	43	162	28	202	11	242	-18
43	85	83	60	123	43	163	28	203	11	243	-20
44	84	84	59	124	42	164	27	204	10	244	-21
45	83	85	59	125	42	165	27	205	10	245	-23
46	82	86	58	126	42	166	26	206	9	246	-25
47	82	87	58	127	41	167	26	207	9	247	-27
48	81	88	57	128	41	168	26	208	8	248	-29
49	80	89	57	129	40	169	25	209	7	249	-31
50	79	90	56	130	40	170	25	210	7	250	-34
51	78	91	56	131	40	171	24	211	6	251	-38
52	78	92	56	132	39	172	24	212	6	252	-40
53	77	93	55	133	39	173	24	213	5		
54	76	94	55	134	39	174	23	214	5		

Appendix 2:

External OTP: AD value corresponds to temperature

T °C	R (kΩ)	AD Value	T °C	R (kΩ)	AD Value	T °C	R (kΩ)	AD Value
35	6.948	10	67	2.435	99	99	1.00	154
36	6.707	13	68	2.364	101	100	0.97	155
37	6.475	16	69	2.294	103	101	0.95	156
38	6.253	19	70	2.228	105	102	0.93	158
39	6.039	22	71	2.163	108	103	0.90	159
40	5.834	25	72	2.100	110	104	0.88	160
41	5.636	28	73	2.040	112	105	0.86	161
42	5.445	31	74	1.981	114	106	0.84	162
43	5.262	34	75	1.925	116	107	0.82	163
44	5.086	37	76	1.870	118	108	0.80	164
45	4.917	40	77	1.817	120	109	0.78	165
46	4.754	43	78	1.766	122	110	0.76	166
47	4.597	46	79	1.716	123	111	0.74	167
48	4.446	49	80	1.669	125	112	0.72	168
49	4.301	52	81	1.622	127	113	0.70	169
50	4.161	55	82	1.578	129	114	0.69	170
51	4.026	58	83	1.535	131	115	0.67	170
52	3.896	60	84	1.493	132	116	0.66	171
53	3.771	63	85	1.452	134	117	0.64	172
54	3.651	66	86	1.413	136	118	0.63	173
55	3.535	69	87	1.375	137	119	0.61	174
56	3.423	71	88	1.338	139	120	0.60	174
57	3.315	74	89	1.303	140	121	0.58	175
58	3.211	77	90	1.268	142	122	0.57	176
59	3.111	79	91	1.234	143	123	0.56	177
60	3.014	82	92	1.202	145	124	0.54	177
61	2.922	84	93	1.170	146	125	0.53	178
62	2.834	87	94	1.139	147			
63	2.748	89	95	1.110	149			
64	2.666	92	96	1.081	150			
65	2.586	94	97	1.053	151			
66	2.509	96	98	1.026	153			

Disclaimer

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