

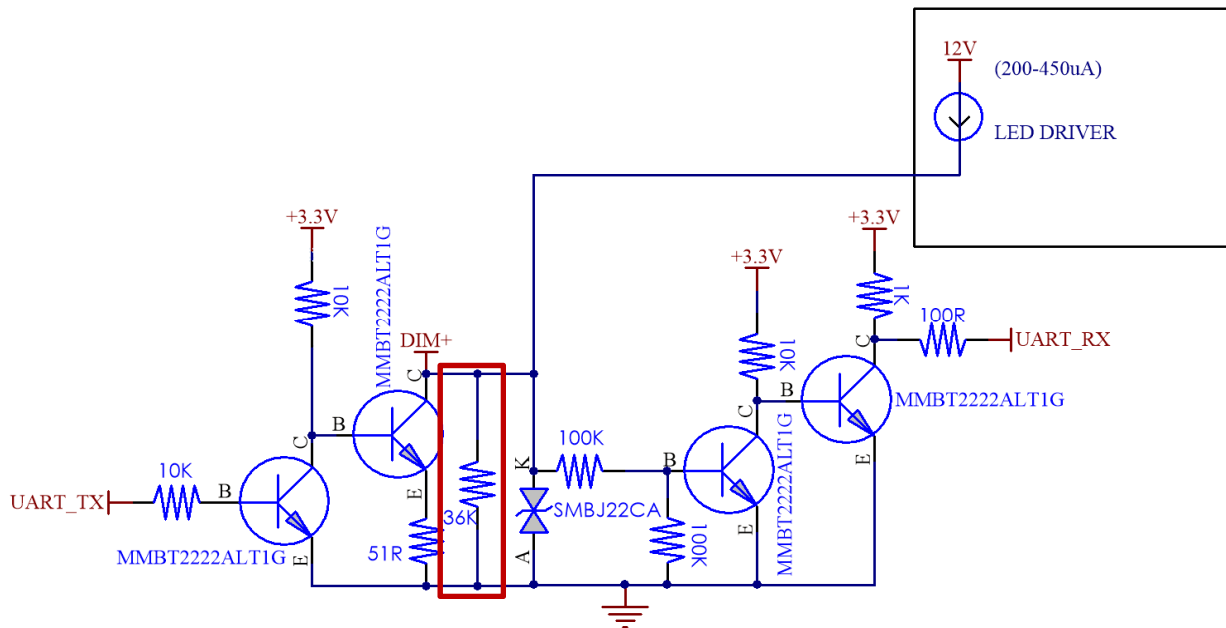
# Inventronics Digital Dimming V2.0

## Communication Protocol

### I. Hardware Interface Design

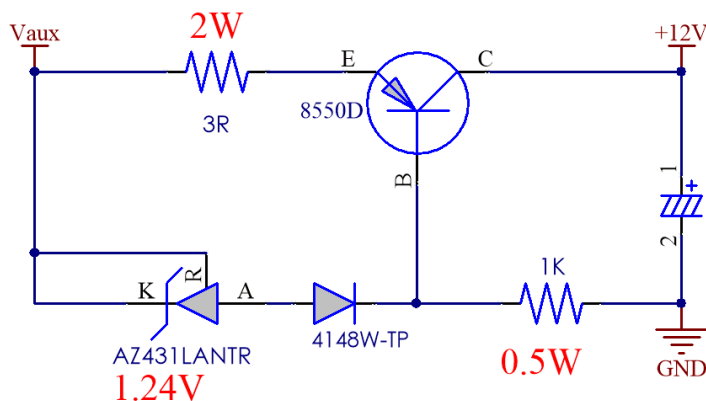
- Digital Dimming utilizes a Master-Slave single line UART communication bus
- To communicate with the driver via UART\_TX and UART\_RX, a conversion circuit is needed
- DIM+ is internally pulled high by the 12V auxiliary supply, which regulates a 200- 450uA constant current supply on the DIM+ line.
- 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 return value(Rtv) of driver internal NTC, see Appendix 1 for corresponding Rtv value and temperature values
- **Read External Temperature**
  - Reads return value(Rtv) of driver external NTC, see Appendix 2 for corresponding Rtv value 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 2seconds, an intermittent state will be reflected.

## **Compatible Drivers:**

Digital Dimming V2.0 is available on drivers ending in Lx, Mx versions.

Note: Mx version cannot achieve some commands are marked with “ \* ” in Command List below. Command List

## 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
	0x3C	0x00	0x01	0x00 - 0xC8				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	

*Note: The commands/functions marked with \* in "Definition" column cannot achieved by Mx version*

## 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	0x3E	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**

Rtv value of internal driver NTC. See Appendix 1 for correlation between Rtv 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**

Rtv value of external driver NTC. See Appendix 2 for correlation between resistance, Rtv 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 0D0A

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: Rtv value corresponds to temperature

Rtv Value	T °C	Rtv Value	T °C	Rtv Value	T °C	Rtv Value	T °C	Rtv Value	T °C	Rtv Value	T °C
00	0	1C	28	38	56	54	84	70	112	F1	-15
01	1	1D	29	39	57	55	85	71	113	F0	-16
02	2	1E	30	3A	58	56	86	72	114	EF	-17
03	3	1F	31	3B	59	57	87	73	115	EE	-18
04	4	20	32	3C	60	58	88	74	116	ED	-19
05	5	21	33	3D	61	59	89	75	117	EC	-20
06	6	22	34	3E	62	5A	90	76	118	EB	-21
07	7	23	35	3F	63	5B	91	77	119	EA	-22
08	8	24	36	40	64	5C	92	78	120	E9	-23
09	9	25	37	41	65	5D	93	79	121	E8	-24
0A	10	26	38	42	66	5E	94	7A	122	E7	-25
0B	11	27	39	43	67	5F	95	7B	123	E6	-26
0C	12	28	40	44	68	60	96	7C	124	E5	-27
0D	13	29	41	45	69	61	97	7D	125	E4	-28
0E	14	2A	42	46	70	62	98	FF	-1	E3	-29
0F	15	2B	43	47	71	63	99	FE	-2	E2	-30
10	16	2C	44	48	72	64	100	FD	-3	E1	-31
11	17	2D	45	49	73	65	101	FC	-4	E0	-32
12	18	2E	46	4A	74	66	102	FB	-5	DF	-33
13	19	2F	47	4B	75	67	103	FA	-6	DE	-34
14	20	30	48	4C	76	68	104	F9	-7	DD	-35
15	21	31	49	4D	77	69	105	F8	-8	DC	-36
16	22	32	50	4E	78	6A	106	F7	-9	DB	-37
17	23	33	51	4F	79	6B	107	F6	-10	DA	-38
18	24	34	52	50	80	6C	108	F5	-11	D9	-39
19	25	35	53	51	81	6D	109	F4	-12	D8	-40
1A	26	36	54	52	82	6E	110	F3	-13		
1B	27	37	55	53	83	6F	111	F2	-14		

## Appendix 2:

External OTP: Designated type of NTC is NCP18XH103J03, refers to Appendix 1 for corresponding R<sub>tv</sub> value and temperature values

## Disclaimer

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Inventronics (Hangzhou), INC