DFDI2: dimmer module for lamp driving

DFDI2 dimmer output module allow the brightness regulation of lamps up to 500W through the **Domino** bus. DFDI2 module operates the phase control of the 230V~ mains supply by an IGBT power transistor; thanks to this technique, DFDI2 module can be set for two operating modes:

- reversed phase control ("trailing edge"): IGBT is switched ON at the zero crossing and switched OFF afterward; this mode is suitable for resistive or capacitive loads such as electronic transformers and incandescent lamps
- direct phase control ("leading edge"): IGBT is switched OFF at the zero crossing and switched ON beforehand; this mode is suitable for inductive loads such as ferromagnetic or toroidal transformers

DFDI2 module features protections against overload, short circuit on the output, over voltage on the output and over temperature.
The module can be controlled by pushbuttons connected to **Domino** input modules or by a supervisor or by a video-terminal (e.g. touch screen).
DFDI2 module provides a 2-way terminal block for the connection to the **Domino** bus and a 4-way terminal block for the connection to the 230V~ mains supply and to the load. The low level supply needed by the module is carried by the bus itself.
On the top side, the module features a small pushbutton with double function (see the related paragraph) and a green LED that shows the operating status; the same green LED normally flashes every 2 seconds about to signal that the module is properly supplied and operating.
A small connector (PRG) under the bus terminals cover allows the connection to the optional tester/programmer. For more details about the address assignment and programming, refer to the related documentation.
A white label on the top panel allows the writing of the programmed module address for an immediate visual identification. DFDI2 module is housed in a standard 4M modular box for rail mounting .

Note: this data sheet applies DFDI2 module equipped with firmware 6.1 or higher.

Mode of operation

DFDI2 module can be controlled by one or more pushbuttons connected to one or more **Domino** input modules. It is possible to control the dimmer module by two pushbuttons (Up/Down) and/or by a unique pushbutton (Single command) as here described.

Up/Down pushbuttons: pushing and holding Up (Down) button, the brightness increases (decreases) until the max (min) value is reached. When the brightness has reached the desired level, release the button to hold it.

Single Command: holding down the button, the brightness increases until the max value is reached and after 1 second about, the brightness decreases to the min value, then it increases again and so on. Release the button at the desired level to hold it.

When the lamp is ON, a short pulse (one-touch) on any control button will cause the complete switching OFF. When the lamp is OFF, a short pulse on any control pushbutton will cause the switching ON at the last brightness level or at a fixed programmable value.
DFDI2 module also allows to define one or more (real and/or virtual) inputs recalling some brightness levels that can be freely set during the setting up.
These levels, called Presets, can be also set by a supervisor simply sending to the module the desired brightness level in the range 0÷100%. This feature allows to create suggestive light scenes.

Standard programming

A typical equation controlling DFDI2 dimmer module is as in the following example:

```
O1.1 = UI1.1 | DI1.2 | MI1.3 | P(40)I1.4
```

In this example `O1.1` is the dimmer module, `I1.1` and `I1.2` are the inputs controlling the brightness Up and Down, `I1.3` is the Single command and `I1.4` set the brightness to 40%. More Up/Down/Single commands and Presets are allowed in the same equation.
Two Presets have a special meaning: `P(0)` switch off the output and stores the previous level, `P(255)` switch on the lamp to last stored level.

The transition from the brightness levels due to Presets and to ON/OFF by one-touch function occurs according to a default ramp (in the range 1 to 60 seconds). On the contrary, the ramp for the brightness regulation by Up, Down and Single commands is fixed. The module keeps the chosen ramp value even if a power supply failure occurs.
The default ramp can be specified in the equation controlling the dimmer as follows:

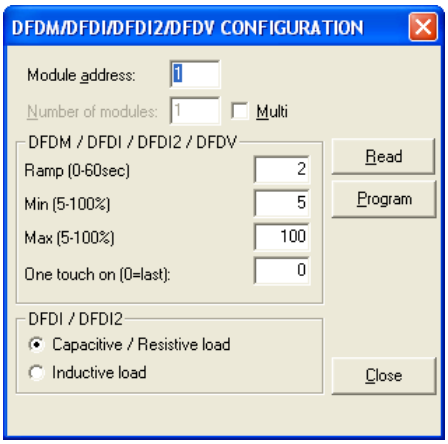
```
O1.1(30) = UI1.1 | DI1.2 | P(40)I1.4
```

In this case the default ramp will be set to 30 seconds. If this value is not specified, then the default value will be 2 seconds.
The transition from a Preset to another one may be executed according to ramps different than the default value; to do this, simply specify the chosen value as in the following example:

```
O1.1(3) = MI1.1 | P(80,25)I1.2 | \
          P(0,10)I1.3
```

In this case the first Preset (80%) will be executed by a 25 sec ramp and the second one by a 10 sec ramp. The ramp for the ON and OFF by one-touch function will be 3 sec as specified inside the brackets after `O1.1`. If no value was specified for Presets, or if the specified value is zero, then the default value will be used.

The default ramp value can be also set by BDTools (*release 6.1.4 or higher*) selecting from main menu the option "Programming" and then "DFDM/DFDI/DFDV Configuration"; the following window will appear:



Enter in the related text box the address of DFDI2 module to be set and the ramp value, then click on Program button. Clicking on the Read button, it is possible to check the current setting of the module.
Enabling the **Multi** option and specifying a number in the "Number of Modules" text box, it is possible to perform sequential setting of more module (e.g., if "Module address = 5" and "Number of modules = 4", then all modules from 5 to 8 included will be set (if they are dimmer modules). The option Multi has not any meaning on the Read function (only the module having the specified address will be read).
It is also possible to set the **MIN** and **MAX** regulation levels entering the desired values in the relevant text boxes of the previous window or specifying them in the equation as in the following example:

```
O1.1(30,5,100) = UI1.1 | DI1.2
```

Warning: the ramp setting by BDTools must be executed AFTER the transferring of the equation to the module; otherwise the ramp value will be set to the value specified in the equation (that, as said above, will be 2 seconds if omitted.

The parameter "One touch on" allows to specify the brightness value (in the range 1 to 100) to be recalled by one touch function; if the value is 0, then the last stored value will be recalled.

Finally, for DFDI and DFDI2 modules only, the load type can be specified among the options **"Capacitive/Resistive load"** or **"Inductive load"**; to first type comprehends ***electronic*** transformer for halogen lamps, incandescent lamps and 230V~ halogen lamps, the second type comprehends ***ferromagnetic*** transformer or small induction motors.

Always check that the connected load can be dimmed (in special way for electronic and ferromagnetic transformers).

Automatic brightness regulation

DFDI2 module, in addition to the dimmer standard functions (Up, Down, Single Command and Preset), features an extended function allowing to implement the automatic regulation of the brightness on a room, comparing the value read from a light sensor connected on the **Domino** bus with a fixed setpoint. The keyword identifying this function is "`A`"; the following equation is a typical example:

```
O1.1 = UI1.1 | DI1.2 | \
       V130.1 & A(650,20,2)AI18
```

The block `A(sp,h,p)AIx` identifies the automatic brightness regulation function, where:

- `sp` is the setpoint, that is the brightness level to be maintained; in the example, the setpoint is `650`
- `h` is the hysteresis (`20` in the example); the regulation function acts so that the light level will be maintained in the range from (setpoint-hysteresis) to (setpoint+hysteresis); therefore, in the example, the range is from 630 to 670; the hysteresis value must be ≤ 255
- `p` is the time period (`2` in the example): the module, every `p` seconds, compares light level read from the sensor and the setpoint (± hysteresis)
- `x` is the address (`18` in the example) of a light sensor module (e.g. DFLUX), or of a DFAI analog input module connected to a light sensor

The block `A(sp,h,p)AIx` must be preceded by a consent input (real or virtual point) activating and deactivating the automatic regulation function.
In the previous example, the consent is `V130.1`; activating this point, the automatic regulation will enabled, while deactivating it the automatic regulation will be disabled, but the output level of the dimmer module remains the last one reached. If, with the consent activated, one or more point for manual regulation will be activated (`I1.1` or `I1.2` in the previous example), or if the supervisor sends a brightness value, then the automatic regulation will be disabled until the occurrence of a new OFF to ON variation of the consent (in other words, the consent works on the edge, not on the level).

When the dimmer module has the automatic regulation function activated, the ramp is automatically set to 30 seconds, in order to make imperceptible the fluctuations of the output level due to the variations of the measured light (caused by external factors).

Variable setpoint by a potentiometer
The "fixed" setpoint specified int the block `A(sp,h,p)` can be replaced by the address of a channel of a DFAI module connected to a potentiometer (or, however, to a variable voltage). In this mode, the setpoint can be easily modified. Therefore, the equation of the previous example could be modified as follow:

```
O1.1 = UI1.1 | DI1.2 | \
       V130.1 & A(AI41,20,2)AI18
```

Multiple automatic regulation blocks
More than one block for automatic regulation can be specified in the same equation of a dimmer module, as in the following example:

```
O1.1 = UI1.1 | DI1.2 | \
       V130.1 & A(650,20,2)AI18 | \
       V130.2 & A(400,20,2)AI18
```

In this case, depending on the activated consent, the setpoint will be set to 650 or to 400.

Automatic regulation with parameters set by a supervisor
The master modules, like DFCP, DFTS and DFTouch, must have the possibility to change the value of setpoint, hysteresis and period. For instance, think to **DFCP** controller that evaluate the best setpoint as function of several factors; the result can be stored in a register and then it can be sent to the dimmer module to modify its setpoint.

To send these commands, the high side of the data field sent to the dimmer module has to be used.

To set the setpoint (10-bit value) the following Word has to be sent to the output address of the dimmer module:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	Setpoint value (10 bit)									

To set the hysteresis (8-bit value) the following Word has to be sent to the output address of the dimmer module:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	Hysteresis value (8 bit)							

To set the regulation period (8-bit value) the following Word has to be sent to the output address of the dimmer module:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	Period value (8 bit)							

Note: when changing setpoint, hysteresis and period by sending the just described commands, the equation of the dimmer module will be changed. This means that reading the program loaded in the dimmer module, the resulting equation will contain the last parameters sent by the supervisor (of course if the automatic regulation is used).

Status request to a dimmer module
If a supervisor (e.g. DFTouch) executes a status request to a dimmer module, this one will answer with the following Word:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
P	T	R	S	0	0	0	0	K	Output level						

Where :
- P: the address programming function is activated (this point reflects the fixed ON status of the PRG LED)
- T: Protection occurrence (DFDI and DFDI2 only)
- R: the automatic regulation is running
- S: output level is not zero
- K: status of generic output Ox.2 (DFDV only)
- Output level: the current value of the output level of the dimmer module (in the range 0 to 100)

Example: regulation with occupancy sensor
In the following example, `I1.1` is connected to a button for the Single Command function, `I1.2` is connected to an occupancy sensor, `AI18` is a light sensor and `O1.1` is a dimmer output.

```
O1.1 = MI1.1 | \
       I1.2 & A(650,20,2)AI18 | \
       P(0)!I1.2
```

At the activation of the occupancy sensor, the dimmer module enables the automatic regulation, thus it continuously regulates the output level so that the light sensor read a value in the range 630 to 670. At the deactivation of the occupancy sensor, the term `P(0)!I1.2` causes the light switch off. Acting on the Single Command while the automatic regulation is enabled, this last one will be disabled and the module enter the manual mode; in this case too, at the deactivation of the occupancy sensor, the light will be switched off.

Special codes

A supervisor or a touch screen video-terminal can set the brightness level of a dimmer module simply sending the wanted value (in the range 0 to 100) to the address of the module itself. In addition the supervisor can execute special commands (e.g. set the ramp value) sending to DFDI2 module some special codes as listed in the following table:

Code	Function
0	Switch off and store the previous level
101 ÷ 110	Set ramp to 1 ÷ 10 sec (1 sec step)
111 ÷ 120	Set ramp to 12 ÷ 30 sec (2 sec step)
121 ÷ 123	Set ramp to 40 ÷ 60 sec (10 sec step)
124	Switch on to last stored level
127	Save current ramp value as default

Equations with extended notation

The dimmer module DFDI2 allows the extended notation in the equations. In other words, the number of input point (real or virtual) placed on the right side of the "=" symbol in a dimmer equation can be in the range 1 to 16.
For instance, the following equation is valid:

```
O1.1 = UI1.1 | DI1.5 | MI1.7 | P(40)I1.8
```

This notation allows the compatibility with special modules and with future **Domino** modules.

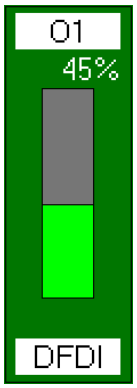
Protections

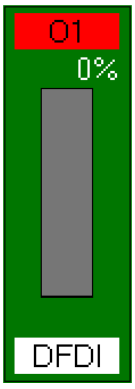
DFDI2 module features an internal over current protection that limit the peak value to 9A about; when the load current overrides this value, the protection circuit switch OFF the power device (IGBT), holding it in the OFF state until the next command is sent and however for the next 5 seconds starting from the protection occurrence. This circuit also protects DFDI2 module against short circuit on the output.
DFDI2 module also features a protection circuit against over voltages on the output that can be generated, for instance, when an inductive load has been connected and the module is set for capacitive load. In this case too, the module will be maintained in lock condition until the next command is sent and however for the next 5 seconds starting from the protection occurrence.
Finally, DFDI2 module features a protection against over temperature of the power device: when the detected temperature overrides a fixed value, the load will be switched OFF, denying any further switching ON command until the temperature goes down under a fixed safety threshold.

If one of the 3 just described protections take2 place, or if a disconnection of 230V~ mains supply occurred, the green LED of DFDI2 module will be fixed lighted in order to inform about the lock condition.

Mapping

DFDI2 module can be displayed on the map of BDTools as in the picture on this right side.
As for all **Domino** modules, the background of the module is in green color if the module is connected and properly working, otherwise the background is in red color.





The bar graph shows the output level of the module, and the number over the bar shows the same value in numerical format.
To change the output level, click on the bar graph using the left button of the mouse, enter the desired value and then confirm it by the Enter button on the keyboard.
If the automatic brightness regulation in on, the background of the module address field (O1 in the example) will be in yellow color.

In the occurrence of one of the protections, the displaying of the module changes as shown by the picture on this left side: the output level goes to zero and the background of the module address field (O1 in this example) changes to red color. When the protection has been restored, the background of the address field automatically returns to white color.

Functions of the local pushbutton

The pushbutton on the module has a double function: pushing it for a time lower than 3 seconds, the module switches to the addressing mode, during which the LED on the module is fixed lighted; the addressing mode will be active until the module receives the address and anyway no more than 10 seconds from the last release of the push-button. When the module enters the addressing mode, the output will be switched off.

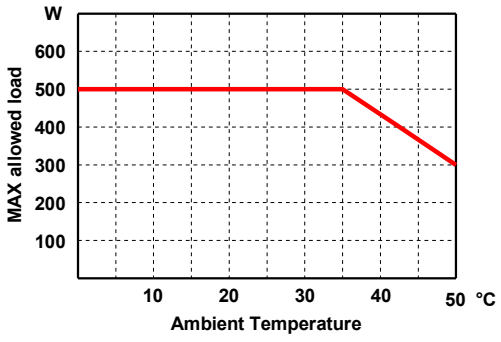
Holding down the pushbutton for more than 3 seconds, the module switches to the test mode; the LED signals this condition by a regular blinking (1s ON and 1s OFF). At every successive pushing of the button the output will be alternatively switched between 0% and 100%. The module exit the test mode after 30 seconds from the last release of the pushbutton. If one of the protections occurs during the test mode, the LED will be lighted in fixed mode.

Cooling

Ensuring a good cooling is an essential condition for reliable and safe operation. DFDI2 module produces about 1.2% heat with regard to the connected load; for instance, with 300W connected load, the dissipated power is around 3.6W, therefore the installation must take in account this data and an adequate air volume and recirculation must be foreseen.

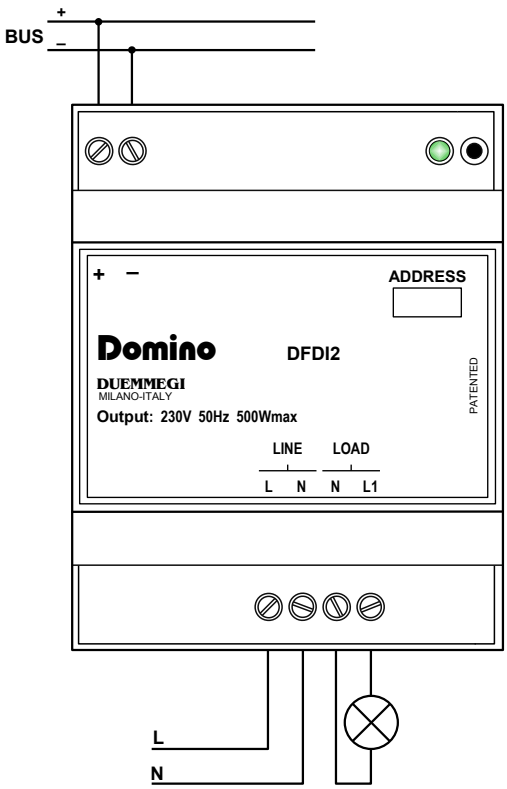
Operating conditions

The power section of DFDI2 module has been developed for 230V~ ±15%, 50Hz mains supply. The minimum power of the connected load must be 20W, and the maximum power must not override 500W at 35°C max ambient temperature; at higher temperatures, the max load decrease as shown in the following derating diagram. Anyway, the ambient temperature cannot be higher than 50°C.



Module connection

DFDI2 module can be connected to 230V~ 50Hz load, according to the limits listed in the technical characteristics; the following figure shows the proper connections to be made.



Technical characteristics

Power supply (bus side)	By specific centralized power supply Mod. DFPW2
Allowable load	Incandescent or halogen lamps, with or without transformer: 20 ÷ 500 W max, 230V~ 50Hz, see derating diagram about max load vs. ambient temperature
Protections	Output short circuit, over current, over temperature and over voltage
Protection fuse	5A / 230V~, included (under the cover of power terminal block)
Operating temperature	-5 ÷ +50 °C (at +50 °C the max allowable load is 300W)
Storage temperature	-20 ÷ +70 °C
Protection degree	IP20

Note:
DFDI2 is not suitable for dimming fluorescent lamps.

Outline dimensions