DFANA-M/CC: Load-shedding controller for **Domino** bus

DFANA-M/CC and DFANA-S modules allow the measurements of several electrical parameters including the management of load-shedding, both for single-phase and three-phase network. DFANA-M module interfaces directly to the **Domino** bus, thus making the measurements immediately available and easy to use. The measurements are also shown on the front panel of DFANA-S by a back-lighted LCD display.
DFANA-M/CC module integrates an algorithm which, in combination with relay output modules (e.g. DF4RI, DF8RIT), creates a complete sequential load-shedding system.
DFANA-M/CC reports on the **Domino** bus the 19 measurements listed in the following table:

Measurement	Symbol	Measured units
Voltage phase 1 (*)	V1N	[V]
Current phase 1 (**)	I1	[A]
Active power phase 1	P1	[W]
Apparent power phase 1	S1	[VA]
Reactive power phase 1	Q1	[VAR]
Power factor phase 1	PF1	-
Voltage phase 2 (*)	V2N	[V]
Current phase 2 (**)	I2	[A]
Active power phase 2	P2	[W]
Apparent power phase 2	S2	[VA]
Reactive power phase 2	Q2	[VAR]
Power factor phase 2	PF2	-
Voltage phase 3 (*)	V3N	[V]
Current phase 3 (**)	I3	[A]
Active power phase 3	P3	[W]
Apparent power phase 3	S3	[VA]
Reactive power phase 3	Q3	[VAR]
Power factor phase 3	PF3	-
Total positive active energy (***)	Wh(+)	[Wh]

(*): Voltages are sent on the bus multiplied x 10
(**): Currents are sent on the bus multiplied x 100
(***): Energy can be reset via bus

DFNA-M/CC module features a 2-way fixed terminal block for the connection to **Domino** bus and a 3-way fixed terminal blocks for the connection to DFANA-S module.

For information about terminal blocks, connections and the several possible settings of the measurements section of DFANA-S module, refer to the related User's Manual (DFANA-S_xxMIT).

Near to the bus terminal block, DFANA-M/CC module features a small pushbutton and a green LED that shows the operating status; this LED normally flashes every 2 seconds about to signal that the module is properly connected to the bus. DFANA-M/CC module is housed in a standard 2M modular box for rail mounting

Load-shedding operation

DFANA-M/CC module, as mentioned, allows to manage the power consumption a three-phase (or single-phase) electrical system, avoiding the intervention of the meter protection due to the simultaneous switching on of loads with excessive total power. DFANA-M/CC can manage up to 24 different loads in three-phase mode and 8 loads in single-phase mode. The module takes into account the direction of the current, therefore it can be used in systems equipped with a photovoltaic generator. DFANA-M/CC module can work both in systems with DFCP controller and in the absence of this one.

The module continuously measures the total active power absorbed by the connected loads and this value is compared to the threshold value fixed during the setting up through the support program BDTools or DCP Ide. If the value exceeds the threshold, it begins to disconnect the loads in sequence until the total power returns below the threshold. The loads to be disconnected from the system if the threshold is exceeded are connected to output modules with power relays (e.g. DF4RI or DF8RIT) which, through the **Domino** bus, are linked to the DFNA-M/CC module using equations programmed in the output modules.

If an overload occurs, the first load that is disconnected will be number 24 (which must be with the one less important for the user). Disconnection occurs 5 seconds after the threshold is exceeded; in this case, if the overload condition still persists, the module will disconnect the subsequent loads until the total power returns below the threshold.
The reconnection of the last disconnected load takes place in any case after a maximum time from its disconnection (parameter TOff Max), or after a shorter time if the conditions established by a precise algorithm exist.
However, it is possible to prevent a load from being disconnected, or it is possible to reconnect it after a disconnection, by acting on the relative point of the module output address (see following paragraphs).

Address programming

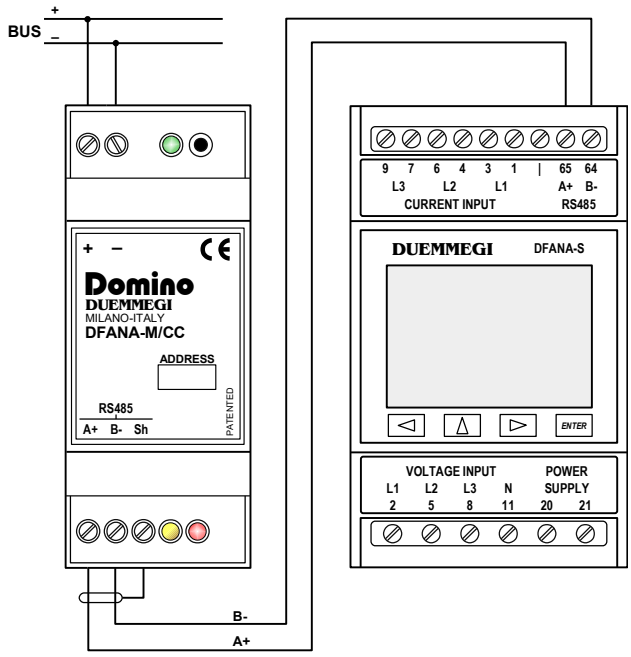
DFANA-M/CC module takes the following addresses on the **Domino** bus:

- ✗ three-phase mode: 30 input addresses and 3 optional output addresses 3 with a value equal to base address, base address + 10 and base address + 20
- ✗ single-phase mode: 10 input addresses and 1 optional output address with a value equal to base address

The base address can be assigned by DFPRO programmer or by BDTools or DCP IDE. A white label on the front panel allows the writing of the assigned base address for an immediate visual identification.

Module connection

The following schematic diagram shows the connection between DFANA-M/CC, DFANA-S and and **Domino** bus.



For details about the connection to the AC line and to the aux power supply, refer to the related User's Manual (DFANA-S_xxMIT.

Information reported on the bus

Input section

As already mentioned, the DFANA-M / CC module takes, inside the **Domino** bus, up to 30 input addresses reporting the ON/OFF status of the individual loads and the measurements of the various electrical parameters for each phase; in single-phase configuration, only the first block of 10 addresses has to be considered. The following tables show how the information in the 3 blocks is mapped.

Phase 1 or single-phase:

	IN											
Addr	**16..12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n	-	S 1	-	-	C 24	C 23	C 22	C 21	C 20	C 19	C 18	C 17
n+1	Voltage phase 1											
n+2	Current phase 1											
n+3	Active power phase 1											
n+4	Apparent power phase 1											
n+5	Reactive power phase 1											
n+6	Power factor phase 1											
n+7	Positive active energy Wh											
n+8	Positive active energy kWh, byte LSB											
n+9	Positive active energy kWh, byte MSB											

Phase 2:

	IN											
Addr	**16..12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n+10	-	S 2	-	-	C 16	C 15	C 14	C 13	C 12	C 11	C 10	C 9
n+11	Voltage phase 2											
n+12	Current phase 2											
n+13	Active power phase 2											
n+14	Apparent power phase 2											
n+15	Reactive power phase 2											
n+16	Power factor phase 2											
n+17	Positive active energy Wh											
n+18	Positive active energy kWh, byte LSB											
n+19	Positive active energy kWh, byte MSB											

Phase 3:

	IN											
Addr	**16..12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n+20	-	S 3	-	-	C 8	C 7	C 6	C 5	C 4	C 3	C 2	C 1
n+21	Voltage phase 3											
n+22	Current phase 3											
n+23	Active power phase 3											
n+24	Apparent power phase 3											
n+25	Reactive power phase 3											
n+26	Power factor phase 3											
n+27	Positive active energy Wh											
n+28	Positive active energy kWh, byte LSB											
n+29	Positive active energy kWh, byte MSB											

The first input address of each one of the three blocks (n, n + 10 and n + 20) report 16 digital points which, instead of being connected to “physical contacts”, are managed by the module itself. The first 8 points of each block (Cx) correspond to a load; when the state of a point is 1 (ON) the load must be connected. These “virtual” input points will then be used as described below.

Point 11 of each block (S1, S2 and S3), when active, indicates that at least one load of that block has been disconnected.

If the power threshold is exceeded, the disconnection sequence starts from the higher order load towards the lower order one (from C24 to C17 in single-phase, from C24 to C1 in three-phase).

The points in the input section at base address must be used in the programming of **Domino** system to control the loads (up to 8 in single-phase mode and up to 24 in tree-phase mode), adding to relay output modules a simple equation as in the following example:

```
O31.1 = I41.1
```

where `O31.1` is the relay output controlling the load 1 and `I41.1` is the point 1 of DFANA-M/CC having base address 41. Of course, up to 24 equations of this type are needed, one for each load to be controlled.

Regarding the electrical parameter measurements, the following considerations apply:

- **voltages** are expressed in V multiplied by 10 (e.g. a 230.4V voltage will be sent on the bus as 2304)
- **currents** are expressed in A multiplied by 100 (e.g. a current 22.65A will be sent on the bus as 2265)
- **active powers** (symbol P) are expressed in W and they are given in two's complement (since they can assume negative value) in the range -32768 to +32767; e.g. if the active power is 1825W, the module will send on the bus the value 1825. A negative value of the active power means that the system is yielding energy rather than consuming it (e.g. photovoltaic system).
- **apparent powers** (symbol S) are expressed in VA and they have always positive values; e.g. if the apparent power is 2478VA, the module will send on the bus the value 2478.
- **reactive powers** (symbol Q) are expressed in VAR and they are given in two's complement (since they can assume negative value) in the range -32768 to +32767; e.g. if the reactive power is 357VAR, the module will send on the bus the value 357.
- **power factors** (symbol PF) are multiplied by 1000 and they are given in two's complement in the range -1000 to +1000; e.g. if the PF is 0,985, the module will send on the bus the value 985. The PF is dimensionless. The power factor is the ratio P/S (active power divided by apparent power) and it gives an indication of the phase shift of the voltage with respect to the current; the sign of PF has the following meaning:
  - PF positive → inductive load
  - PF negative → capacitive load

- the last 3 addresses of each block report the same value and they allows to calculate the **total active energy** (kWh); the formula to have the value in kWh is:

  65536 x V(n+9) + V(n+8) + [V(n+7) / 1000]

  where V(n+9), V(n+8) and V(n+7) are the values at the input addresses [n+9, n+8 e n+7] respectively. The same result can be obtained by using the triplet of values at addresses [n+19, n+18 e n+17] and [n+29, n+28 e n+27].

Output section

In addition to the input addresses already described, the DFANA-M/CC module takes the following optional output addresses:

- three-phase mode: 3 output addresses with a value equal to base address, base address + 10 and base address + 20
- single-phase mode: 1 output address with a value equal to base address

9 digital points are available on each output address n. The first 8 allow to avoid the disconnection of the related load: when the state of a point is 1 (ON) the load always remains connected. Point 9, when activated, resets the Energy counter (kWh). The following tables show how the information on the 3 output addresses is mapped .

Fase 1 o monofase:

	OUT										
Addr	**16..11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n	-	-	Reset Energy counter	C24 always connected	C23 always connected	C22 always connected	C21 always connected	C20 always connected	C19 always connected	C18 always connected	C17 always connected

Fase 2:

	OUT										
Addr	**16..11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n+10	-	-	Reset Energy counter	C16 always connected	C15 always connected	C14 always connected	C13 always connected	C12 always connected	C11 always connected	C10 always connected	C9 always connected

Fase 3:

	OUT										
Addr	**16..11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
n+20	-	-	Reset Energy counter	C8 always connected	C7 always connected	C6 always connected	C5 always connected	C4 always connected	C3 always connected	C2 always connected	C1 always connected

Note: *the output section of the DFANA-M/CC module cannot be programmed using equations. The listed output points must be controlled by the supervisor by writing the desired point, or by I/V table (see in the next pages).*

DFANA-M/CC configuration panel

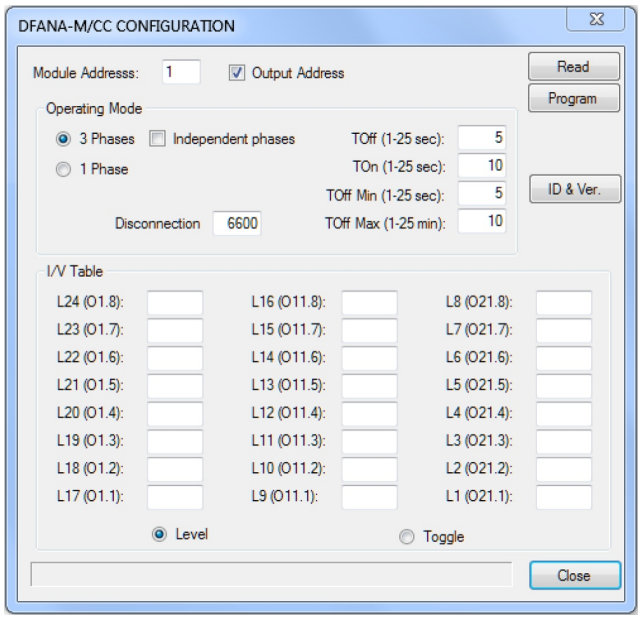
The configuration panel in BDTools and DCP IDE allows to configure DFANA-M/CC module as required.
The configuration of the module is performed through the **Domino** bus as described below.
If DFCP controller is used, all DFANA-M/CC modules installed in the system must be declared in the configuration, specifying their addresses as in the following example, where it is assumed to have a single DFANA-M/CC configured for three-phase mode with base address 22 and enabled output addresses:

```
DFANA-M/CC = ( I22, I23, I24, I25, I26,
I27, I28, I29, I30, I31, O22 )

DFANA-M/CC = ( I32, I33, I34, I35, I36,
I37, I38, I39, I40, I41, O32 )

DFANA-M/CC = ( I42, I43, I44, I45, I46,
I47, I48, I49, I50, I51, O42 )
```

From the main menu of DCP IDE select Configuration, Energy Management, and then DFANA-M/CC; the following window will be shown:



The meaning of the several fields is described below.

Module Address: it is the base address of DFANA-M/CC module to be configures or to be read

Output Address: enabling these parameter, the output address (or addresses for 3-phases mode) will be activated

3-Phases / 1-Phase: operating mode selection

Independent phases: this option affects three-phase mode only; if this option is not activated, the module will take into account the total three-phase power and will perform the load shedding starting from load 24 to arrive to 1.

If instead this option is activated, the 3 powers of each phase will be considered and the load disconnection will take place from C24 to C17, from C16 to C9 and from C8 to C1 independently; this operating mode is equivalent to 3 DFANA-M/CC modules configured in single-phase mode

TOff (1-25 sec): it is the time that elapses between the disconnection of one load and the next if the power has not returned below the threshold

TOn (1-25 sec): it is the time that elapses between the reconnection of one load and the next if there is power available to do so

TOff Min (1-25 sec): it is the minimum time during which a load remains disconnected; in other words, if the conditions exist to reconnect the load just disconnected but this has been disconnected for less than "TOff Min" seconds, then one still waits for "TOff Min" seconds before reconnecting it

TOff Max (1-25 min): is the maximum time during which a load can remain disconnected; in other words, if within “Toff Max” minutes the measured power does not return below the value established by the re-connection algorithm, the load will be reconnected anyway

Disconnection (Watt): it defines the threshold for disconnection (Watt): the active power value (in Watt) beyond which the load disconnection sequence begins; the disconnection of the first load takes place with a maximum delay of 5 seconds from exceeding the threshold. This value, generally, should be set equal to the size of your counter incremented by 10%; for example, for a 3kW meter, this threshold could be 3300W

I/V Table: it is useful to change the states of “Cx always connected” output points (see output sections) by acting on switches, buttons or other connected to **Domino** bus input modules. In other words, in this section you can specify the input points (real or virtual) which, when activated, must enable or disable the disconnection of the corresponding load

Level / Toggle: it defines the behavior of the points declared in the I/V Table . In Level mode, the output point that disables the disconnection of the related load follows the status of the I/V input point (therefore if the point is active the disconnection is disabled, vice-versa if the point is disabled the disconnection is enabled). In Toggle mode, the output point that disables the disconnection of the relative load changes state at each OFF-ON variation of the I/V input point (therefore at each OFF-ON variation the disconnection is enabled/disabled.

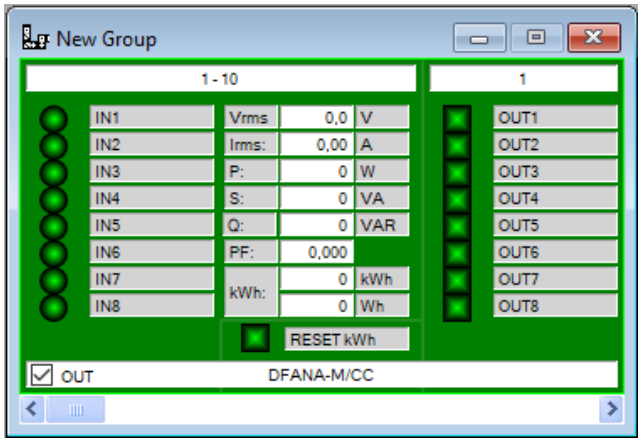
Read: transfer the current configuration of DFANA-M/CC to the configuration window

Program: transfer the configuration currently displayed in the window to DFANA-M/CC

ID & Ver.: ask to DFANA-M/CC the ID code and the firmware version.

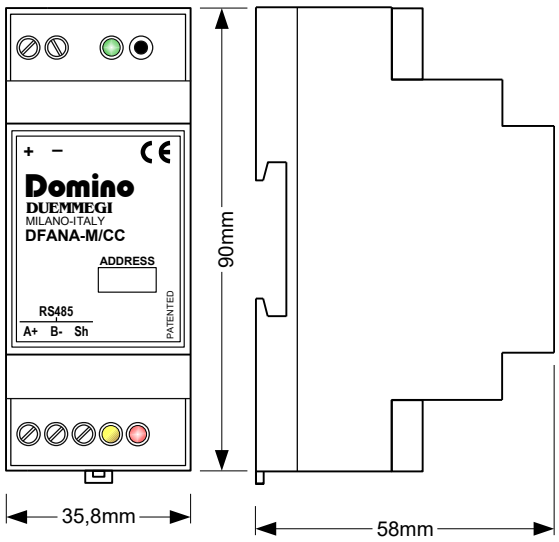
Mapping

The map of DFANA-M/CC module can be displayed by BD-Tools or DCP IDE as shown in the following figure; this figure relates to only one of the 3 sections of the module.



The points identified IN1 .. IN8 are related to the base input address; the status of these points is shown by a green “dot” if the point is not active or red if the point is active.
The points identified OUT1..OUT8 and RESET kWh are related to the output address (if enabled); the status of these points is represented by a green “square” if the point is not active or by a red “square” if the point is active.
The central section of the symbol shows the measured values as indicated.
As usual, the background of the module is shown in green when it is connected and working, otherwise the background will be red.

Outline dimensions



Technical characteristics

Power supply, bus side	By specific centralized power supply mod. DFPW2
MAX current consumption bus side	Equivalent to 2 standard modules
Communication protocol and parameters for DFANA-S	MODBUS RTU, slave addr.=1, 9600 baud, no parity, 8 data bits, 2 stop bits
RS485 cable type for connection to DFANA-S	Twisted pair, shield is not needed (if available, connect it to terminal Sh)
RS485 cable max length	5 meters
Amount of managed loads	Up to 8 in 1-phase mode and up to 24 in 3-phase mode
Threshold for load shedding	Up to 16.777.215 MAX
Available measurements for each phase	Voltage RMS Current RMS Active power Apparent power Reactive power Power factor Total active energy
Operating temperature range	-5 ÷ +50 °C
Recommended operating temperature range	+5 ÷ +40 °C
Storage temperature	-20 ÷ +70 °C
Protection degree	IP20

Note: *For more information about the technical characteristics of the measurements section DFANA-S, refer to the user's manual DFANA-S_xxMIT.*

Correct disposal of this product

(Waste Electrical & Electronic Equipment)
(Applicable in the European Union and other European countries with separate collection systems). This marking on the product, accessories or literature indicates that the product should not be disposed of with other household waste at the end of their working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, please separate these items from other types of waste and recycle them responsibly to promote the sustainable reuse of material resources. Household users should contact either the retailer where they purchased this product, or their local government office, for details of where and how they can take these items for environmentally safe recycling. This product and its electronic accessories should not be mixed with other commercial wastes for disposal.

Installation and use restrictions

Standards and regulations

The design and the setting up of electrical systems must be performed according to the relevant standards, guidelines, specifications and regulations of the relevant country. The installation, configuration and programming of the devices must be carried out by trained personnel.
The installation and the wiring of the bus line and the related devices must be performed according to the recommendations of the manufacturers (reported on the specific data sheet of the product) and according to the applicable standards.
All the relevant safety regulations, e.g. accident prevention regulations, law on technical work equipment, must also be observed.

Safety instructions

Protect the unit against moisture, dirt and any kind of damage during transport, storage and operation. Do not operate the unit outside the specified technical data.
Never open the housing. If not otherwise specified, install in closed housing (e.g. distribution cabinet). Earth the unit at the terminals provided, if existing, for this purpose. Do not obstruct cooling of the units. Keep out of the reach of children.

Setting up

The physical address assignment and the setting of parameters (if any) must be performed by the specific softwares provided together the device or by the specific programmer. For the first installation of the device proceed according to the following guidelines:

- Check that any voltage supplying the plant has been removed
- Assign the address to module (if any)
- Install and wire the device according to the schematic diagrams on the specific data sheet of the product
- Only then switch on the 230Vac supplying the bus power supply and the other related circuits

Applied standards

This device complies with essential requirements of the following directives and norms:
2014/30/UE (EMC)
2014/35/UE (Low Voltage)
2011/65/UE (RoHS)

Note

Technical characteristics and this data sheet are subject to change without notice.