AC 31 technical documentation

Chapter 12

NCBR-M

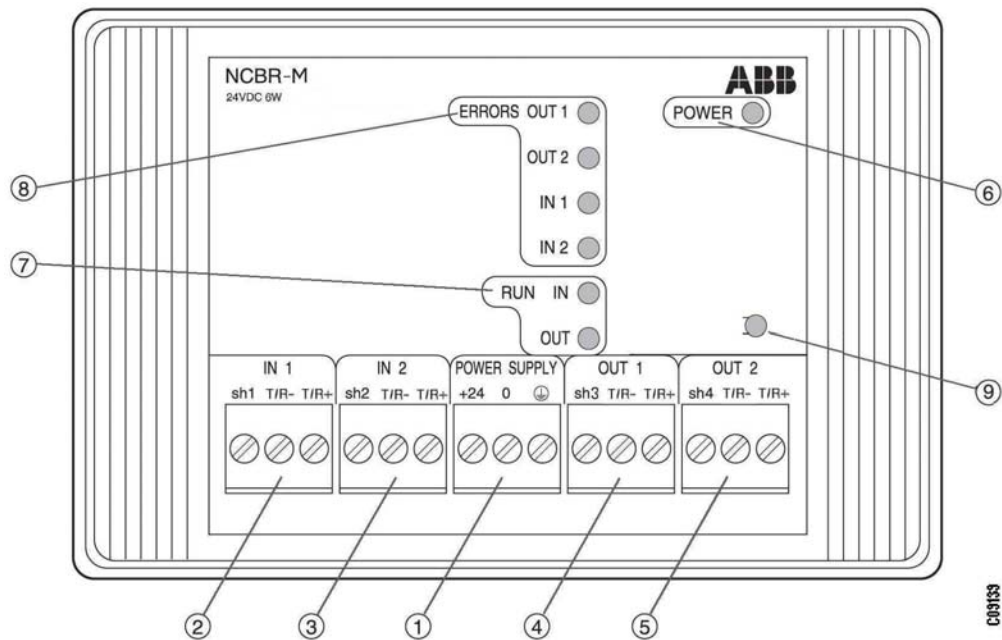## MODBUS amplifier with redundancy

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NCBR-M
MODBUS amplifier with redundancy

The purpose of this chapter is to describe the general characteristics and operating conditions of NCBR-M MODBUS® amplifier with redundancy.

1. NCBR-M presentation

1.1.1   The front of NCBR-M


1 – Removable connector for 24 V d.c.

2 – Removable connector for MODBUS® input 1

3 – Removable connector for MODBUS® input 2

4 – Removable connector for MODBUS® output 1

5 – Removable connector for MODBUS® output 2

6 – One green led display labelled as "POWER" to indicate the presence of supply 24 V d.c.

7 – Two yellow led displays labelled as "IN" and "OUT" to indicate the communication between master or slave devices and NCBR-M

8 – Four red led displays labelled as "OUT1" , "OUT2" , "IN1" and "IN2" to indicate the default on the different MODBUS® buses

9 – selector not used - Reserved

NCBR-M
MODBUS amplifier with redundancy
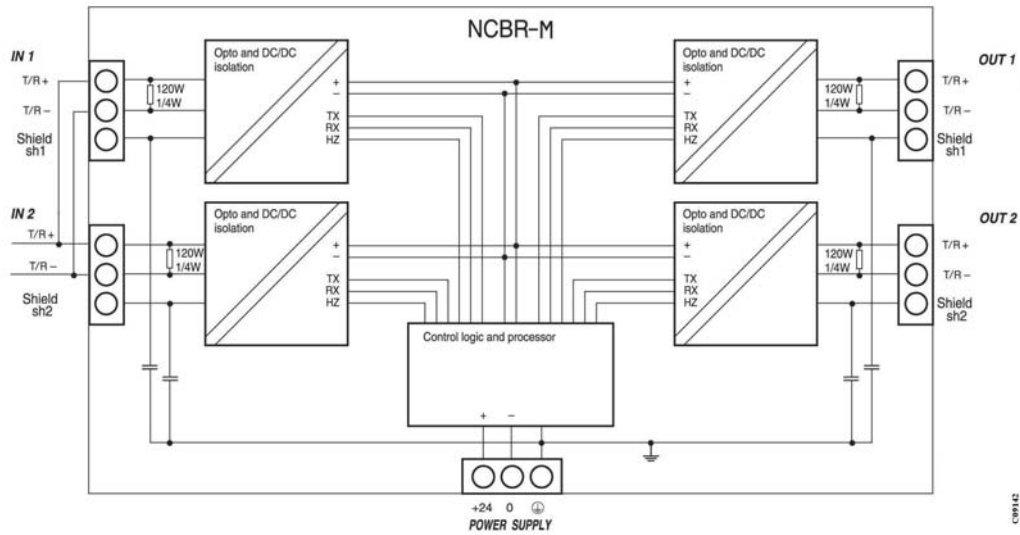
Electrical connections for MODBUS® system bus amplifier NCBR-M
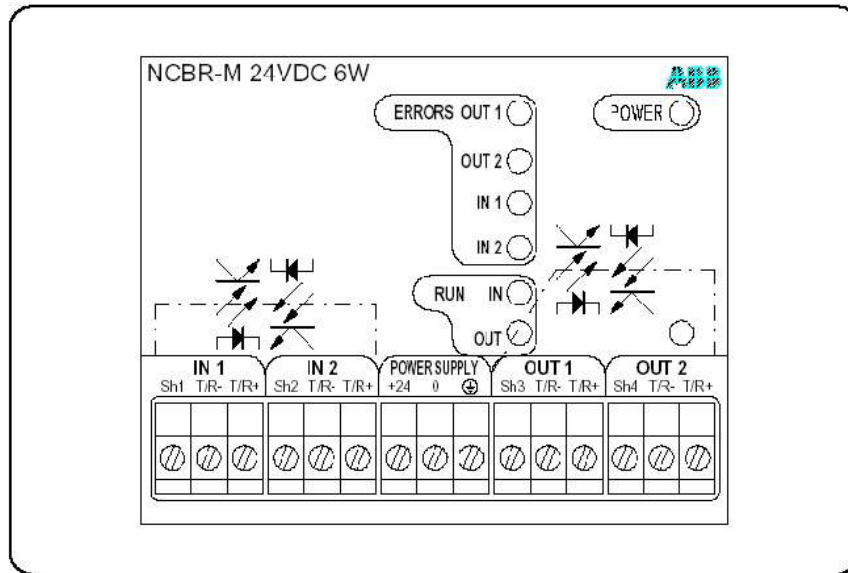
Electrical of isolation for MODBUS® system bus amplifier NCBR-M

NCBR-M
MODBUS amplifier with redundancy

1.2   General operating conditions

The NCBR-M unit was developed according to the European EC directives, the main national and international IEC 1131-1 and IEC 1131-2 standards and the EN61131-2 product standard concerning automation devices.

| Ambient conditions	
- Temperature:	
operation:	0°C to + 55°C
storage	- 40°C to + 75°C
transport	- 25°C to + 75°C
- Humidity:	DIN 40040 class F without condensation
annual average	≤ 75%
up to 30 days per year	95%
occasionally	85%
- Atmospheric pressure:	DIN 40050
operation	≥ 800 hPA (≤ 2000 m)
storage	≥ 600 hPA (≤ 3500 m)
Mechanical data	
- Protection index	IP20
- Unit	UL V2
- Vibration stress	CEI68-2-6 test Fc
- Shock stress	CEI68-2-27 test Ea
Tolerances for main voltage	
- 24 V d.c.	19.2 to 30 V (- 20%, + 25%)
- Maximum consumption	6 W
Voltage isolation RS485	
- IN1, IN2, OUT1,OUT2 and power supply.	Yes (500 V a.c.)
- IN1/OUT1, IN1/OUT2, OUT1/OUT2, IN1/IN2, IN2/OUT1 and IN2/OUT2	Yes (1000 V a.c.)
Maximum delay	
between input/ output signal	< 2 μs
Weight	340 g
Width x Height x Depth	120 x 80 x 85
Reference	
NCBR-M	1SBP260161R1001

|	
Creepage distances and clearances	IEC 664 and DIN VDE0160
Insulation test	IEC 1131-2
Electromagnetic compatibility Immunity tests against: - Electrostatic discharge - Radiated fields - Fast transient bursts - High energy pulse - Conducted high frequencies	 IEC 1000-4-2 (level 3) IEC 1000-4-3 (level 3) IEC 1000-4-4 (level 3) IEC 1000-4-5 IEC 1000-4-6 (level 3)
Voltage drops and short power cut off - D.C. power supply	 Duration of the power cut off: $\leq$ 10 ms Time between 2 voltage drops: $\geq$ 1 s
Clearance	IEC 664-664A DIN VDE 0160
Dielectric test	IEC 1131-2
Mountings - only with DIN rail	 35 mm

Connections
- Connectors
- Section for:
  Power supply
 	
  Bus
 	
- Screws tightening torque
	
	Removable terminal blocks (2.5 mm²)
	
	Rigid or multi-conductor wire AWG 14 (1.95 mm²)
	
	Twisted pair AWG 24 (0.22 mm²) to AWG 18 (0.8 mm²)
	0.5 Nm (given as an indication only)

Interface - For the bus	 RS 485

NCBR-M
MODBUS amplifier with redundancy

1.3 MODBUS® system bus technical specifications

Type	
- Number of RS485	2x RS 485 inputs
	2x RS485 outputs for loop connection
- RS485 Transceiver type	Low EMI
Mode	Half-duplex
Number of connection points	RS485 standard
	- standard load 32 max (CPU or RU…)
	- ¼ load 128 max (07KP53…)
Support	Shielded twisted pair
- Section	0.22...0.8 mm²
- Twists	> 10 per meter
- Resistance	$\leq 300\ \Omega$ / km
- Characteristic Impedance	100 à 150 Ω
- Capacity	< 150 nF / km
- Shielding	Braiding
- Line impedance adaptation	
Inputs	Integrated (120 Ω)
Outputs	Integrated (120 Ω)
- Line polarisation (high impedance level)	
Inputs	2 x 1 KΩ
Outputs	2 x 330 Ω
Protocol	MODICON MODBUS® RTU
Maximum length	
- Input line	1000 m Maximum depending of speed
- Output line	1200 m Maximum depending of speed
Isolation	yes by optocoupler
Speed	
- Maximum speed	115200 Bauds
- Self detection	9600, 19200, 38400, 57600, 76800, and 115200 Bauds

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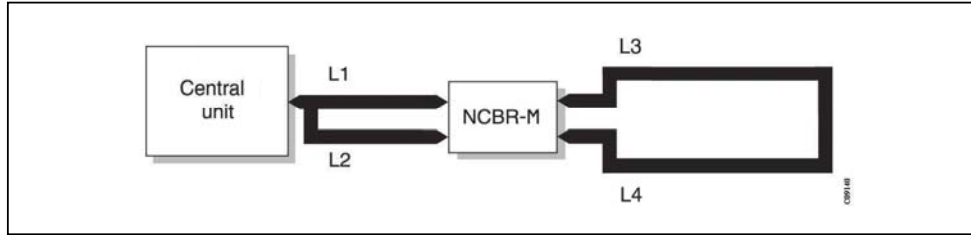
Configuration MODBUS® with NCBR-M
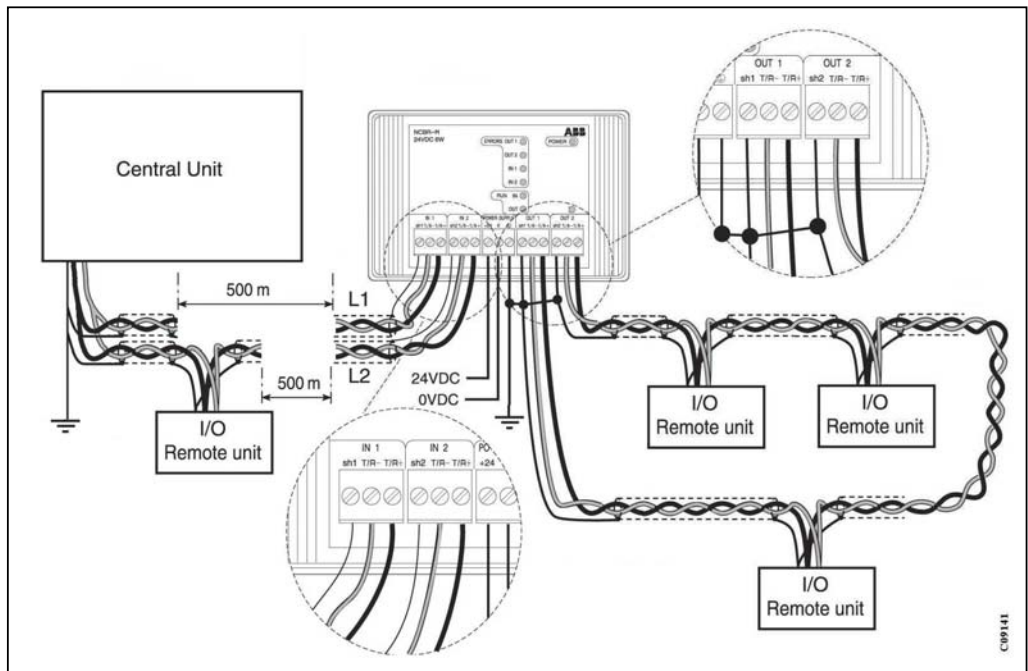
Cabling of MODBUS® network with NCBR-M

1.4   Presentation of MODBUS® system bus NCBR-M

1.4.1   Introduction

The NCBR-M is an amplifier for MODBUS® protocol with integrated redundancy function by loop connections on outputs. The loop will be able to have a maximum of length up to 1200 meters depending of speed used.

It also ensures an amplifier function whereas the maximum length on MODBUS line can reached 2200 meters with a speed at 57600 Bauds, (1000 meters between MODBUS® master and NCBR-M and 1200 meters on the output loop).

The use of NCBR-M is totally transparent, and a Led diagnosis is available on NCBR-M and one output line (OUT1) can be forced for communication by the Master MODBUS®, in order to find where the loop is opened in case of line faulty.

1.4.2   Configuration

The NCBR-M can be used with all type of master MODBUS® modules.

The number of MODBUS® slave modules accepted by the RS485 lines depend of type of MODBUS® slave modules (low or high RS485 impedance).

For example:

Up to 31 MODBUS® slave modules when the slaves are central units 40/50 & 90 series or remote units ICMK14F1/N1-M

or up to 127 MODBUS® slave modules when the slaves are MODBUS® coupler MCD or MODBUS® coupler 07KP53.

Any configuration is necessary by the user,

The NCBR-M is able to work with six speeds from 9600 Bauds up to 115200 Bauds, the speed is automatically detected by the NCBR-M .

Speed (Bauds)	Maximum length of loop OUT1-OUT2
9600	1200 meters
19200	1200 meters
38400	1200 meters
57600	1200 meters
76800	900 meters
115200	600 meters

The MODBUS® address of NCBR-M is fixed at 245, This MODBUS® address will be used by the Master MODBUS® to question the NCBR-M

1.4.3   Installation

The NCBR-M product has been conceived for operation in extreme industrial environments. The correct operation of these products is only ensured if all EMC protection rules have been applied.

(see technical documentation 1SBC260400R1001 chapter 4)

1.4.3.1 Assembly conditions

The NCBR-M must be mounted on a DIN rail (35 mm) by using the support lock . It may be installed vertically or horizontally.

For a cabinet assembly:

operating temperature from 0 to 55°C, envisage sufficient free volume around the units to allow the heat to dissipate correctly. It is recommended that the cabinet is fitted with a ventilation system.

Warning avoid placing heat generating devices next to the products (transformers, mains, power contactors, ...).

All electrical connections are realized through removable terminal blocks with an acceptable wire section equal to 2.5 mm^2.

The tightening torque, for reference, is equal to 0.5 Nm.

In order to guaranty the safety and error free data transmission over long distances, the selection of an appropriate MODBUS$^®$ communication cable is very important.

1.4.3.2 Power supply

Use rigid or multi-conductor wires to connect the external 24 Vd.c. power supply for NCBR-M.

The connection of an external thermal fuse is necessary to provide material protection.

The NCBR-M executes a complete series of auto tests and configuration at each start-up. During power ON, all Led displays flash and the red error Led displays IN1 and IN2 stay at On as long as any communication between Master MODBUS$^®$ and the NCBR-M.

The green Led display POWER indicates presence of 24 V d.c. power supply on NCBR-M.

NCBR-M
MODBUS amplifier with redundancy

1.4.3.3   Connection on inputs IN1 and IN2

The maximum length between master MODBUS® and the NCBR-M is 1000 meters.

A redundancy function can be provided by two parallel lines between Master MODBUS® and inputs of NCBR-M. These two parallel lines can have different lengths.

In case only one line is used between Master MODBUS® and inputs of NCBR-M, it will be necessary to connected in parallel the inputs IN1 and IN2 of NCBR-M.

Warning always connect inputs IN1 and IN2 to avoid red error Led displays.

The connections of inputs IN1 and IN2 are realized through removable terminal blocks with an acceptable wire section equal to 2.5 mm^2 and tightening torque, is equal to 0.5 Nm.

The MODBUS® communication cable used to connect Master MODBUS® and inputs of NCBR-M is a RS 485 serial interface and composed of a shielded twisted pair. The same cable type should be used for the whole system bus and bus interruptions should be avoided.

Use a AWG 24 (0.22 mm^2) to AWG 18 (0.18 mm^2) twisted pair.

The bus ending resistance of 120 Ω is already integrated in the NCBR-M.

1.4.3.4   Connection on outputs OUT1 and OUT2

The NCBR-M allows only to realize a redundancy by loop connection on outputs between OUT1 and OUT2. This loop will be able to have a maximum of length up to 1200 meters depending of speed used.

The connections of outputs OUT1 and OUT2 are realized through removable terminal blocks with an acceptable wire section equal to 2.5 mm^2 and tightening torque, for reference, is equal to 0.5 Nm.

The MODBUS® communication cable used to connect the loop is a RS 485 serial interface and composed of a shielded twisted pair. The same cable type should be used for the whole loop system bus and bus interruptions should be avoided.

Use a AWG 24 (0.22 mm^2) to AWG 18 (0.18 mm^2) twisted pair.

The bus ending resistance of 120 Ω is already integrated in the NCBR-M.

1.4.4 Operation and diagnosis

1.4.4.1 How the NCBR-M is working

The speed of communication is automatically detected by the NCBR-M , the NCBR-M can work with different speed from 9600 Bauds up to 115200 Bauds.

Input communication: The NCBR-M is waiting a character from master MODBUS® on the inputs IN1 and IN2. When the first character of a frame is received on one of two input lines, the corresponding line becomes valid and then the characters on the other input line are ignored. After the complete frame has been received (delay>300µs), the NCBR-M waits again a new frame on the two input lines or on output lines (answer).

Output communication (loop): After initialisation, the electrical signal on OUT1 is changed and the NCBR-M checks if the electrical signal on OUT2 follows this change.

- If yes, the loop is closed and then the data frame is sent only on output OUT1.

- If no, the loop is opened and the data frame is sent from both outputs OUT1 and OUT2 now and the red Leds OUT1 and OUT2 are alternatively ON. And the NCBR-M checks if character arrives on OUT2. If the loop is closed again, the two frames are overlapping each other.

If a transmission error occurs, the telegram currently sent is ignored and has to be sent again.

After power supply ON, the red Leds go out and the yellow ones indicate the communication.

The Master MODBUS® can interrogate the NCBR-M in order to check the status of input or output lines, in case an error is present.

- The MODBUS® slave number of NCBR-M is fixed at **245**, This MODBUS® slave number will be use by the master MODBUS® to read or write a special word command inside NCBR-M in order to realize diagnosis of the lines in case an error is present.

- The MODBUS® address corresponding to word command is fixed for read and write = **2555** in hexadecimal or **9557** in decimal. Only one word is available for exchange between master MODBUS® and NCBR-M.

Only the following MODBUS® operation codes may be processed by the master MODBUS® :

Function codes		Description
In Hexadecimal	In Decimal	
03	03	Read n words
06	06	Write a word

The MODBUS® frames transmitted by the master to interrogate the NCBR-M will contain the following information:

- The MODBUS® address of the NCBR-M (1 byte) = 245

- The function code defining the master request (1 byte) = 03 or 06

- The data commands (N bytes)

- The CRC16 control code (2 bytes)

The MODBUS® frames to interrogate the NCBR-M with series 40/50 and 90 will be realized by the function block MODMASTK with AC31GRAF programming software or by function block MODMASTW with 907AC1131 programming software.

1.4.4.2   Led displays

Led displays on the front face allow to indicate and control information about communication process and status of NCBR-M.

ERRORS	OUT1	✳
	OUT2	✳
	IN1	✳
	IN2	✳
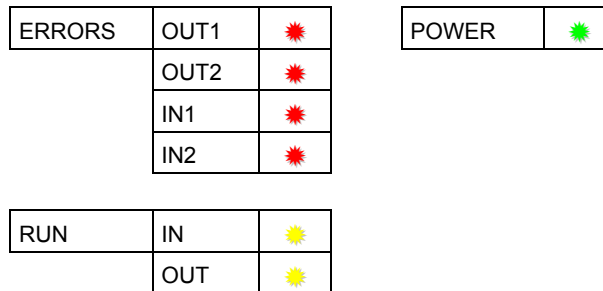
| POWER | ✳ |

| RUN | IN | ✳ |
| | OUT | ✳ |

| **POWER** | Green Led |
| | Indicates presence of supply voltage 24 V d.c. on NCBR-M. |

RUN	Yellow Leds
IN	Indicates data reception on input, is flashing during communication.
OUT	Indicates data transmission on outputs, is flashing during communication.

ERRORS	Red Leds
IN1 & IN2	Indicate error of communication, no communication or short-circuit.
OUT1 & OUT2	Indicate error of communication, open loop or short-circuit.

The flashing frequency depends on communication rate:
- If only one frame per second => flashing frequency = 0.2 Hz.
- If ten frames per second => flashing frequency = 0.5 Hz.

1.4.4.3   Diagnosis through the MODBUS® master

An open circuit or short-circuit on Inputs or outputs on the MODBUS® system bus is detected by NCBR-M (Led displays) and after that the MODBUS® master is able to identify the type of error and where it is located.

In order to interrogate the NCBR-M, the MODBUS® master will use a MODBUS® request, with function codes to read or write only one word, always at the same MODBUS® address **2555** in hexadecimal (**9557** in decimal) and the MODBUS® slave number is **F5** in hexadecimal (**245** in decimal).

Function code 03 (read a word) : To identify the presence and type of error

MODBUS® status request of the master

NCBR-M slave number	Function code	Address		Number of words		CRC control code	
		High	Low	High	Low	High	Low
F5	03	25	55	00	01	8A	62

MODBUS® status answer from NCBR-M

NCBR-M slave number	Function code	Address		Answer		CRC control code	
		High	Low	High	Low	High	Low
F5	03	02	00		00	09	91
F5	03	02	00		A3	49	E8
F5	03	02	00		35	C9	86

Answer = 00   correspond to " No error "

Answer = A3   correspond to " Input error " connection IN1 or IN2 is open or in short-circuit.

Answer = 35   correspond to " Loop error " loop OUT1 and OUT2 is open or in short-circuit

Function code 06 (write a word) : To identify where the loop is open and reset force mode

Writing = 00   correspond to " Reset force mode "

> * If value of Data is different from 21 H or 33 D, same effect than value = 0

MODBUS® request of the master

NCBR-M slave number	Function code	Address		Data		CRC control code	
		High	Low	High	Low	High	Low
F5	06	25	55	00	00	87	A2

MODBUS® answer from NCBR-M

NCBR-M slave number	Function code	Address		Answer		CRC control code	
		High	Low	High	Low	High	Low
F5	06	25	55	00	00	87	A2

Writing = 21 H or 33 D   correspond to " Set force only OUT1 ON "

In case of loop error, this command allows to send MODBUS® request only on OUT1 line and after checking the list of MODBUS® slaves number with a time-out error, it is possible to define where the loop is opened.

To reset force OUT1 ON, Send writing = 00 or XX or switch ON/OFF power supply of NCBR-M.

MODBUS® request of the master

NCBR-M slave number	Function code	Address		Number of words		CRC control code	
		High	Low	High	Low	High	Low
F5	06	25	55	00	21	47	BA

MODBUS® answer from NCBR-M

NCBR-M slave number	Function code	Address		Answer		CRC control code	
		High	Low	High	Low	High	Low
F5	06	25	55	00	21	47	BA

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