



Tecnoroll BMB srl

Via Olona 9, 21040 Veduggio Olona VA

www.tecnoroll.it

FLEXMod modules

Connectors, pin description and programming protocol

Rev J, Jun, 4 2009

Hardware revision 2.00

Firmware version 1.40

1. The use of this product in conformity with the DVB Standard is prohibited in any case, unless the license of patents applicable to the DVB patent group is granted.
2. It's the purchaser's duty to check which patents with potentially payable author's rights are used in his/her own final project and act accordingly with the bodies in charge.
3. The contents of this manual are subject to change without notice.
4. Of the specifications described in this manual, the functions and performance the supply of which is assured with this product are only those that can be confirmed with the separate Basic Firmware attached.
5. When the product or information described in this manual is used, our company does not guarantee or grant any license of the intellectual property rights and other rights of our company or of third parties. If any problems concerning the ownership rights of third parties attributable to the above use occur, our company will not be responsible for them.
6. Since the product described in this manual was not developed specially for equipment related to human life, those who intend to use it for equipment whose failure or malfunction may directly threaten human life or endanger the human body or for special applications requiring high reliability (such as aerospace, nuclear power control, submarine repeaters, travel control, and medical equipment for life support) must consult our sales responsible personnel in advance. Our company will not be responsible for any damages that may occur due to such use without consulting us.
7. Although our company is endeavoring to improve quality and enhance reliability, semiconductor products will fail with a certain probability. Users are requested to pay due attention to safe design techniques such as redundant design, preventive measures against the spreading of fire, over-current, and malfunctions, so that failure of the products described in this manual will not result in accidents leading to injury or death, fire, or social damage.
8. The product described in this manual is not designed to be radiation-resistant.
9. This board is just an 'electronic component' that cannot work in a standalone mode, therefore all the tests and qualifications for electromagnetic compatibility, all the CE certifications and any other regulations concerning the final product implemented by the customer are to be carried out by the customer himself referring to the final product for which this electronic component has been used.

Revision history:

Rev A, September, 22 2008, abesani@tecnoroll.it

First release

Rev B, October, 23 2008, abesani@tecnoroll.it

Added modulator status pins

Added *GetTemp*, *TempAlarm*, *ModFlags*

Added Typical output characteristics.

Rev C, November, 3 2008, abesani@tecnoroll.it

Added *SetChannel*, *TSoOutBypass*

Rev D, November, 7 2008, abesani@tecnoroll.it

Added automatic index assignment to *AddServ* command.

Rev E, November, 11 2008, abesani@tecnoroll.it

Firmware 1.18.

Rev F, November, 13 2008, abesani@tecnoroll.it

Added *BootDelay*.

Rev G, January, 27 2009, abesani@tecnoroll.it

Added documentation for FLEXMod-2xx

Added documentation for DVB-H parameters for the COFDM modulator

Rev H, February, 13 2009, abesani@tecnoroll.it

Fixed TSoOut/Modulator flags pinout.

Added *SidRemap*.

Rev I, April, 28 2009, abesani@tecnoroll.it

Added *FlagsMatrix*.

Added Product Identification System

Rev J, June, 4 2009, abesani@tecnoroll.it

Removed *PIDMon* and *TuneW* commands.

Modified *AddServ* and *ServList* for LCN support.

Added *LowPriServ* for low priority services.

Index

1. FLEXMOD BLOCK DIAGRAM	7
1.1. FLEXMOD-101 AND FLEXMOD-111	7
1.2. FLEXMOD-281	8
2. CONNECTORS AND PIN DESCRIPTION	9
3. SERIAL PORT USAGE	12
3.1. HELP	12
4. FLEXMOD SYSTEM CONFIGURATION	13
4.1. SAVE	13
4.2. CLEAR	13
4.3. REBOOT	13
4.4. BAUD	13
4.5. ECHO	13
4.6. FWVERSION	14
4.7. SWVER	14
4.8. GETSN	14
4.9. WELCOME	14
4.10. PROGMANUF	14
4.11. MANUF	16
4.12. TEMPALARM	16
4.13. MODFLAGS	16
4.14. FLAGSMATRIX	16
4.15. BOOTDELAY	17
5. FLEXMOD-1XX COFDM SPECIFIC CONFIGURATION	18
5.1. CARR	18
5.2. CHBW	18
5.3. GUARD	18
5.4. CONST	18
5.5. DVBHPARMS	18
5.6. FEC	18
5.7. FREQ	19
5.8. SETCHANNEL	19
5.9. SPECT	19
5.10. FILTER	19
5.11. POWER	19
5.12. PCR	19
5.13. SFN	20
6. FLEXMOD-2XX QPSK SPECIFIC CONFIGURATION	21
6.1. SYMBOLRATE	21
6.2. SPECT	21
6.3. FEC	21
6.4. FILTER	21
6.5. POWER	21
6.6. FREQ	21
6.7. PCR	22

6.8. SFN.....	22
7. INPUT TRANSPORT STREAM CONFIGURATION	23
7.1. TSINSELECT	23
7.2. TSINVALID.....	23
7.3. TSINCLOCK.....	23
7.4. TSINREVERSE	23
7.5. TSINREFCLOCK	23
7.6. TSINSTATUS.....	23
8. OUTPUT TRANSPORT STREAM CONFIGURATION	25
8.1. TsOUTENABLE.....	25
8.2. TsOUTVALID	25
8.3. TsOUTCLOCK	25
8.4. TsOUTCLOCKRATE	25
8.5. TsOUTPSYNC	25
8.6. TsOUTREVERSE.....	25
8.7. TsOUTASI.....	26
8.8. TsOUTBYPASS.....	26
9. DVB TABLE FILTERING AND REMULTIPLEXING	27
9.1. NETSCAN.....	27
9.2. GETSERV.....	27
9.3. CLEARSERV	27
9.4. ADDSERV	27
9.5. SERVLIST	28
9.6. SIDREMAP.....	28
9.7. NITPARAM (COFDM).....	28
9.8. NITPARAM (QPSK).....	29
9.9. SETPID	29
9.10. ALLPIDS.....	29
9.11. REMUX.....	29
9.12. RUNSERV	29
9.13. CHECKTIME	30
9.14. CHECKTABLES	30
9.15. LOWPRI SERV	30
10. SYSTEM MONITORING COMMANDS.....	31
10.1. MODINFO	31
10.2. TSINFO.....	31
10.3. TSMON.....	31
10.4. SINGLETONE	31
10.5. GETTEMP.....	31
11. FLEXMOD MODULE UPGRADE	32
11.1. FLASHFORMAT.....	32
11.2. UPGRADE	32
12. LVDS ASI INPUT/OUTPUT.....	33
12.1. ASI INPUT SAMPLE SCHEMATIC.....	33
12.2. ASI OUTPUT SAMPLE SCHEMATIC	34

13. POWER SUPPLIES CHARACTERISTICS35

14. ALPHABETICAL COMMAND LIST36

15. FLEXMOD-1XX TYPICAL OUTPUT CHARACTERISTICS38

16. FLEXMOD-2XX TYPICAL OUTPUT CHARACTERISTICS39

17. PACKAGING INFORMATION.....40

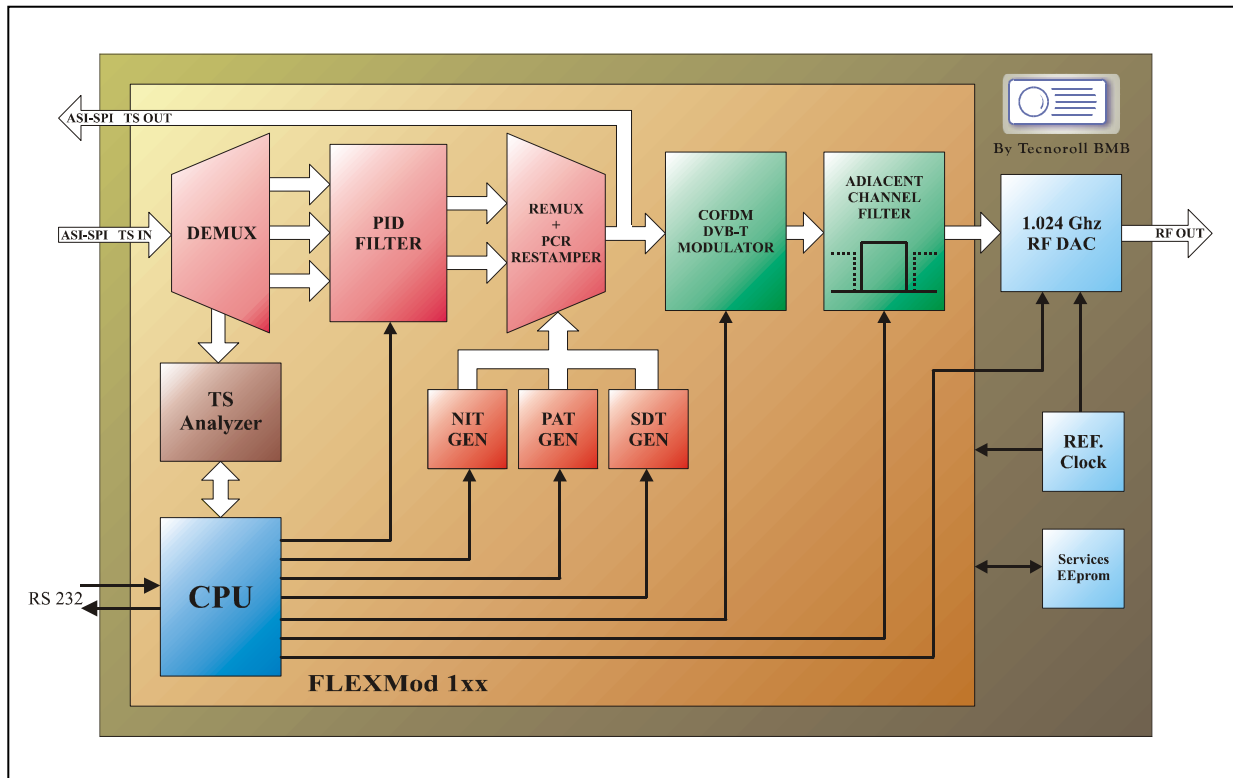
APPENDIX A 'TYPE' DESCRIPTION FOR CONNECTOR PINS41

APPENDIX B FLEXMOD PRODUCT IDENTIFICATION SYSTEM.....42

1. FLEXMod Block Diagram

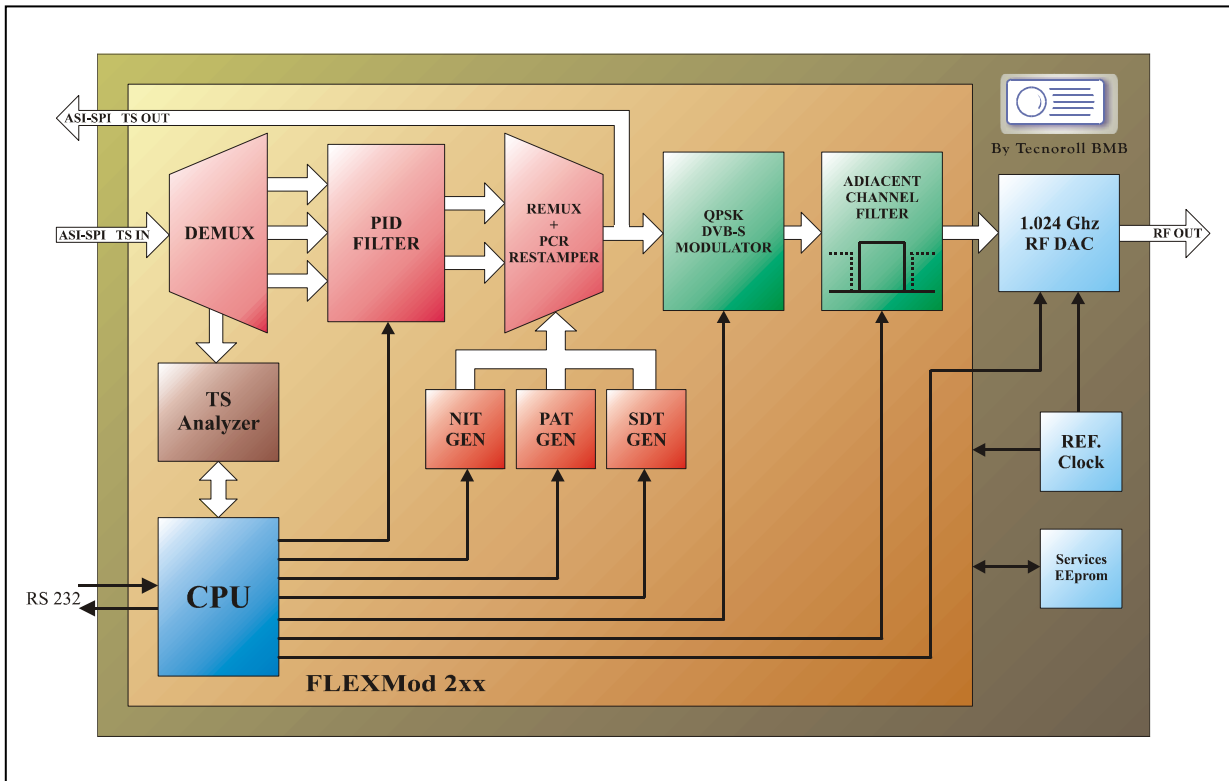
1.1. FLEXMod-1xx

The FLEXMod-1xx is an *ETSI EN 300 744* compliant COFDM modulator with an integrated microprocessor, TS remultiplexer, enhanced output filtering and a 1GHz output DAC.

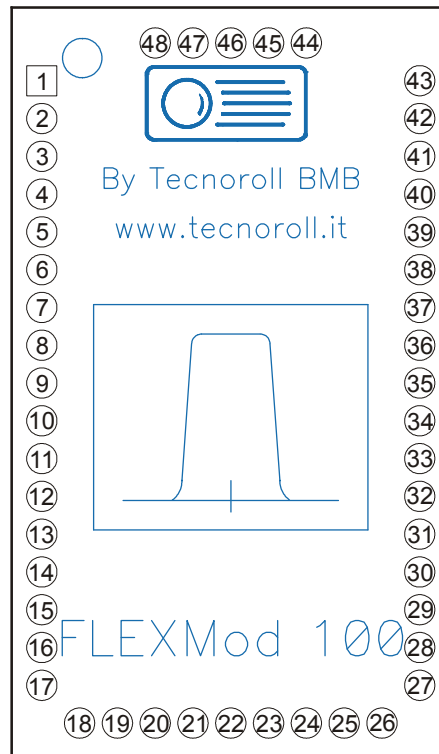


1.2. FLEXMod-281

The FLEXMod-281 is an *ETSI EN 300 421* compliant QPSK modulator with an integrated microprocessor, TS remultiplexer, enhanced output filtering and a up to 1GHz output DAC.



2. Connectors and pin description



FLEXMod-100, Top view

Pin	Symbol	Type	Description
1	GNDA	P	Analog ground
2	1V8A	P	+1.8V Analog Power Supply
3	1V8	P	+1.8V Digital Power Supply
4	GND	P	Digital Ground
5	REF_CLOCK	O ₃	Optional 27 MHz Reference Clock Output
6	ASI_IN	I _{LVDS+}	LDVS TS ASI Input. Requires Cable equalizer and an adaptation network. See <i>ASI Input</i> on page 33 for more information.
7		I _{LVDS-}	
8	TSin_CLK	I ₃	Transport Stream Input CLOCK signal
9	TSin_VALID	I ₃	Transport Stream Input VALID signal
10	TSin_D0	I ₃	Transport Stream Input Data line, bit 0
	TSin_D7		Transport Stream Input Data line, bit 7 ⁽¹⁾
11	TSin_D1	I ₃	Transport Stream Input Data line, bit 1
	TSin_D6		Transport Stream Input Data line, bit 6 ⁽¹⁾
12	TSin_D2	I ₃	Transport Stream Input Data line, bit 2
	TSin_D5		Transport Stream Input Data line, bit 5 ⁽¹⁾

¹ Input TS can be inverted using the *TsInReverse* command, see page 23.

Pin	Symbol	Type	Description
13	TSin_D3	I ₃	Transport Stream Input Data line, bit 3
	TSin_D4		Transport Stream Input Data line, bit 4 ⁽²⁾
14	TSin_D4	I ₃	Transport Stream Input Data line, bit 4
	TSin_D3		Transport Stream Input Data line, bit 3 ⁽²⁾
15	TSin_D5	I ₃	Transport Stream Input Data line, bit 5
	TSin_D2		Transport Stream Input Data line, bit 2 ⁽²⁾
16	TSin_D6	I ₃	Transport Stream Input Data line, bit 6
	TSin_D1		Transport Stream Input Data line, bit 1 ⁽²⁾
17	TSin_D7	I ₃	Transport Stream Input Data line, bit 7
	TSin_D0		Transport Stream Input Data line, bit 0 ⁽²⁾
18	GND	P	Digital Ground
19	1V2	P	+1.2V Digital Power Supply
20	3V3	P	+3.3V Digital Power Supply
21	TxD	O ₃	RS232 TX Line
22	RxD	I ₃	RS232 RX Line
23	RSVD	-	Reserved
24	3V3	P	+3.3V Digital Power Supply
25	1V2	P	+1.2V Digital Power Supply
26	GND	P	Digital Ground
27	TSout_D7	O ₃	Transport Stream Output Data line, bit 7
	Flag7		Flags bit 7 ⁽³⁾
	TSout_D0		Transport Stream Output Data line, bit 0 ⁽⁴⁾
28	TSout_D6	O ₃	Transport Stream Output Data line, bit 6
	Flag6		Flags bit 6 ⁽³⁾
	TSout_D1		Transport Stream Output Data line, bit 1 ⁽⁴⁾
29	TSout_D5	O ₃	Transport Stream Output Data line, bit 5
	Flag5		Flags bit 5 ⁽³⁾
	TSout_D2		Transport Stream Output Data line, bit 2 ⁽⁴⁾
30	TSout_D4	O ₃	Transport Stream Output Data line, bit 4
	Flag4/ OverTEMP		Flags bit 4/ <i>FlexMOD-100 temperature is above the maximum temperature set with the TempAlarm command</i> ⁽³⁾
	TSout_D3		Transport Stream Output Data line, bit 3 ⁽⁴⁾
31	TSout_D3	O ₃	Transport Stream Output Data line, bit 3
	Flag3/Overflow		Flags bit 3/ <i>Modulator overflow</i> ⁽³⁾
	TSout_D4		Transport Stream Output Data line, bit 4 ⁽⁴⁾
32	TSout_D2	O ₃	Transport Stream Output Data line, bit 2
	Flag2/BURST		Flags bit 2/ <i>Input TS in burst mode</i> ⁽³⁾
	TSout_D5		Transport Stream Output Data line, bit 5 ⁽⁴⁾

² Input TS can be inverted using the *TsInReverse* command, see page 23.

³ Output flags can be set using the XXXX command, see page YY. In *Italics*, the default value.

⁴ Output TS can be inverted using the *TsOutReverse* command, see page 25.

Pin	Symbol	Type	Description
33	TSout_D1	O ₃	Transport Stream Output Data line, bit 1
	Flag1/204		Flags bit 1/Input TS is formatted with 204 bytes packets ⁽⁵⁾
	TSout_D6		Transport Stream Output Data line, bit 6 ⁽⁶⁾
34	TSout_D0	O ₃	Transport Stream Output Data line, bit 0
	Flag0/DCD		Flags bit 0/Transport Stream detected on input ⁽⁵⁾
	TSout_D7		Transport Stream Output Data line, bit 7 ⁽⁶⁾
35	TSout_VALID	O ₃	Transport Stream Output VALID signal
36	TSout_CLK	O ₃	Transport Stream Output CLOCK signal
37	ASI_OUT	O _{LVDS-}	LDVS TS ASI Output. Requires an adaptation network and a Cable Driver. See <i>ASI Output</i> on page 34 for more information.
38		O _{LVDS+}	
39	TSout_PSYNC	O ₃	Transport Stream Output PSYNC signal
40	GND	P	Digital Ground
41	3V3	P	+3.3V Digital Power Supply
42	3V3A	P	+3.3V Analog Power Supply
43	GNDA	P	Analog ground
44	GNDA	P	Analog ground
45	$\overline{\text{IFOUT}}$	O _a	Analog output (current mode): Open source DAC complementary output source. Connect through 50Ω to GNDA.
46	GNDA	P	Analog ground
47	IFOUT	O _a	Analog output (current mode): Open source DAC output source. Connect through 50Ω to GNDA.
48	GNDA	P	Analog ground

See Appendix A on page 41 for *type* description.

⁵ Output flags can be set using the XXXX command, see page YY. In *Italics*, the default value.

⁶ Output TS can be inverted using the *TsOutReverse* command, see page 25.

3. Serial port usage

The Rs232 serial port allows the configuration and the operation of the FLEXMod boards.

This serial port normally operates at 9600 bps, 8 data bits, 1 stop bit, no parity but the operating baud rate can be changed using the *Baud* command. Regardless of the setting done with the *Baud* command, the FLEXMod will always boot using a baud rate of 9600 bps.

This serial port normally echoes back to the terminal the characters received. When this is not desirable (because you are using a microcontroller, for example) echoing can be disabled using the *ECHO* command (see *Echo* on page 13).

Most of the command used to set values with one or more parameters, returns the current configured value if issued without any parameter.

A list of available commands can be obtained using the *HELP* command.

3.1. HELP

Used for: FLEXMod Help.

Parameters: None

Example: Help ↵

Notes: Pressing SPACE will pause the help output.

4. FLEXMod system configuration

The configuration setup of the operating parameters is stored in an onboard EEPROM. Commands change the current operating parameters in ram: to make any configuration change permanent, the *SAVE* command (see below) should be issued.

4.1. Save

Used for: Saves operating parameters into EEPROM.
Parameters: None
Example: Save ↵
Notes: -.

4.2. Clear

Used for: Clears EEPROM values to factory defaults.
Parameters: None
Example: Clear ↵
Notes: The current parameters are NOT changed. The factory defaults will be loaded the next system boot. Use the *Reboot* command to restart FLEXMod through the serial port.

4.3. Reboot

Used for: Restart the FLEXMod.
Parameters: None
Example: Reboot ↵
Notes: -.

4.4. Baud

Used for: Changes the serial port baud rate.
Parameters: BaudRate
Example: Baud 9600 ↵
Baud 115200 ↵
Notes: Boot baud rate will always be 9600 bps. Nearly all baud rates can be selected up to 3Mbps.

4.5. Echo

Used for: Activates/Deactivate character echoing.
Parameters: 0 or 1
Example: Echo 0 ↵
Echo 1 ↵
Notes: Echoing could be disabled to ease the use of a microcontroller. When operating the FLEXMod using a terminal program, having the FLEXMod echoing the characters back simplifies its use.

4.6. FwVersion

Used for: Query FLEXMod product name and firmware version.
 Parameters: None
 Example: FwVersion ↵
 Notes: Return value is (FLEXMod-1xx COFDM modulator):
FLEXMod-100
Version:x.xx
 Or (FLEXMod-2xx QPSK modulator):
FLEXMod-2xx
Version:x.xx

4.7. SwVer

Used for: Query FLEXMod firmware version.
 Parameters: None
 Example: SwVer ↵
 Notes: Return value is *COFDM Version: x.xx*.

4.8. GetSN

Used for: Query FLEXMod serial number.
 Parameters: None
 Example: GetSN ↵
 Notes: Return value is:
SN: xx.xx.xx.xx.xx.xx.xx

4.9. Welcome

Used for: Activates/Deactivate welcome message.
 Parameters: 0 to 2
 Example: Welcome 0 ↵ (*Welcome message disabled*)
 Welcome 1 ↵ (*Standard welcome message*)
 Welcome 2 ↵ (*Custom welcome message*)
 Notes: There is a special welcome message sent by the FLEXMod when receiving the first ENTER (CR, 0x0D) character after a boot. This is helpful when using the FLEXMod connected to a USB serial port since the original power-up message will be lost because the USB is not yet connected. It is advisable to disable this welcome message when operating the FLEXMod using a microcontroller.
 Custom welcome message can be programmed using the *ProgManuf* command.

4.10. ProgManuf

Used for: Program manufacturer/custom welcome message text.
 Parameters: Password
 Example: ProgManuf xxxxxx ↵

Notes:

This command allows programming of a custom welcome/manufacturer message. The FLEXMod will ask for the message. Use CTRL-Z (0x1A) to end the message.

This message can be programmed only once. To erase a welcome/manufacturer message a firmware upgrade (see

FLEXMod module upgrade on page 32) has to be done.
 Contact Tecnoroll BMB srl to obtain the *ProgManuf* password.

4.11. Manuf

Used for: Display currently programmed welcome/manufacturer message.
 Parameters: None
 Example: Manuf ←
 Notes: If no custom welcome/manufacturer message has been programmed, a Tecnoroll srl copyright message will be displayed.

4.12. TempAlarm

Used for: Set point for output alarm signal.
 Parameters: 0 to 124
 Example: TempAlarm 75 ←
 Notes: Temperature is set in Celsius degrees. Output pin OverTEMP, if enabled, will go high when FlexMOD temperature is above this set value.

4.13. ModFlags

Used for: Enables/disables status output signals.
 Parameters: 0 or 1
 Example: ModFlags 0 ←
 Notes: These status pins are output on pins 27 to 31. See *Connectors and pin description* on page 9. Either these or the output TS interface can be active at once, but not both. Before activating these status pins, the output TS interface must be deactivated. See *TsOutEnable* on page 25.

4.14. FlagsMatrix

Used for: Configure the output of the Modulator flags pins.
 Parameters: A,B,C,D,E,F,G,H
 Example: FlagsMatrix 0,1,2,3,4,5,6,7 ← *(Default values)*
 FlagsMatrix 7,6,5,4,3,2,1,0 ← *(Reversed output: DCD is on flag 7 and so on)*
 FlagsMatrix 0,1,2,7,7,5,6,15 ← *(Flag 7 set in case of error: Overflow, Overtemp or Selftest failed)*

Notes: Each letter represent a function (see table below) and is a number 0 to 15, which indicates the Flag output pin to route the function output to (0 to 7, add 8 for inverted output).
 Different flags can be output to the same pin, if needed.
 The output flags must be activated using the *ModFlags* command (See above)

A	Carrier detect
B	ASI 204 bytes
C	ASI burst
D	Overflow

E	OverTemp
F	Reserved
G	Reserved
H	Modulator SELFTest OK

4.15. BootDelay

Used for: Enables/disables a boot delay.

Parameters: 0 to 255

Example: BootDelay 2 ←¹ *(A 2 seconds delay is done)*
BootDelay 130 ←¹ *(A 2 seconds delay after having locked to the incoming TS is done)*

Notes: If the transport stream arrives at the FlexMOD input well after the FlexMOD power on or reset, the boot time table build will fail and an unfiltered TS will reach modulator input. To avoid this problem, a delay can be introduced by the FlexMOD so the boot time build will be done when the TS is available. This delay can be a simple delay from 0 to 127 seconds, or, by adding 128 to the desired delay, the delay is done after having locked to some incoming TS. In both cases, the delay will be interrupted if a CR (0x0d) is received on the serial port.

5. FLEXMod-1xx COFDM specific configuration

5.1. Carr

Used for: Set COFDM carriers.
 Parameters: 2 , 4 or 8
 Example: Carr 2 ←
 Carr 8 ←
 Notes: 2 selects 2K, 4 selects 4K, 8 selects 8K.

5.2. ChBW

Used for: Set COFDM channel bandwidth.
 Parameters: 6 or 7 or 8
 Example: ChBW 8 ←
 ChBW 7 ←
 Notes: Available bandwidths are 6 MHz, 7 MHz and 8 MHz.

5.3. Guard

Used for: Set COFDM guard interval.
 Parameters: 4 or 8 or 16 or 32
 Example: Guard 8 ←
 Guard 32 ←
 Notes: 4 selects 1/4 guard interval, 8 selects 1/8, 16 selects 1/16 and 32 selects 1/32.

5.4. Const

Used for: Set COFDM constellation.
 Parameters: 4 or 16 or 64
 Example: Const 4 ←
 Notes: 4 selects QPSK, 16 selects 16-QAM, 64 selects 64-QAM.

5.5. DVBParm

Used for: Set DVB-H specific parameters.
 Parameters: Hmode, HpServMode, LpServMode, Alpha, CellID, SwapTS
 Example: DVBParm 1,0,0,4,4567,0 ←
 Notes: Hmode if set to 1 enables DVB-H mode, HpServMode and LpServMode are the service mode for the High and Low priority streams (0 to 3), Alpha is the hierarchy information (0 = non hierarchical, 1, 2 or 4 are the α value) and SwapTS swaps high priority transport stream with low priority transport stream.

5.6. FEC

Used for: Set COFDM forward error correction.
 Parameters: 12 or 23 or 34 or 56 or 78
 Example: FEC 23 ←
 Notes: 12 select 1/2, 23 selects 2/3, 34 selects 3/4, 56 selects 5/6, 78 selects 7/8.

5.7. Freq

Used for: Set COFDM output frequency.
 Parameters: 0 to 1024000000.
 Example: Freq 36000000 ←
 Notes: Not all frequencies work. Since the DAC is working at approx 1GHz, frequencies greater than 500 MHz are obtained using the image frequency and modulator performance is not guaranteed.

5.8. SetChannel

Used for: Set COFDM output frequency and bandwidth.
 Parameters: C or S,Channel.
 Example: SetChannel C,21← *(Set frequency to 474MHz and bandwidth to 8 MHz)*
 SetChannel S,13← *(Set frequency to 247.5Mhz and bandwidth to 7MHz)*
 Notes: This command set both the frequency and the channel bandwidth accordingly to the chosen frequency. C Channels are in range 1 to 69, S channels in range 1 to 41. Since the DAC is working at approx 1GHz, frequencies greater than 500 MHz are obtained using the image frequency and modulator performance is not guaranteed.

5.9. Spect

Used for: Set COFDM output spectrum.
 Parameters: 0 or 1
 Example: Spect 0 ←
 Notes: Select 1 to invert the output spectrum.

5.10. Filter

Used for: Activates/Deactivate enhanced output filtering.
 Parameters: 0 or 1
 Example: Filter 1 ←
 Notes: Activating output filtering enhance the output spectrum reducing noise generated into the adjacent channels at the expense of greater power consumption.

5.11. Power

Used for: Set COFDM output power.
 Parameters: 0 to 255
 Example: Power 128 ←
 Notes: Programs the AD 9957 output power. Default value is 128.

5.12. Pcr

Used for: Activates/Deactivate modulator PCR restamper.
 Parameters: 0 or 1
 Example: Pcr 1 ←
 Notes: -.

5.13. Sfn

Used for: Activates/Deactivate modulator SFN compatibility mode.

Parameters: 0 or 1

Example: Sfn 1 ↵

Notes: In SFN compatibility mode, the PCR restamper is forced deactivated and null packets inserted by the modulator are specially signed to be removed by the receiver end. Doing this, the data stream passes the COFDM modulator/demodulator unchanged.

6. FLEXMod-2xx QPSK specific configuration

6.1. SymbolRate

Used for: Set QPSK Symbol Rate.

Parameters: SymbolRate *or*
 0, PLLMultiplier, Interpolator, VCOSelector

Example: SymbolRate 27500 ← *(Set a 27500 kSample/s symbol rate)*
 SymbolRate 0,8,64,5 ← *(Sets all the parameters explicitly)*

Notes: The symbol rate is in kSample/s
 In the simple form in which only the SymbolRate is given, the FLEXMod-2xx automatically calculates all the parameters needed to obtain the requested symbol rate.
 If desired, all the parameters can be explicitly set using complete version of this command.

6.2. Spect

Used for: Set QPSK output spectrum.

Parameters: 0 or 1

Example: Spect 0 ←

Notes: Select 1 to invert the output spectrum.

6.3. FEC

Used for: Set QPSK forward error correction.

Parameters: 12 or 23 or 34 or 56 or 78

Example: FEC 23 ←

Notes: 12 select 1/2, 23 selects 2/3, 34 selects 3/4, 56 selects 5/6, 78 selects 7/8.

6.4. Filter

Used for: Activates/Deactivate enhanced output filtering.

Parameters: 0 or 1

Example: Filter 1 ←

Notes: Activating output filtering enhance the output spectrum reducing noise generated into the adjacent channels at the expense of greater power consumption.

6.5. Power

Used for: Set COFDM output power.

Parameters: 0 to 255

Example: Power 128 ←

Notes: Programs the AD 9957 output power. Default value is 128.

6.6. Freq

Used for: Set QPSK output frequency.

Parameters: 0 to 1024000000.

Example: Freq 70000000 ←
Notes: Since the DAC is working between 700Mhz and 1GHz depending on the requested Symbol Rate, some frequencies are difficult be obtained and others are obtained using the image frequency.

6.7. Pcr

Used for: Activates/Deactivate modulator PCR restamper.
Parameters: 0 or 1
Example: Pcr 1 ←
Notes: -.

6.8. Sfn

Used for: Activates/Deactivate modulator SFN compatibility mode.
Parameters: 0 or 1
Example: Sfn 1 ←
Notes: In SFN compatibility mode, the PCR restamper is forced deactivated and null packets inserted by the modulator are specially signed to be removed by the receiver end. Doing this, the data stream passes the QPSK modulator/demodulator unchanged.

7. Input Transport Stream configuration

7.1. TsInSelect

Used for: Select Parallel or ASI TS input.
 Parameters: 0 to 2
 Example: TsInSelect 0 ↵ *(Select Parallel TS input)*
 TsInSelect 1 ↵ *(Select ASI TS input)*
 TsInSelect 2 ↵ *(Select inverted ASI TS input)*
 Notes: Inverted ASI inverts LVDS+ and LVDS- signals.

7.2. TsInValid

Used for: Set polarity of VALID signal for input parallel TS.
 Parameters: 0 or 1
 Example: TsInValid 1 ↵
 Notes: 0 means data valid when VALID is LOW, 1 means data valid when VALID is HIGH.

7.3. TsInClock

Used for: Set polarity of CLOCK signal for input parallel TS.
 Parameters: 0 or 1
 Example: TsInClock 1 ↵
 Notes: 0 means data are sampled on falling edge, 1 means data are sampled on rising edge.

7.4. TsInReverse

Used for: Select parallel input TS data bus.
 Parameters: 0 or 1
 Example: TsInReverse 1 ↵
 Notes: Default value is 0 which means standard D0 to D7 configuration. *TsInReverse 1* select inverted TS D7 to D0. See pins 10 to 17 on *Connectors and pin description* on page 9.

7.5. TsInRefClock

Used for: Activate reference output clock.
 Parameters: 0 or 1
 Example: TsInRefClock 1 ↵
 Notes: When active, a 27 MHz reference clock is output on pin 5. This can be used to drive, for example, a CY7B933 ASI deserializer without having to use an external oscillator.

7.6. TsInStatus

Used for: Show input transport stream status.
 Parameters: None or 1 or 2
 Example: TsInStatus ↵

Notes: TsInStatus 1↵
When no parameter is given, a simple output of current input status is given.
TsInStatus 1 activate a continuous monitoring of input status that can be terminated by sending an ENTER (CR, 0x0D). *TsInStatus 2* is similar to *TsInStatus 1* except that ANSI characters are used to improve readability.

8. Output Transport Stream configuration

The FLEXMod has an optional output transport stream which outputs the exact TS sent to the COFDM modulator.

8.1. TsOutEnable

Used for: Activate/Deactivate parallel TS output.
 Parameters: 0 or 1
 Example: TsOutEnable 0 ← (No output)
 TsOutEnable 1 ← (Parallel TS output)
 Notes: This transport stream is output on pins 27 to 39. See *Connectors and pin description* on page 9. These pins are shared with the modulator status pins. Either the output transport stream or the modulator status pins can be active at once. To enable this output, modulator status pins must be deactivated. See *ModFlags* on page 16.

8.2. TsOutValid

Used for: Set polarity of VALID signal for output TS.
 Parameters: 0 or 1
 Example: TsOutValid 1 ←
 Notes: 0 means data valid when VALID is LOW, 1 means data valid when VALID is HIGH.

8.3. TsOutClock

Used for: Set polarity of CLOCK signal for output TS.
 Parameters: 0 or 1
 Example: TsOutClock 1 ←
 Notes: 0 means data are to be sampled on falling edge, 1 means data are to be sampled on rising edge.

8.4. TsOutClockRate

Used for: Set output TS clock frequency.
 Parameters: 0, 1
 Example: TsOutClockRate 1 ←
 Notes: Output clock can be 13.5 MHz (*TsClockRate 0*) or 27 MHz (*TsClockRate 1*).

8.5. TsOutPSync

Used for: Set polarity of PSYNC signal for output TS.
 Parameters: 0 or 1
 Example: TsOutPSync 1 ←
 Notes: 0 means PSYNC LOW, 1 means PSYNC HIGH.

8.6. TsOutReverse

Used for: Select output TS data bus.

Parameters: 0 or 1
 Example: TsOutReverse 1 ←
 Notes: Default value is 0 which means standard D0 to D7 configuration. *TsOutReverse 1* select inverted TS D7 to D0. See pins 27 to 34 on *Connectors and pin description* on page 9.

8.7. TsOutASI

Used for: Activate/Deactivate ASI TS output.
 Parameters: 0 to 2
 Example: TsOutASI 0 ← (No output)
 TsOutASI 1 ← (ASI TS output)
 TsOutASI 2 ← (Inverted ASI TS output)
 Notes: This transport stream is output on pins 37 and 38 (ASI output) See *Connectors and pin description* on page 9. Inverted ASI inverts LVDS+ and LVDS- signals.

8.8. TsOutBypass

Used for: Activate/Deactivate TS output bypass.
 Parameters: 0 to 1
 Example: TsOutBypass 0 ← (Outputs modulator input)
 TsOutBypass 1 ← (Outputs ASI input)
 Notes: When TS bypass is active, both TS (parallel and ASI) outputs the data received from the parallel/ASI input, instead of outputting the modulator input.

9. DVB table filtering and remultiplexing

The FLEXMod can remultiplex input TS in order to remove some channels and/or change the NIT. The service list is downloaded, analyzed, modified as required, rebuilt and multiplexed back in the output transport stream.

The following commands allow the configuration and monitoring of these tables.

9.1. Netscan

Used for: Retrieve the service list from the input or output TS.
 Parameters: None or 0 to 3
 Example: Netscan ↵ *(Scans input TS and returns the service list)*
 Netscan 1↵ *(Scans input TS and returns the number of services found)*
 Netscan 2↵ *(Scans output TS and returns the service list)*
 Netscan 3↵ *(Scans output TS and returns the number of services found)*

Notes: *Netscan* without parameters (or *Netscan 0*) returns the list of available services found in the input transport stream. *Netscan 1* returns only the number of services found. The services can be later retrieved one by one using the *GetServ* command. *Netscan 1* and *GetServ* can be conveniently used when operating the FLEXMod using a microcontroller. *Netscan 2* and *Netscan 3* are similar to *Netscan 0* and *Netscan 1* but work on the output transport stream (after the remultiplexer). These commands can be used to verify that the remultiplexer is configured and working as expected.

9.2. GetServ

Used for: Returns information for a given service.
 Parameters: ServiceIndex
 Example: GetServ 1 ↵
 Notes: The service list must be previously retrieved using *NetScan 1*. Then for every service a *GetServ #* command can be issued to get service information. The returned list is in the form 'ServiceID ServiceName' where ServiceID is a 5 character decimal number.

9.3. ClearServ

Used for: Clears remultiplexed service list.
 Parameters: None
 Example: ClearServ ↵
 Notes: -.

9.4. AddServ

Used for: Add/Remove one service to the remultiplexed service list.
 Parameters: [Index,] ServiceID [, LCN]
 Example: AddServ 9876 *(Add service 9876 to the first free position)*
 AddServ 1234, 12 ↵ *(Add service 1234 to the first free position with LCN set to 12)*

AddServ 1, 5678, 23 ← (Add service 5678 at index position 1
with LCN set to 23)

AddServ 1, 5678, 1000 ← (Add service 5678 at index position 1
with no LCN)

AddServ 2,0,0 (Remove service at index position 2)

Notes:

The remultiplexed service list can contain a maximum of 32 services (so *Index* can be 0 to 31). The service number is given in the *Netscan* or *GetServ* command. Using a *ServiceNumber* of 0, the service is actually removed from the remultiplexed list.

If one parameter only is given, the service is added to the first free position with no LCN.

If two parameters are given, the service is added to the first free position with the given LCN.

If all the three parameters are given the service is added to the specified position with the given LCN. Use 1000 as LCN if you do not want the LCN.

9.5. ServList

Used for:

Return the current remultiplexed service list.

Parameters:

None or Index

Example:

ServList ← (Returns the whole service list)

ServList 1 ← (Returns service stored at index position 1)

Notes:

The *ServList Index* form of this command can be conveniently used when operating the FLEXMod using a microcontroller.

9.6. SidRemap

Used for:

Activate and configure Service ID Remapping.

Parameters:

BaseSID

Example:

SidRemap 0 ← (Disables SID remapping)

SidRemap 100 ← (Enables SID remapping starting from SID 100)

Notes:

The FLEXMod can optionally remap Service IDs in such a way that services IDs are renumbered starting from the number given to the *SidRemap* command. So, for example, if *SidRemap 100* is given, service add to index position 0 (*AddServ 0,xxxx*) will have 100 as its Service ID, service add to index position 1 (*AddServ 1,yyyy*) will have 101 as its Service ID, and so on.

A maximum of 8 services can be remapped.

9.7. NitParm (COFDM)

Used for:

Sets the NIT parameters for the remultiplexed service list.

Parameters:

NetworkName, NetworkID, OutputFrequency

Example:

NitParm MyNetwork,1234,600000000 ← (Sets the NetworkName to
"MyNetwork", the NetworkID to 1234 and the frequency field
of the terrestrial delivery system to 600 MHz)

Notes:

For the NIT Terrestrial delivery system descriptor only the frequency field is required since all the other fields are automatically compiled from the current COFDM configuration.

9.8. NitParm (QPSK)

Used for: Sets the NIT parameters for the remultiplexed service list.
Parameters: NetworkName, NetworkID, OutputFrequency,OrbitalPos,E/W,Polarization
Example: NitParm MyNetwork,1234,10600000,130,E,H ← (Sets the NetworkName to
“MyNetwork”, the NetworkID to 1234, the frequency field
of the satellite delivery system to 10600 MHz,
Orbital position at 13.0 degree East, Horizontal polarization)
Notes: The frequency is in kHz, and the orbital position is in tenth of a degree (so
192 is 19.2 degrees).
All the other modulation fields are automatically compiled from the current
QPSK configuration.

9.9. SetPID

Used for: Enables/Disables a single PID in the transport stream.
Parameters: PID, 0 or 1
Example: SetPID 100, 0 ← (Disables PID 100 so it is no longer output)
SetPID 200, 1 ← (Enables PID 200 so it is multiplexed in the output TS)
Notes: Changes to the filtered list done using the SetPID command are **NOT** saved
into EEPROM.

9.10. AllPIDs

Used for: Enables/Disables all PIDs in the transport stream.
Parameters: 0 or 1
Example: AllPIDs 0 ← (Disables all PIDs)
AllPIDs 1 ← (Enables all PIDs)
Notes: Changes to the filtered list done using the AllPIDs command are **NOT** saved
into EEPROM.

9.11. Remux

Used for: Activates/Deactivates transport stream remultiplexing.
Parameters: 0 or 1
Example: Remux 0 ← (Disables remultiplexing)
Remux 1 ← (Compiles the new service list and activate remultiplexing)
Notes: When the remultiplexing has been disabled, the input transport stream is
directly routed to the COFDM modulator.

9.12. RunServ

Used for: Compiles the new service list.
Parameters: None
Example: RunServ ←
Notes: The list will be compiled, but will not be used unless Remux is active (See
Remux on page 29).

If SID remapping (see *SidRemap* on page 28) is active, the number of remapped services and the free space in the internal renumber buffer will be returned.

9.13. CheckTime

Used for: Configures the automatic tables update.
 Parameters: Seconds
 Example: `CheckTime 60 ↵` (*Check for table updates every 60 seconds*)
 Notes: The FLEXMod can check the input transport stream DVB tables for changes and compile the new service list if needed. These tables are typically checked for changes every 120/180 seconds (2 or 3 minutes). Maximum interval is 255 seconds.
CheckTime 0 disables the automatic tables update.
 Note that while doing the periodic table check, the system will reply more slowly than normal. If this cannot be accepted, disable automatic tables update and periodically force an update using the *CheckTables* command.

9.14. CheckTables

Used for: Force a scan of the incoming DVB tables.
 Parameters: -
 Example: `CheckTables ↵`
 Notes: The FLEXMod can check the input transport stream DVB tables for changes and compile the new service list if needed. With this command you can force this check. The return value will be either *Changed* or *Unchanged*.
 This command can be used in place of the automatic update (see *CheckTime* command) when desired.

9.15. LowPriServ

Used for: Set Low Priority Services.
 Parameters: ServiceID1, ServiceID2
 Example: `LowPriServ 3401, 3402 ↵` (*Sets services 3401 and 3402 as low priority*)
`LowPriServ 3401, 0 ↵` (*Sets service 3401 as low priority*)
 Notes: This command sets up to 2 low priority services.
 Internal FLEXMod multiplexer will drop data from low priority services in case of modulator overflow, trying to keep non low priority services running smoothly.
 TS packets for the Video and first Audio PIDs of the two selected services will be dropped first in case of modulator overflow.
 Use 0 as ServiceID if no Low Priority service has to be selected.

10. System monitoring commands

10.1. ModInfo

Used for: Get COFDM/QPSK modulator operating conditions.
 Parameters: None
 Example: ModInfo ↵
 Notes: -.

10.2. TsInfo

Used for: Get Transport stream operating conditions.
 Parameters: None
 Example: TsInfo ↵
 Notes: -.

10.3. TsMon

Used for: Show transport streams bitrates.
 Parameters: None or 1 or 2
 Example: TsMon ↵ *(Simple output)*
 TsMon 1 ↵ *(Simple continuous monitoring)*
 TsMon 2 ↵ *(ANSI continuous monitoring)*
 Notes: When no parameter is given, a simple status of TS rate and Null packet rate of both incoming TS and modulator TS is reported. *TsMon 1* activate a continuous monitoring of these informations that can be terminated by sending an ENTER (CR, 0x0D). *TsMon 2* is similar to *TsMon 1* except that ANSI characters and colors are used to improve readability.

10.4. SingleTone

Used for: Activates/Deactivates single tone (continuous wave) output.
 Parameters: 0 to 16383
 Example: SingleTone 0 ↵ *(Deactivate CW output, normal COFDM output)*
 SingleTone 256 ↵ *(CW output, power set to 256)*
 Notes: Any number greater than 0 and less than 16383 activates single tone output with different output power. Use *SingleTone 0* to resume standard COFDM output.

10.5. GetTemp

Used for: Display currently FlexMOD temperature.
 Parameters: None
 Example: GetTemp ↵
 Notes: The temperature is shown in Celsius degree.

11. FLEXMod module upgrade

The FLEXMod firmware can be user upgraded if needed.

The upgrade procedure is performed with the following steps:

1. Change the baud rate to something faster than 9600 bps (115200, for example). This step is not necessary (the upgrade can also be done at 9600 bps) but since the firmware is quite long it is advisable to do this.
2. Issue the *FlashFormat 741852* command which erases the onboard serial flash containing the firmware.
3. Wait for the FLEXMod signaling the end of the flash erasing procedure (it takes normally 10 seconds)
4. Issue the *Upgrade 741852* command and upload the new firmware using the XMODEM protocol.
5. When the upload has been completed, wait for the acknowledge that the upgrade has been successfully completed.
6. Power off and then back on the FLEXMod.

Please note:

Should the procedure fail for any reason, perform the procedure again starting from step 2. **Do not** power off the board since the flash has been erased (or contains an invalid firmware) and hence the board will not work (and could also, in rare occasions, be damaged). Should this happen, the board has to be returned to factory for reprogramming

Note also that this procedure will erase the welcome/manufacture message.

11.1. FlashFormat

Used for: Erases the onboard serial flash.

Parameters: 741852

Example: FlashFormat ↵

Notes: The *741852* parameter is a constant value used to avoid the risk of issuing this command by chance.

Do not erase the flash if you are not ready to perform an upgrade procedure.

After the flash has been erased, the FLEXMod will not be able to boot.

This will also erase the welcome/manufacture message.

11.2. Upgrade

Used for: XMODEM upload of a new firmware.

Parameters: 741852

Example: Upload ↵

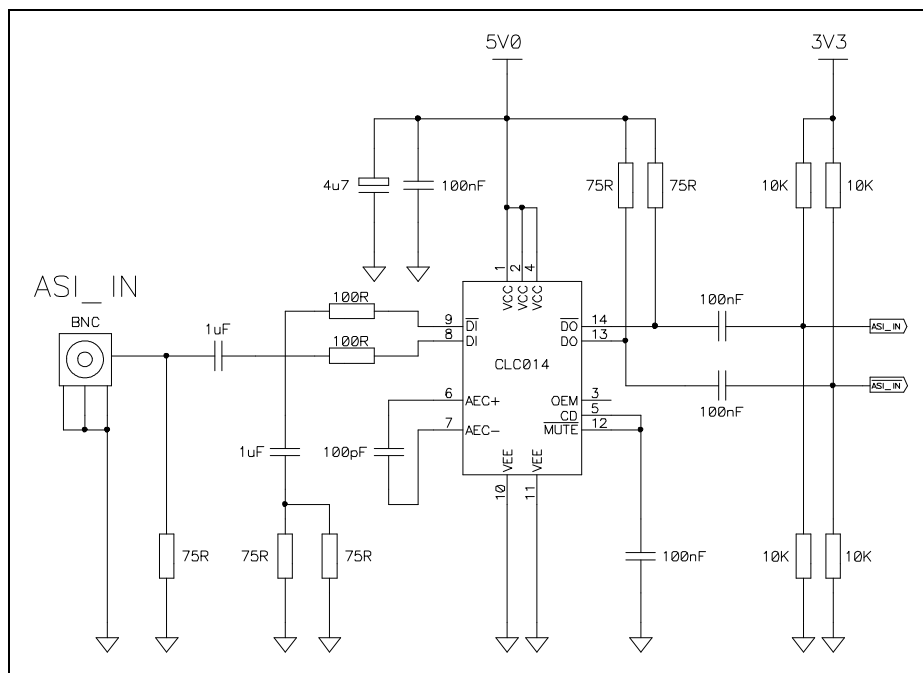
Notes: Any terminal software capable of the XMODEM protocol can be used.

The *741852* parameter is a constant value used to avoid the risk of issuing this command by chance.

12. LVDS ASI input/output

12.1. ASI Input sample schematic

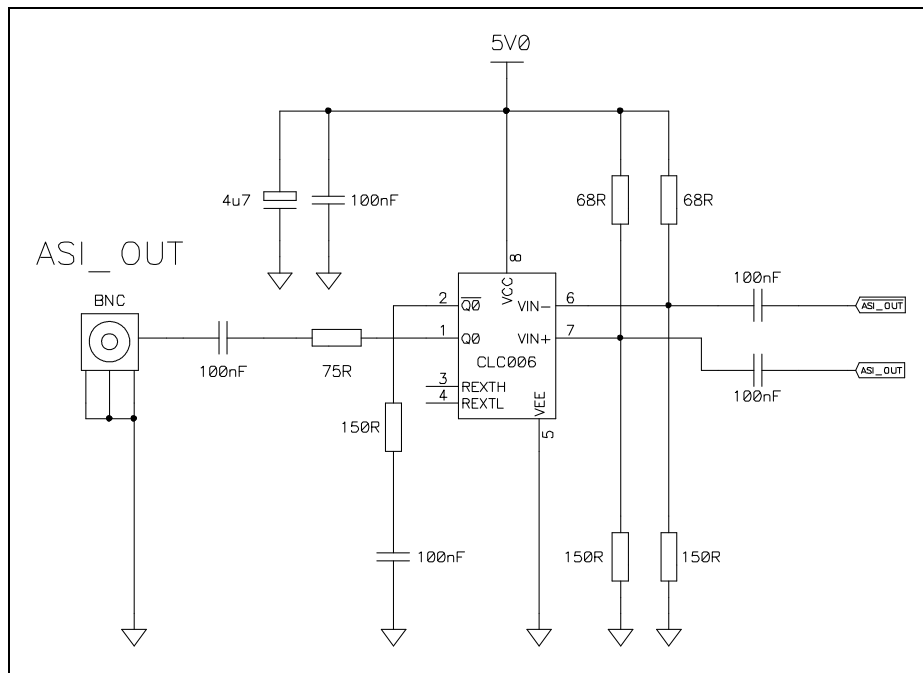
The LDVS TS ASI Input requires a cable equalizer and an adaptation network in order to adjust input levels. Note that ASI_IN is a LVDS signal, so route accordingly. The following schematics is a typical application ASI input:



Typical ASI input

12.2. ASI Output sample schematic

The LDVS TS ASI Output requires an adaptation network in order to adjust input levels and an output driver. Note that ASI_OUT is a LVDS signal, so route accordingly. The following schematics is a typical application ASI output:



Typical ASI output

13. Power supplies characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
1V2	Core voltage			640		mA
1V8	DAC voltage			330		mA
1V8A	Analog voltage			110		mA
3V3	I/O voltage			140		mA
3V3A	Analog voltage			90		mA

14. Alphabetical command list

A		H	
AddServ	27	HELP	12
AllPIDs	29		
B		L	
Baud	13	LowPriServ	30
BootDelay	17		
C		M	
Carr	18	Manuf	16
ChBW	18	ModFlags	16
CheckTables	30	ModInfo	31
CheckTime	30		
Clear	13	N	
ClearServ	27	Netscan	27
Const	18	NitParm (COFDM)	28
		NitParm (QPSK)	29
D		P	
DVBHParms	18	Per	19; 22
		Power	19; 21
E		ProgManuf	14
Echo	13		
F		R	
FEC	18; 21	Reboot	13
Filter	19; 21	Remux	29
FlagsMatrix	16	RunServ	29
FlashFormat	32		
Freq	19; 21	S	
FwVersion	14	Save	13
		ServList	28
G		SetChannel	19
GetServ	27	SetPID	29
GetSN	14	Sfn	20; 22
GetTemp	31	SidRemap	28
Guard	18	SingleTone	31
		Spect	19; 21
		SwVer	14
		SymbolRate	21

T

TempAlarm 16
 TsInClock 23
 TsInfo 31
 TsInRefClock 23
 TsInReverse 23
 TsInSelect 23
 TsInStatus 23
 TsInValid 23
 TsMon 31
 TsOutASI 26
 TsOutBypass 26

TsOutClock 25
 TsOutClockRate 25
 TsOutEnable 25
 TsOutPSync 25
 TsOutReverse 25
 TsOutValid 25

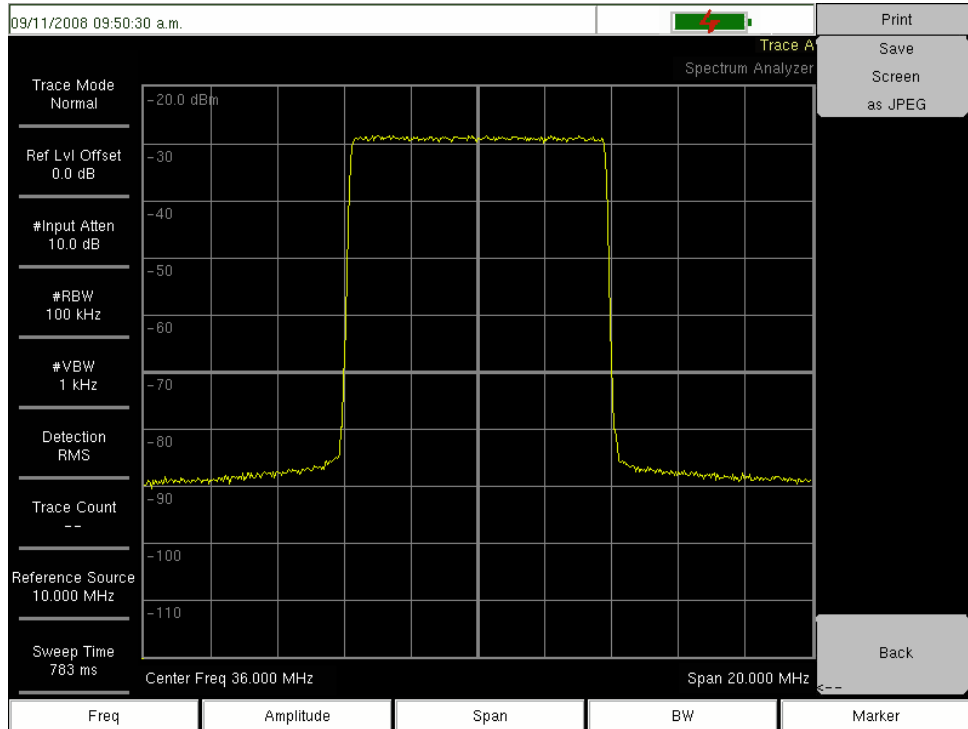
U

Upgrade 32

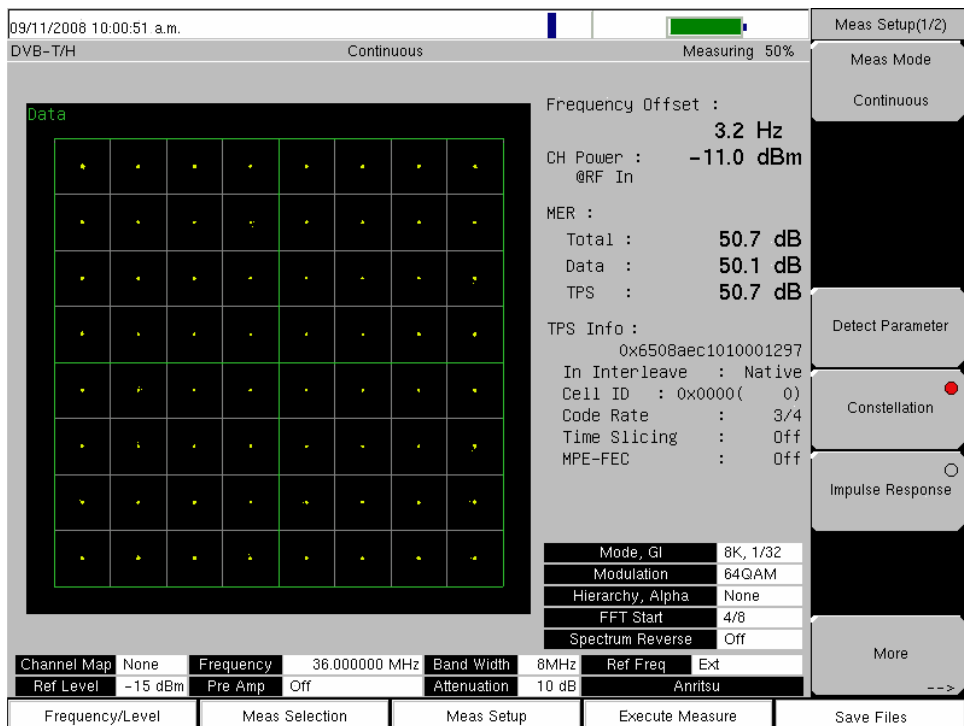
W

Welcome 14

15. FLEXMod-1xx typical output characteristics

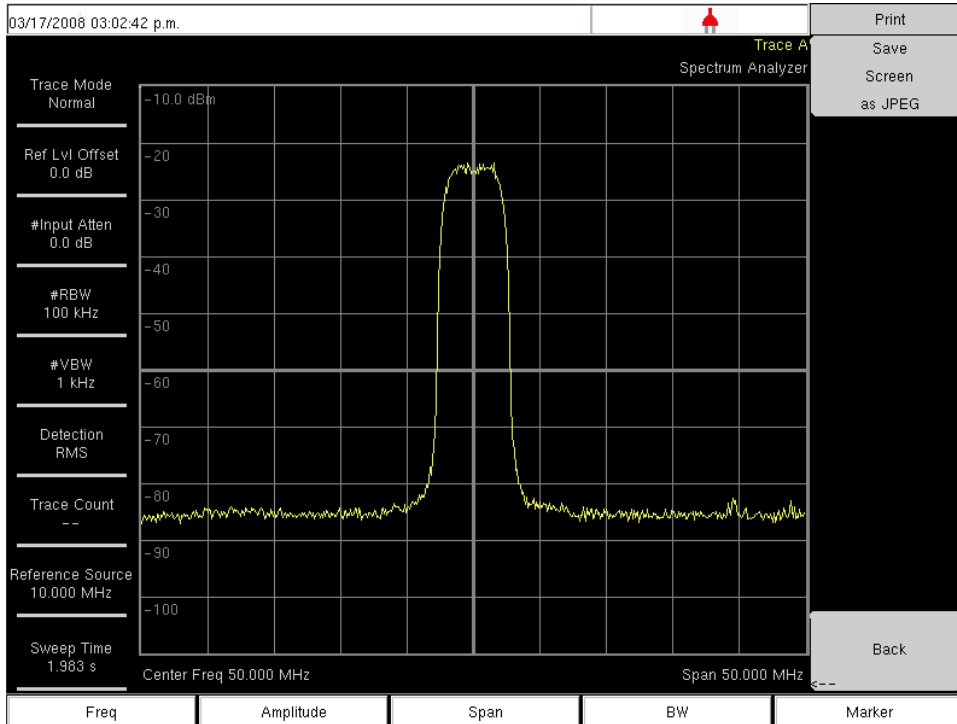


Typical output spectrum at 36MHz

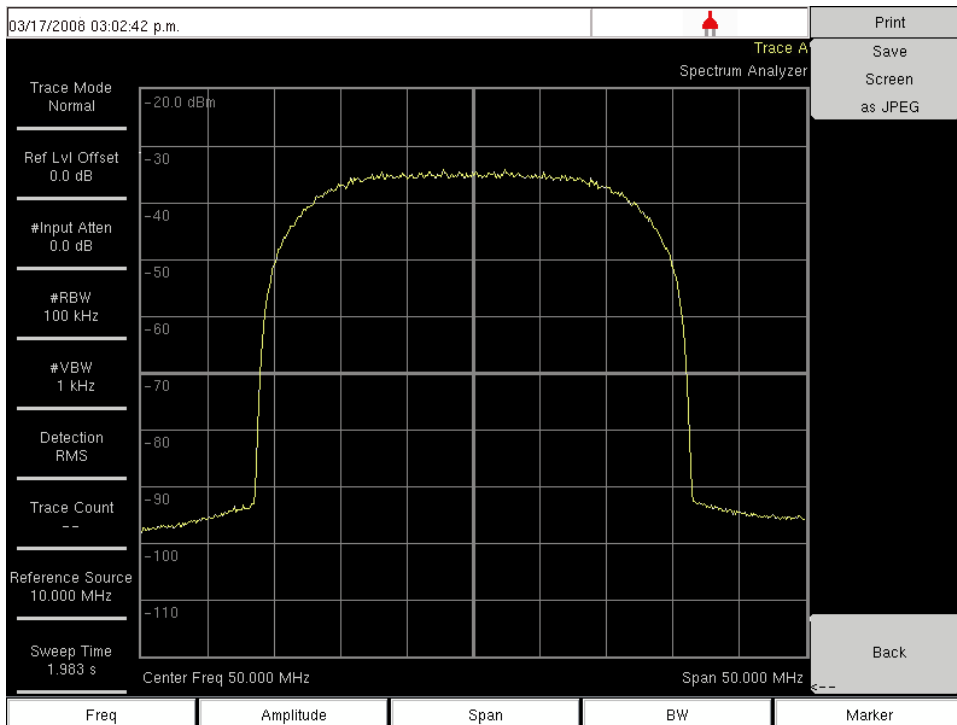


Typical constellation at 64QAM and output MER

16. FLEXMod-2xx typical output characteristics

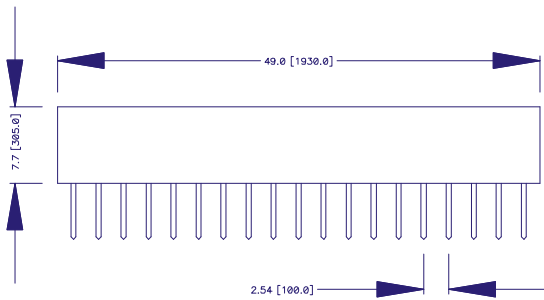
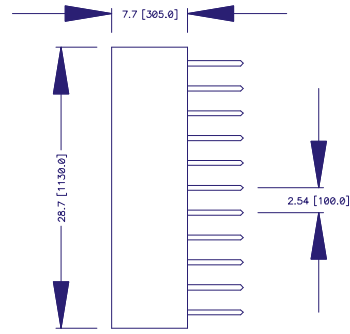
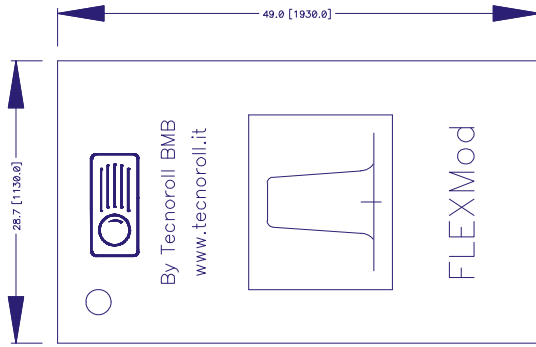


Typical output spectrum at 50MHz for a symbol rate of 4000 kSample/s

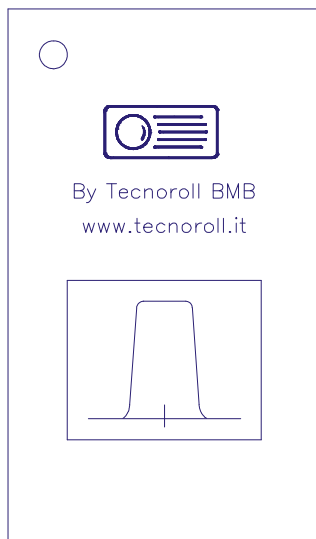


Typical output spectrum at 50MHz for a symbol rate of 24000 kSample/s

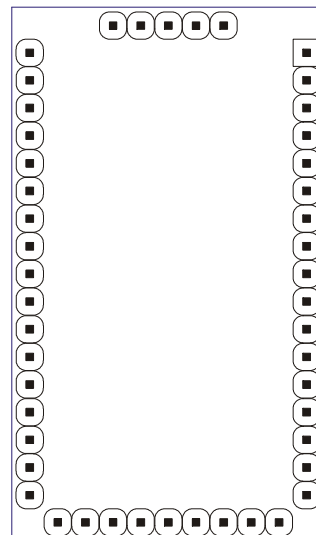
17. Packaging information



Units: mm [mils]
Controlling dimensions: mm



Top View

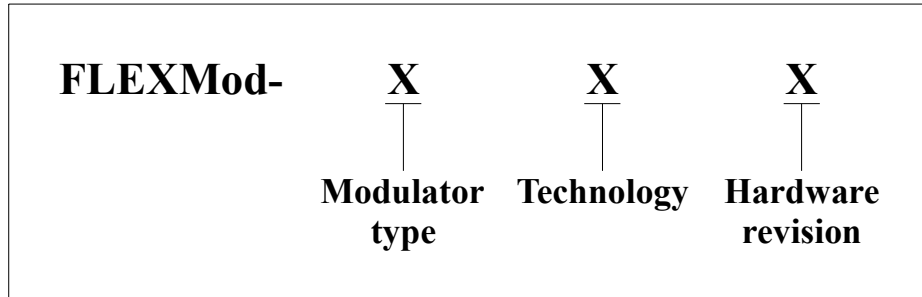


Bottom View

Appendix A ‘Type’ description for connector pins

Type	Description
I _a	Analog input
I ₅	5V compatible input
I ₃	3.3V compatible input
I _{3/5}	3.3V compatible input, 5V tolerant
I _{LVDS±}	Positive/Negative LVDS input
O _a	Analog output
O ₃	3.3V output
O ₅	5V output
OC ₃	3.3V output, Open Collector
O _{LVDS±}	Positive/Negative LVDS output
P	Power supply line
P _o	Power supply output line

Appendix B FLEXMod Product Identification System



Modulator type	
1	DVB-T MFN: <i>ETSI EN 300 744</i> compliant COFDM modulator.
2	DVB-S: <i>ETSI EN 300 421</i> compliant QPSK modulator.

Technology	
0	Consumer grade, Xilinx FPGA, reference clock: 1.024 GHz
1	Professional grade, Xilinx FPGA, reference clock: 1.024 GHz
8	Consumer grade, Xilinx FPGA, reference clock: 16 MHz

Examples:

- FLEXMod-101 Consumer grade DVB-T modulator, reference clock 1.024GHz, HW revision 1
 FLEXMod-281 Consumer grade DVB-S modulator, reference clock 16MHz, HW revision 1