

FLEXMod-AV_{xxx} modules

Connectors, pin description and programming protocol

Rev C, Aug, 31st 2011

Hardware revision 2.00

Firmware version 0.29 (DVB-T)

Firmware version 0.29 (DVB-S)

Firmware version 0.29 (DVB-C)

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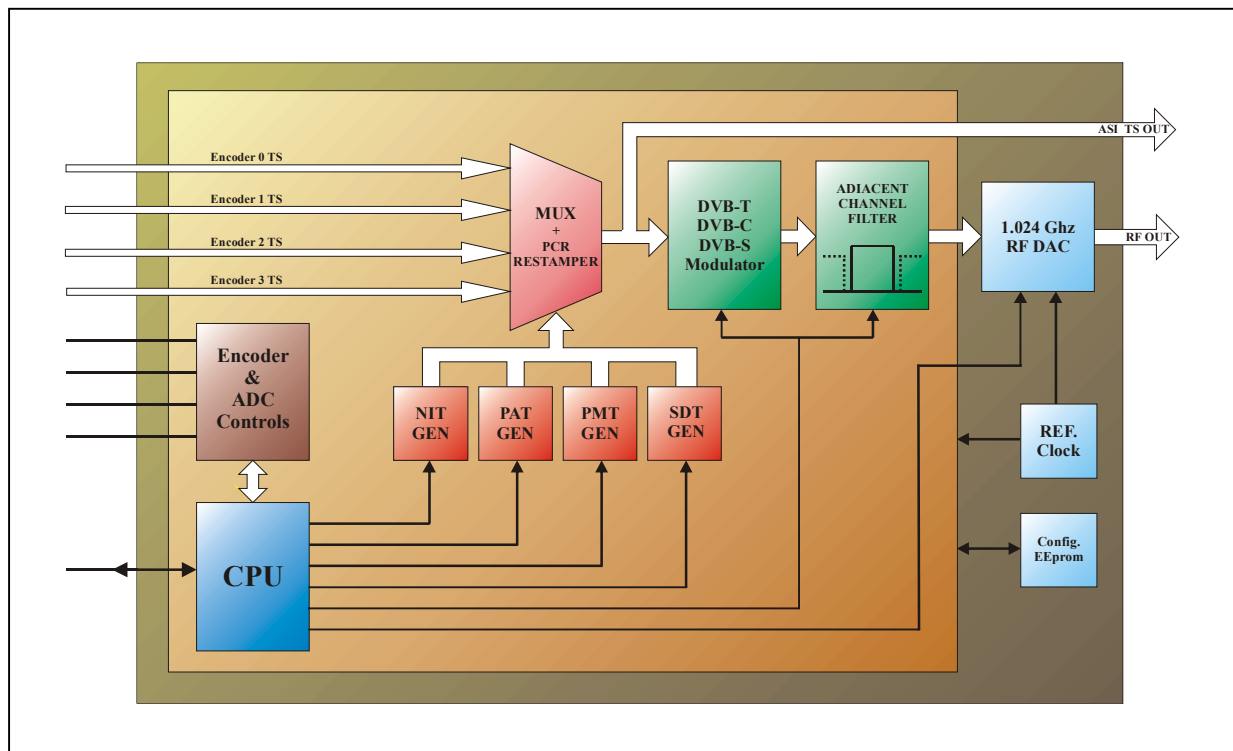
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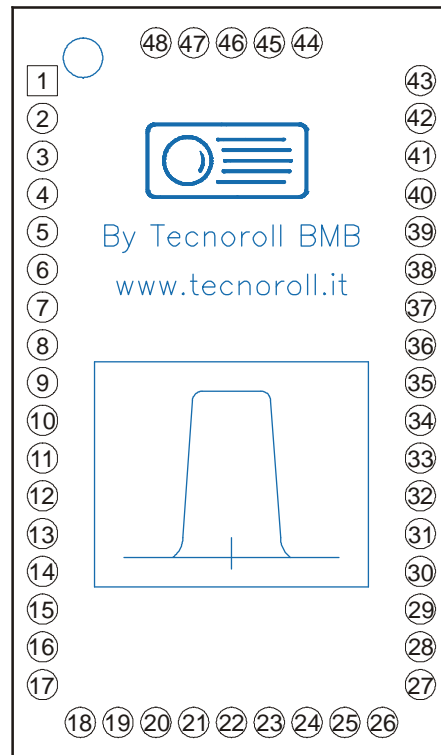
1. FLEXMod-AVxxx Block Diagram

The FLEXMod-AVxxx is an *ETSI EN 300-744* (FLEXMod-AV101) / *ETSI EN 300-421* (FLEXMod-AV201) / *ETSI EN 300-429* (FLEXMod-AV301) compliant DVB-T/DVB-S/DVB-C modulator with an integrated microprocessor, TS multiplexer, enhanced output filtering and a 1GHz output DAC.



2. Connectors and pin description

2.1. Pin Layout



FLEXMod-AVxxx, Top view

2.2. Pin List

Pin	Symbol	Type ⁽¹⁾	Description
1	GND _A	P	Analog ground
2	1V8 _A	P	+1.8V Analog Power Supply
3	1V8	P	+1.8V Digital Power Supply
4	GND	P	Digital Ground
5	MCLK_OUT	O ₃	Master 27 MHz Reference Clock Output
6	TS_8X_CLK	O ₃	Transport Stream Clock output
7	ENC_CS	O ₃	TR391AV module CS
8	ENC_SEL0	O ₃	TR391AV module select, bit 0
9	ENC_SEL1	O ₃	TR391AV module select, bit 1
10	ENC0_SER_TS	I ₃	TR391AV, module 0, Transport Stream input
11	ENC1_SER_TS	I ₃	TR391AV, module 1, Transport Stream input
12	ENC2_SER_TS	I ₃	TR391AV, module 2, Transport Stream input
13	ENC3_SER_TS	I ₃	TR391AV, module 3, Transport Stream input

Pin	Symbol	Type ⁽¹⁾	Description
14	ENC_RST	O ₃	TR391AV module reset signal
15	ENC_CLK	O ₃	TR391AV module configuration clock
16	ENC_DI	O ₃	TR391AV module configuration output
17	ENC_DO	I ₃	TR391AV module configuration input
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	GPIO3	I ₃ /O ₃	General purpose IO pin 3
	OVERTEMP	O ₃	Overtemperature output ⁽²⁾
24	3V3	P	+3.3V Digital Power Supply
25	1V2	P	+1.2V Digital Power Supply
26	GND	P	Digital Ground
27	ENC3_SDA	I ₃ /O ₃	TR391AV, module 3, I ² C SDA line
28	ENC3_SCL	I ₃ /O ₃	TR391AV, module 3, I ² C SCL line
29	ENC2_SDA	I ₃ /O ₃	TR391AV, module 2, I ² C SDA line
30	ENC2_SCL	I ₃ /O ₃	TR391AV, module 2, I ² C SCL line
31	ENC1_SDA	I ₃ /O ₃	TR391AV, module 1, I ² C SDA line
32	ENC1_SCL	I ₃ /O ₃	TR391AV, module 1, I ² C SCL line
33	ENC0_SDA	I ₃ /O ₃	TR391AV, module 0, I ² C SDA line
34	ENC0_SCL	I ₃ /O ₃	TR391AV, module 0, I ² C SCL line
35	GPIO2	I ₃ /O ₃	General purpose IO pin 2
	LEDSPI_CLK	O ₃	LedSPI Clock Line ⁽³⁾
	LEDMTX_COM	O ₃	LedMatrix Common ⁽⁴⁾
36	GPIO1	O ₃	General purpose IO pin 1
	LEDSPI_DATA	O ₃	LedSPI Data Line ⁽³⁾
	LEDMTX_D1	O ₃	LedMatrix Data1 ⁽⁴⁾
37	ASI_OUT	O _{LVDS-}	LDVS TS ASI Output. Requires an adaptation network and a Cable Driver. See <i>ASI Output</i> on page 28 for more information.
38		O _{LVDS+}	
39	GPIO0	O ₃	General purpose IO pin 0
	LEDSPI_LTCH	O ₃	LedSPI Latch Line ⁽³⁾
	LEDMTX_D0	O ₃	LedMatrix Data0 ⁽⁴⁾
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	IFOUT	O _a	Analog output (current mode): Open source DAC complementary output source. Connect through 50Ω to GNDA.
46	GNDA	P	Analog ground

Pin	Symbol	Type ⁽¹⁾	Description
47	IFOUT	O _a	Analog output (current mode): Open source DAC output source. Connect through 50Ω to GNDA.
48	GNDA	P	Analog ground

⁽¹⁾ See Appendix A on page 38 for *type* description.

⁽²⁾ See *LedOvertemp* on page 25 to activate Overtemp output

⁽³⁾ See *LedSPI* on page 26 to activate Led SPI output

⁽⁴⁾ See *LedMatrix* on page 26 to activate Led Matrix output

3. Serial port usage

The Rs232 serial port allows the configuration and the operation of the FLEXMod-AVxxx modules.

This serial port normally operates at 115200 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 entered with the *Baud* command, the FLEXMod- Exxx will always boot using a baud rate of 115200 bps.

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

Most of the commands requiring one or more parameters display the current configured value if issued without any parameters.

Operating mode can be changed at any time by sending one or more of the following characters.

Character	ASCII	Operating mode
CTRL-E	0x05	Echo ON. Enables echoing of characters back to the terminal and shows a command prompt. This setting simplifies the use of a terminal emulation software.
CTRL-O	0x0F	Echo OFF. Disables echoing of characters and command prompt. This operating mode simplifies the software in a microcontroller since it does not require the processing of unnecessary characters.
CTRL-D	0x04	Decimal answers. Every protocol command giving a numeric answer will return a decimal number by using the minimum number of characters needed. Leading zeroes are omitted.
CTRL-X	0x18	Hexadecimal answers. Every protocol command giving a numeric answer will return a hexadecimal number by using the fixed number of characters specified in the command description.

BOLD indicates default values.

Other special functions characters/keys are:

Key	Function
ESC (twice)	Aborts current command editing.
BackSpace	Deletes characters.
TAB	Complete/Help key. If the text entered is not a complete command word this key shows a list of all the commands that begin with the entered text; if the text entered is a complete command word, the system will display a brief explanation of this command.
CR (Enter)	Execute the command.

3.1. Command return values

Every command has a return value. This return value has always the following format: a number (decimal or 2 digit hexadecimal) followed by a human readable text description of the return value. The following table lists the error defined in firmware revision 0.25.

Error	
0	Ok
1	Syntax error
2	Invalid parameter
3	Wrong password
4	XMODEM transfer error
5	Flash programming error
6	Password required
7	Command disable
8	Mask not loaded
9	Value already used
10	Boot image deleted

If the command is supposed to return a value, it is returned AFTER the error code.

Some commands have an alternative syntax when entering parameters: these can be entered both in text and numeric mode. This option is indicated by a number between parenthesis after the text parameter value.

Numbers can be entered both in decimal (normal), octal (leading 0) or hexadecimal (leading 0x). Parameters between square brackets [...] are optional and can be omitted if not required.

3.2. Guidelines on how to use a microcontroller to configure and operate a FLEXMod- Exxx

1. During system boot a copyright message and the command prompt are output from the user serial port. The end of this boot prompt can be detected by waiting for a character of code 0x08 sent by the FLEXMod- Exxx firmware AT THE END of the system boot. After having received that byte the system is ready waiting commands.
2. Send character 0x0F to disable echo and command prompting and, if desired, character 0x18 to activate hexadecimal answers.
3. Send a command followed by CR (0x0d).
4. Wait for the command.
5. Process the error code (that can be a 2 character hexadecimal value if set this way) and discard all the remaining characters up to the ending LF (0x0a)
6. Process return command return values (if present) up to the ending LF (0x0a) again.

Repeat steps 3 to 6 for all the desired commands.

4. FLEXMod-AVxxx system configuration / miscellaneous commands

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, use the *SAVE* command (see below).

4.1. HELP

Used for: FLEXMod-AVxxx Help.
Parameters: None
Example: Help ↵
Notes: -.

4.2. Save

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

4.3. Clear

Used for: Clears EEPROM values to factory defaults and restarts the module.
Parameters: None
Example: Clear ↵
Notes: -.

4.4. Reboot

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

4.5. Baud

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

4.6. Echo

Used for: Activates/Deactivate character echoing.
Parameters: 0 or 1

Example: Echo 0 ↵
Echo 1 ↵

Notes: Echoing could be disabled to simplify the use of a microcontroller. When operating the FLEXMod-AVxxx using a terminal program, having the FLEXMod-AVxxx echoing the characters back simplifies its use. The CTRL-O character can also be used to disable the echo.

4.7. HexMode

Used for: Activates/Deactivate hexadecimal replies.

Parameters: 0 or 1

Example: HexMode 0 ↵
HexMode 1 ↵

Notes: Hexadecimal replies could be enabled to simplify the use of a microcontroller. When operating the FLEXMod-Exxx using a terminal program, having the FLEXMod-Exxx reply in hexadecimal may simplify its use. The CTRL-X character can also be used to enable hexadecimal replies.

4.8. GetFWVersion

Used for: Query FLEXMod-AVxxx product name and firmware version.

Parameters: None

Example: GetFWVersion ↵

Notes: Return value is:

391AV MPEG-2 Encoder - DVB-T XX, vx.xx	(FLEXMod-AV1xx)
391AV MPEG-2 Encoder - DVB-S XX, vx.xx	(FLEXMod-AV2xx)
391AV MPEG-2 Encoder - DVB-C XX, vx.xx	(FLEXMod-AV3xx)

4.9. Welcome

Used for: Activates/Deactivate welcome message.

Parameters: 0 to 1

Example: Welcome 0 ↵ *(Welcome message disabled)*
Welcome 1 ↵ *(Standard welcome message)*

Notes: There is a special welcome message sent by the FLEXMod-AVxxx when receiving the first ENTER (CR, 0x0D) character after a boot. This is helpful when using the FLEXMod-AVxxx connected to a USB serial port since the original power-up message will be lost because the USB is not connected yet. It is advisable to disable this welcome message when operating the FLEXMod-AVxxx using a microcontroller.

4.10. GetSN

Used for: Query FLEXMod-AVxxx serial number.

Parameters: None

Example: GetSN ←
 Notes: Return value is:
 xx.xx.xx.xx.xx.xx.xx

4.11. SystemInfo

Used for: Returns all functional system information.
 Parameters: None
 Example: SystemInfo ←
 Notes: Displays a multiple page information summary of the system divided into the following categories: General informations, Modulator informations, Installed encoders, DVB tables informations, Miscellaneous informations and one page of encoder information for every encoder present.

4.12. FIFOStatus

Used for: Queries Encoder input FIFO status.
 Parameters: None or 0 to 4
 Example: FIFOStatus ← (*Returns status for the 4 encoders and the modulator FIFOs*)
 FIFOStatus 0 ← (*Returns status for encoder 0 FIFO*)
 FIFOStatus 1 ← (*Returns status for encoder 1 FIFO*)
 FIFOStatus 4 ← (*Returns status for modulator FIFO*)
 Notes: Example return value for *FIFOStatus* is:
 0, Encoder 0 fifo ok
 0, Encoder 1 fifo ok
 0, Encoder 2 fifo ok
 0, Encoder 3 fifo ok
 0, Modulator fifo ok
 546, Modulator fifo peak usage 546 Byte
 19904, Modulator bitrate 19904 Kbit/s

4.13. EasyConfig

Used for: Enters the interactive system configurator.
 Parameters: None
 Example: EasyConfig ←
 Notes: Use arrow Keys, Space, Enter to change operating parameters as required. When done, press ESC. The interactive configurator will terminate and the new configuration will be activated.

4.14. ASIOutput

Used for: Enable or disable ASI output
 Parameters: 0 to 2
 Example: ASIOutput 0 ← (*Disables ASI output*)
 ASIOutput 1 ← (*Enables ASI output*)
 ASIOutput 2 ← (*Enables inverted ASI output*)
 Notes: By inverting ASI output you invert the LVDS+ and LVDS- signals.

5. FLEXMod-AV1xx modulator commands (DVB-T).

5.1. Frequency

Used for: Sets or gets COFDM output frequency.
 Parameters: 0 to 1024000000.
 Example: Frequency 36000000 ←
 Notes: Frequency is in Hz. 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.

5.2. RFChannel

Used for: Sets or gets COFDM output frequency and bandwidth.
 Parameters: C or S,Channel.
 Example: RFChannel C,21← (*Set frequency to 474MHz and bandwidth to 8 MHz*)
 RFChannel S,13← (*Set frequency to 247.5Mhz and bandwidth to 7MHz*)
 Notes: This command sets 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.

5.3. Const

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

5.4. Carriers

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

5.5. FEC

Used for: Sets or gets 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.

5.6. Guard

Used for: Sets or gets COFDM guard interval.
 Parameters: 4 or 8 or 16 or 32
 Example: Guard 8 ←

Notes: Guard 32 ←
4 selects 1/4 guard interval, 8 selects 1/8, 16 selects 1/16 and 32 selects 1/32.

5.7. ChannelBW

Used for: Sets COFDM channel bandwidth.

Parameters: 6 or 7 or 8

Example: ChannelBW 8 ←

ChannelBW 7 ←

Notes: Available bandwidths are 6 MHz, 7 MHz and 8 MHz.

5.8. Spectrum

Used for: Sets or gets COFDM output spectrum.

Parameters: 0 or 1

Example: Spectrum 0 ←

Notes: Select 1 to invert the output spectrum.

5.9. CellID

Used for: Sets or gets Cell ID value.

Parameters: 0 to 65535

Example: CellID 1234 ←

Notes: This value is inserted into the Network Information Table and in the Modulator CellID.

5.10. Power

Used for: Sets or gets COFDM output power.

Parameters: 0 to 255

Example: Power 128 ←

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

6. FLEXMod-AV2xx modulator commands (DVB-S).

6.1. Frequency

Used for: Sets or gets DVB-S output frequency.
 Parameters: 0 to 1024000000.
 Example: Frequency 36000000 ←
 Notes: Frequency is in Hz. 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.

6.2. SymbolRate

Used for: Sets or gets the modulator symbol rate
 Parameters: 1000 to 32000
 Example: SymbolRate 8000 ←
 Notes: Value is in kSymbols/s. Value not exactly obtainable are rounded to the nearest value. Use *SRList* to get a list of the possible Symbol rates.

6.3. FSample

Used for: Sets or gets the Master clock frequency
 Parameters: 0 or 1
 Example: FSample 0 ← *(Sets the master clock to 1024 MHz)*
 FSample 1 ← *(Sets the master clock to 512 MHz)*
 Notes: A 1024 MHz master clock is normally used. Use *SRList* to get a list of the possible Symbol rates.

6.4. SRList

Used for: Lists the list of possible symbol rates
 Parameters: None
 Example: SRList ←
 Notes: Two lists are returned. A list for a 1024 MHz master clock and a list for a 512 MHz master clock

6.5. Spectrum

Used for: Sets or gets DVB-S output spectrum.
 Parameters: 0 or 1
 Example: Spectrum 0 ←
 Notes: Select 1 to invert the output spectrum.

6.6. Power

Used for: Sets or gets DVB-S output power.
 Parameters: 0 to 255
 Example: Power 128 ←
 Notes: Programs the AD 9957 output power. Default value is 128.

6.7. FEC

Used for: Sets or gets DVB-S 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.

7. FLEXMod-AV3xx modulator commands (DVB-C).

7.1. Frequency

Used for: Sets or gets DVB-C output frequency.
 Parameters: 0 to 1024000000.
 Example: Frequency 36000000 ←
 Notes: Frequency is in Hz. 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.

7.2. RFChannel

Used for: Sets or gets DVB-C output frequency and bandwidth.
 Parameters: C or S,Channel.
 Example: RFChannel C,21← (*Sets frequency to 474MHz and bandwidth to 8 MHz*)
 RFChannel S,13← (*Sets frequency to 247.5Mhz and bandwidth to 7MHz*)
 Notes: This command sets 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.

7.3. Const

Used for: Sets or gets DVB-C constellation.
 Parameters: 16, 32, 64, 128, 256
 Example: Const 64 ← (*Selects 64-QAM*)

7.4. SymbolRate

Used for: Sets or gets the modulator symbol rate
 Parameters: 600 to 7000
 Example: SymbolRate 6900←
 Notes: Value is in kSymbols/s

7.5. RollOff

Used for: Sets or gets filters roll-off selection
 Parameters: 13 or 15
 Example: RollOff 15←
 Notes: 13 selects a 0.13 roll-off, 15 selects a 0.15 roll-off.

7.6. Spectrum

Used for: Sets or gets DVB-C output spectrum.
 Parameters: 0 or 1
 Example: Spectrum 0 ←
 Notes: Select 1 to invert the output spectrum.

7.7. Power

Used for: Sets or gets DVB-C output power.

Parameters: 0 to 255

Example: Power 128 ↵

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

8. MPEG2 Encoder commands

8.1. EncPresence

Used for: Queries encoder presence
 Parameters: None, or 0 to 3
 Example: EncPresence \leftarrow (*Queries encoder presence for all encoders*)
 EncPresence 1 \leftarrow (*Queries encoder 1 presence*)
 Notes: Return value for *EncPresence* is:
 1, Encoder 0 present
 1, Encoder 1 present
 1, Encoder 2 present
 1, Encoder 3 present

8.2. EncBitrate

Used for: Sets encoder bitrate
 Parameters: 0 or 500 to 13500.
 Example: EncBitrate 0 \leftarrow (*Sets encoder bitrate to Automatic*)
 EncBitrate 4000 \leftarrow (*Sets encoder bitrate to 4000 kbits/sec*)
 Notes: All installed encoders use the same bitrate. Different bitrates for different encoders is not supported.
 If *Automatic* is chosen, the modulator available bitrate is divided among the present encoders. The maximum bitrate is 13500 kbits/sec.

8.3. EncResolution

Used for: Sets encoder resolution
 Parameters: 0 to 6 except 4
 Example: EncResolution 0 \leftarrow (*Sets encoder resolution to full D1*)
 EncResolution 1 \leftarrow (*Sets encoder resolution to Half D1*)
 Notes: Available resolutions are:

Value	Resolution	PAL Resolution	NTSC Resolution
0	D1	720x576	720x480
1	½ D1	360x576	360x480
2	SIF	352x288	352x240
3	QSIF	176x144	176x120
5	2/3 D1	480x576	480x480
6	¾ D1	544x576	544x480

8.4. EncVideoStandard

Used for: Sets encoder frame rate and aspect ratio.
 Parameters: [Encoder],FrameRate,AR
 Example: EncVideoStandard 0,0,0 \leftarrow (*Sets encoder 0 to 50Hz, Automatic AR*)
 EncVideoStandard ,0,4:3 (*Sets all encoders to 50Hz, 4:3 AR*)
 Notes: Frame rate can be 50Hz (0) or 60Hz (1).
 Aspect Ratio can be Automatic (0), 4:3, 16:9, 2.21:1

8.5. EncAudioParms

Used for: Sets Audio bitrate, ES mode and layer

Parameters: [Encoder],Rate,Mode,Layer

Example: EncAudioParms 0,192,0,0 ← *(Sets encoder 0 Audio bitrate to 192kbit/s, stereo, Layer 2)*

Example: EncAudioParms ,256,0,0 ← *(Sets all encoders Audio bitrate to 256kbit/s, stereo, Layer 2)*

Notes: For available bitrates, mode and layers see the following table.

Audio Bitrate	Available AudioMode (Layer 1)			
	Stereo (0)	J-Stereo (1)	DualCh (2)	SingleCh (3)
32Kbps	Not available	Not available	Not available	Available
64Kbps	Available	Available	Available	Available
96Kbps	Available	Available	Available	Available
128Kbps	Available	Available	Available	Available
160Kbps	Available	Available	Available	Available
192Kbps	Available	Available	Available	Available
224Kbps	Available	Available	Available	Not available
256Kbps	Available	Available	Available	Not available
288Kbps	Available	Available	Available	Not available
320Kbps	Available	Available	Available	Not available
352Kbps	Available	Available	Available	Not available
384Kbps	Available	Available	Available	Not available
416Kbps	Available	Available	Available	Not available
448Kbps	Available	Available	Available	Not available

Audio Bitrate	Available AudioMode (Layer 2)			
	Stereo (0)	J-Stereo (1)	DualCh (2)	SingleCh (3)
32Kbps	Not available	Not available	Not available	Available
48Kbps	Not available	Not available	Not available	Available
56Kbps	Not available	Not available	Not available	Available
64Kbps	Available	Available	Available	Available
80Kbps	Not available	Not available	Not available	Available
96Kbps	Available	Available	Available	Available
112Kbps	Available	Available	Available	Available
128Kbps	Available	Available	Available	Available
160Kbps	Available	Available	Available	Available
192Kbps	Available	Available	Available	Available
224Kbps	Available	Available	Available	Not available
256Kbps	Available	Available	Available	Not available
320Kbps	Available	Available	Available	Not available
384Kbps	Available	Available	Available	Not available

9. DVB-SI Tables commands

9.1. ONID

Used for: Sets or gets the Original Network ID.
 Parameters: 0 to 65535
 Example: ONID 8572 ←

9.2. TSID

Used for: Sets or gets the Transport Stream ID.
 Parameters: 0 to 65535
 Example: TSID 13222 ←

9.3. NITParms

Used for: Sets or gets Network Information Table parameters.
 Parameters: NetworkName, NetworkID, Frequency
 Example: NITParms 327, 36000000 ← *(Sets the NetworkName to
 , the NetworkID to 327 and the frequency 36MHz)*
 NITParms ,, 36000000 ← *(Sets only the frequency to 36MHz)*
 Notes: The Frequency is in Hz for the DVB-T and DVB-C modulators and in kHz
 for the DVB-S modulator.

9.4. ServiceParms

Used for: Sets or gets the DVB service parameters
 Parameters: Encoder, ServiceID, LCN, ServiceName
 Example: ServiceParms 0, 11, 1, TR391 CH1 ← *(Sets the parameters for the Encoder 0)*
 ServiceParms 1, 12, 2, TR391 CH2 ← *(Sets the parameters for the Encoder 1)*
 Notes: ServiceID is 1 to 65535, 0 is not allowed.
 LCN is 0 to 999. If the LCN is 0, no LCN is inserted.
 The ServiceName length is 20 character maximum.

10. GPIO, Temperature and Alarm commands

10.1. GetTemp

Used for: Reads the internal chip temperature and temperature alarm status.
 Parameters: None
 Example: GetTemp ↵
 Notes: Temperature is returned in degree Celsius.

10.2. TempAlarm

Used for: Sets or gets the alarm temperature
 Parameters: Temperature
 Example: TempAlarm 80 ↵ *(Sets the temperature alarm to 80 degree celsius)*

10.3. GpioRead

Used for: Reads GPIO values
 Parameters: None or 0 to 3
 Example: GpioRead ↵ *(Reads all the GPIOs)*
 GpioRead 0 ↵ *(Reads GPIO0)*
 Notes: If the GPIO pin is not configured as in input, the returned value is the current pin value,.

10.4. GpioWrite

Used for: Writes GPIO
 Parameters: Gpio, Value
 Example: GpioWrite 0,1 ↵ *(Sets GPIO0 to 1)*
 GpioWrite 2,0 ↵ *(Sets GPIO2 to 0)*
 GpioWrite ,0 ↵ *(Sets all the GPIOs to 0)*
 Notes: If the GPIO pin is not configured as an output, the *GpioWrite* is ignored.

10.5. GpioSetup

Used for: Sets or gets GPIO pin direction
 Parameters: Gpio, Direction
 Example: GpioSetup 0,1 ↵ *(Sets GPIO0 to output)*
 GpioSetup ,0 ↵ *(Sets all the GPIOs to input)*
 Notes: Direction 0 is input, 1 is output. If the GPIO is assigned to a special function (see *LedOvertemp*, *LedSPI* and *LedMatrix*), GPIO pin direction is ignored.

10.6. LedOvertemp

Used for: Sets or gets configuration of overtemp alarm on pin GPIO3
 Parameters: 0 to 2
 Example: LedOvertemp 0 ↵ *(Disables Overtemp output)*
 LedOvertemp 1 ↵ *(Enables Overtemp output, active High)*
 LedOvertemp 2 ↵ *(Enables Overtemp output, active Low)*
 Notes: Enabling OverTemp output overrides any GPIO3 function.

10.7. LedSPI

Used for: Enables or disables SPI output for serial status output.
 Parameters: 0 to 2
 Example: LedSPI 0 ← *(Disables SPI output)*
 LedSPI 1 ← *(Enables SPI, bits are active High)*
 LedSPI 2 ← *(Enables SPI, bits are active Low)*

Notes: Enabling SPI output overrides any GPIO0, GPIO1 and GPIO2 functions.
 See *SPI signalling example schematic* on page 29.
 Bits are assigned as follows:

Bit	Function	Bit	Function
0	Encoder 0 video present	8	Encoder 0 present
1	Encoder 1 video present	9	Encoder 1 present
2	Encoder 2 video present	10	Encoder 2 present
3	Encoder 3 video present	11	Encoder 3 present
4	Overtemperature	12	Encoder 0 error
5	Overflow	13	Encoder 1 error
6	Global Error	14	Encoder 2 error
7	Unused	15	Encoder 3 error

10.8. LedMatrix

Used for: Enables or disables the led matrix output
 Parameters: 0 to 2
 Example: LedMatrix 0 ← *(Disables Led matrix output)*
 LedMatrix 1 ← *(Enables Led matrix, LEDs are active High)*
 LedMatrix 2 ← *(Enables Led matrix, LEDs are active Low)*

Notes: Enabling LED matrix output overrides GPIO0, GPIO1 and GPIO2 GPIOs but not SPI output which has higher priority.
 LedMatrix is a 4 led matrix (see *Led Matrix signalling example schematics* on page 29) to show video presence/absence for the 4 encoders.

11. FLEXMod-AVxxx module upgrade

The FLEXMod-AVxxx firmware be upgraded by the user if needed.

The upgrade procedure is performed through the following steps:

1. Change the baud rate to something faster than 115200 bps (460800, for example). This step is not necessary (the upgrade can also be done at 115200 bps) but is advisable, as the firmware is quite long.
2. Issue the *FlashFormat 741852* command which erases the onboard serial flash containing the firmware.
3. Wait for the FLEXMod-AVxxx signaling the end of the flash erasing procedure (it usually takes 10 seconds)
4. Issue the *Upgrade 741852* command and upload the new firmware using the XMODEM protocol.
5. When the upload is complete, wait for the acknowledgement that the upgrade has been successfully completed.
6. Power off the FLEXMod-Avxxx and then power it back on.

Please note:

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

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 mistake.

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 again. This will also erase the welcome/manufacture message.

11.2. Upgrade

Used for: XMODEM upload of a new firmware.

Parameters: 741852

Example: Upload ↵

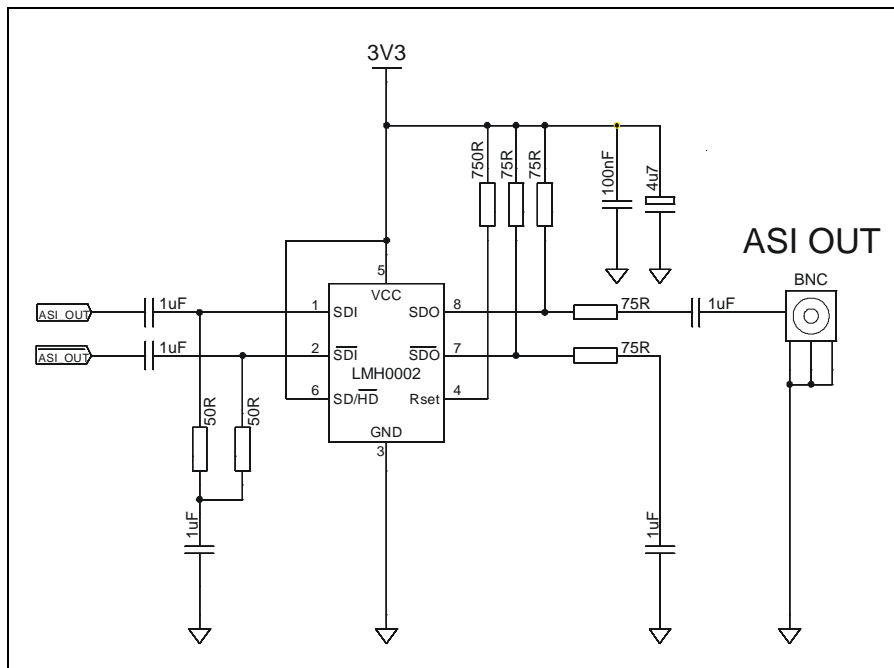
Notes: Any terminal software capable of XMODEM protocol can be used.

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

12. Example schematics

12.1. ASI Output Example schematic

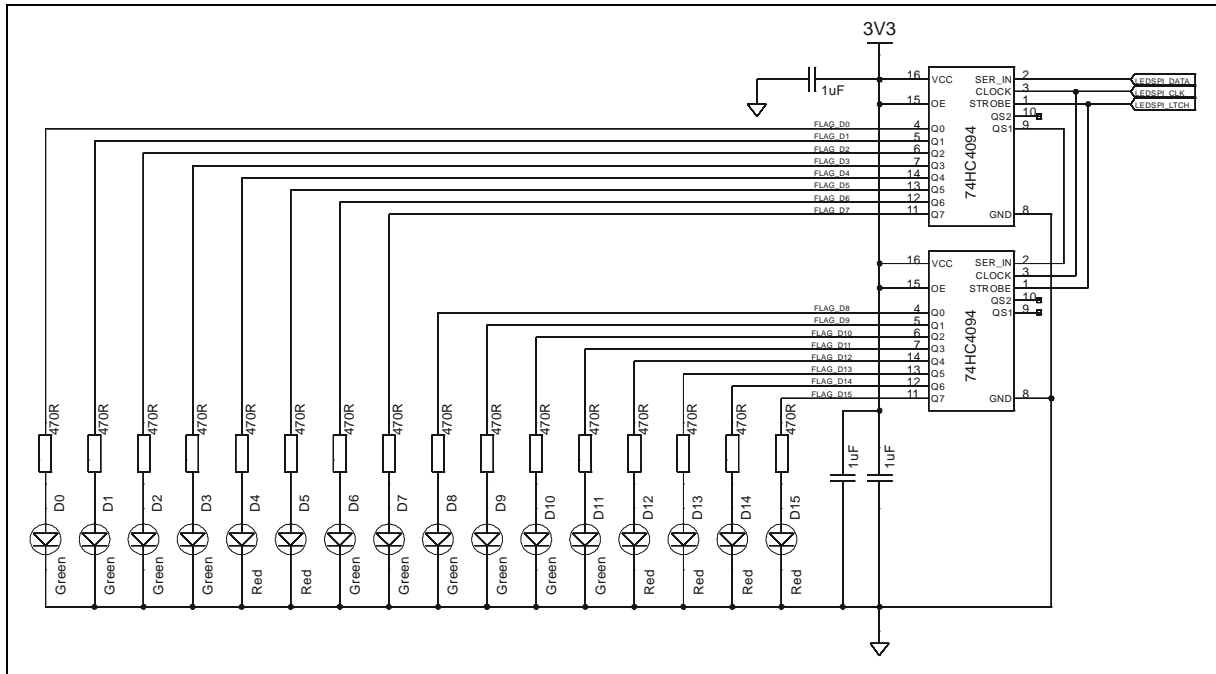
The LVDS TS ASI Output requires an adaptation network (in order to adjust the input levels) and an output driver. Note that ASI_OUT is an LVDS signal, so make sure to route it accordingly. The following schematics is a typical ASI output application:



Typical ASI output

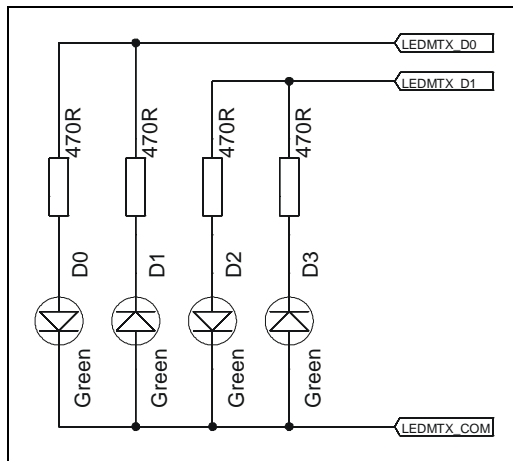
12.2. SPI signalling example schematic

For the meaning of D0 to D15 refer to *LedSPI* on page 26.



12.3. Led Matrix signalling example schematics

D0 to D3 in Led Matrix signalling are the same D0 to D3 in SPI signalling.



13. Power supplies characteristics

13.1. FLEXMod-AV101

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
1V2	Core voltage			900		mA
1V8	DAC voltage			350		mA
1V8A	Analog voltage			150		mA
3V3	I/O voltage			250		mA
3V3A	Analog voltage			130		mA

13.2. FLEXMod-AV201

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
1V2	Core voltage			700		mA
1V8	DAC voltage			450		mA
1V8A	Analog voltage			200		mA
3V3	I/O voltage			250		mA
3V3A	Analog voltage			130		mA

13.3. FLEXMod-AV301

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT
1V2	Core voltage			650		mA
1V8	DAC voltage			440		mA
1V8A	Analog voltage			190		mA
3V3	I/O voltage			260		mA
3V3A	Analog voltage			130		mA

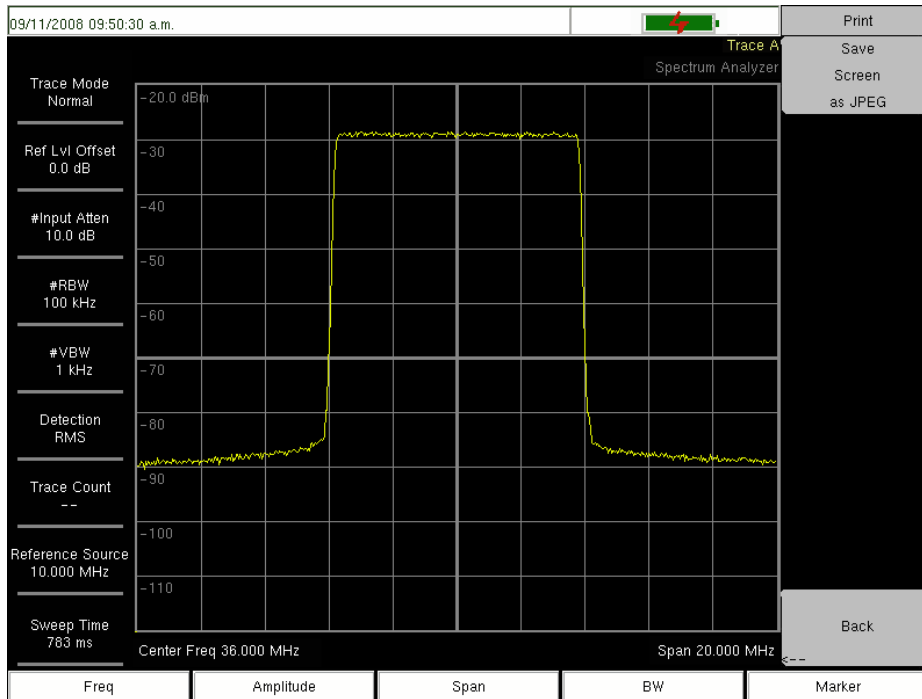
14. Alphabetical command list

A		H	
ASIOutput	15	HELP.....	13
		HexMode.....	14
B		L	
Baud	13	LedMatrix.....	26
		LedOvertemp.....	25
C		LedSPI.....	26
Carriers.....	16		
CellID.....	17	N	
ChannelBW	17	NITParms	24
Clear.....	13		
Const	16; 20	O	
		ONID.....	24
E		P	
EasyConfig	15	Power.....	17; 18; 21
Echo	13		
EncAudioParms.....	23	R	
EncBitrate.....	22	Reboot	13
EncPresence.....	22	RFChannel.....	16; 20
EncResolution.....	22	RollOff	20
EncVideoStandard	22		
		S	
F		Save.....	13
FEC	16; 19	ServiceParms	24
FIFOStatus.....	15	Spectrum.....	17; 18; 20
FlashFormat.....	27	SRList.....	18
Frequency	16; 18; 20	SymbolRate	18; 20
FSample.....	18	SystemInfo.....	15
G		T	
GetFWVersion.....	14	TempAlarm.....	25
GetSN.....	14	TSID.....	24
GetTemp.....	25		
GpioRead.....	25	U	
GpioSetup.....	25	Upgrade	27
GpioWrite.....	25		
Guard.....	16		

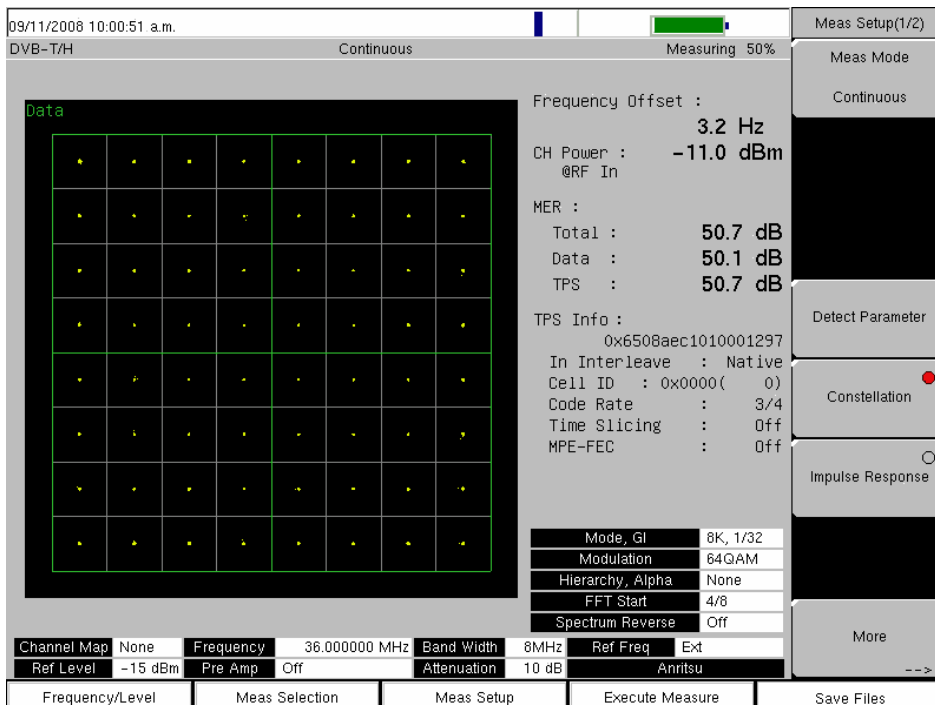
W Welcome..... 14

15. FLEXMod-AVxxx typical output characteristics

15.1. FLEXMod-AV1xx DVB-T

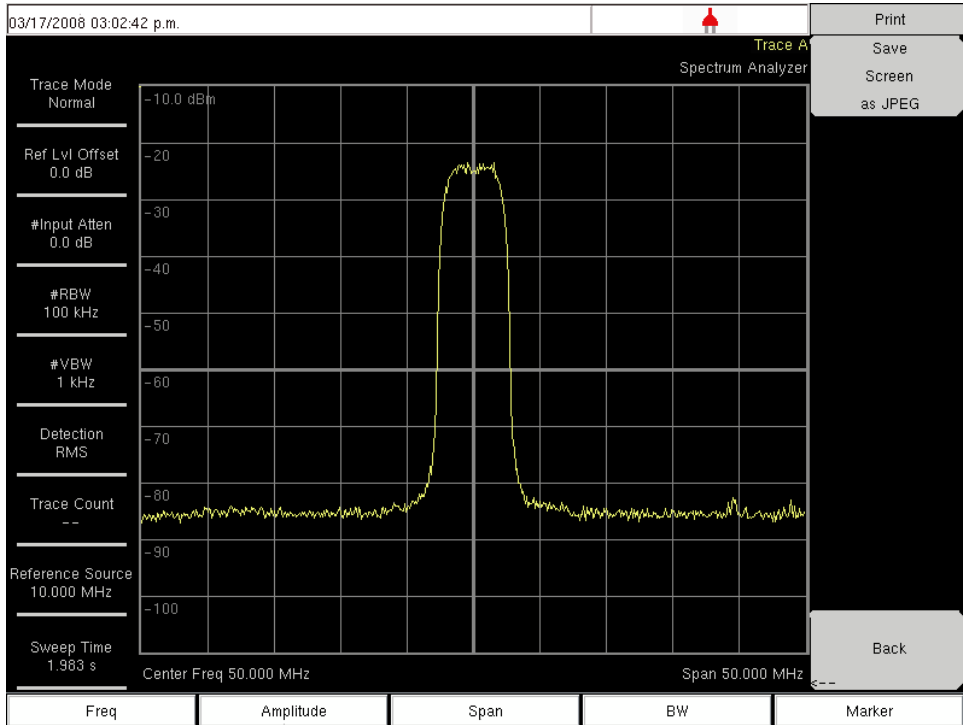


Typical output spectrum at 36MHz

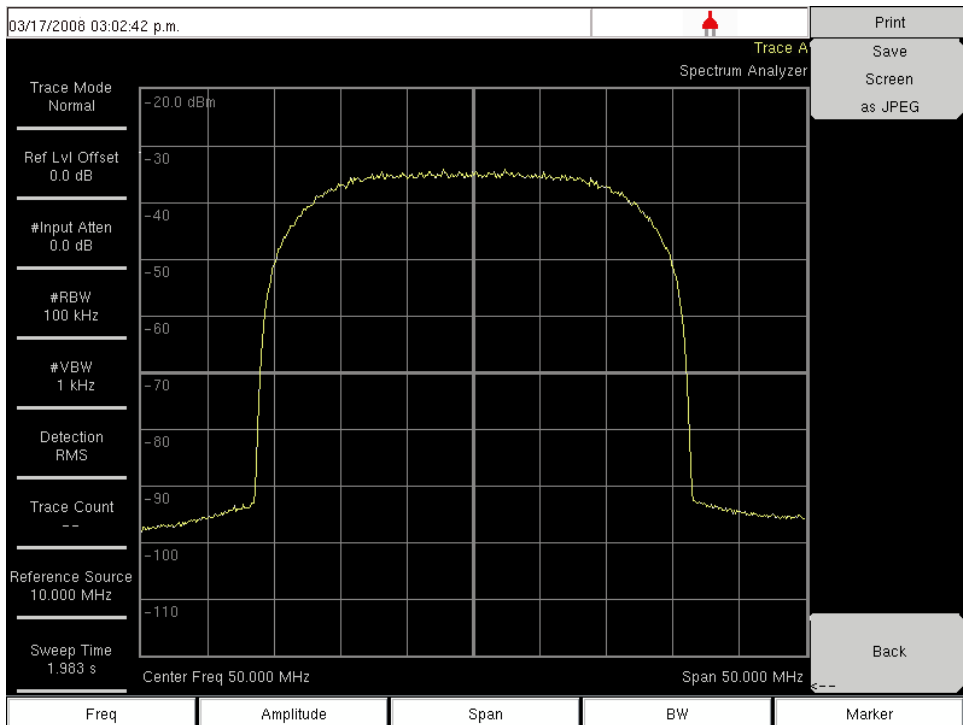


Typical constellation at 64QAM and output MER

15.2. FLEXMod-AV2xx DVB-S

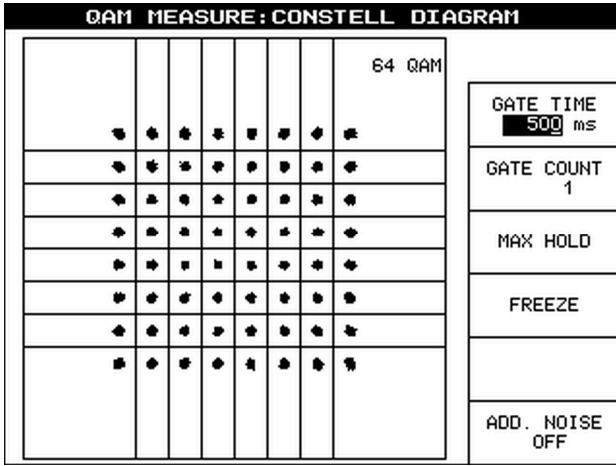


Typical output spectrum at 50MHz for a symbol rate of 4000 kSample/s

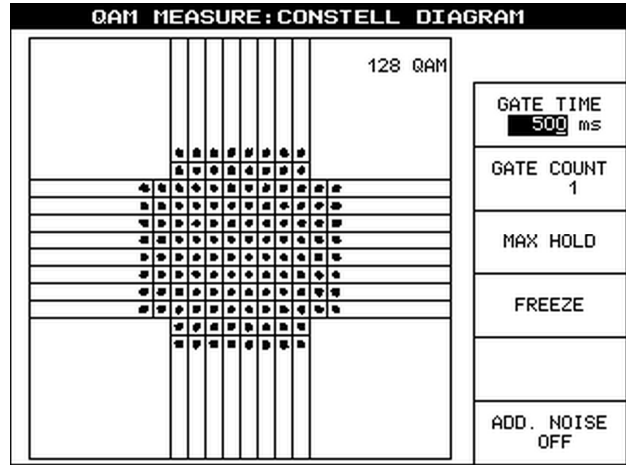


Typical output spectrum at 50MHz for a symbol rate of 24000 kSample/s

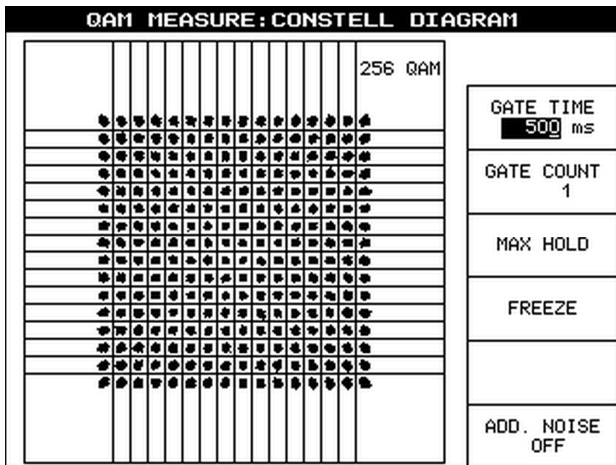
15.3. FLEXMod-AV3xx DVB-C



64-QAM constellation



128-QAM constellation

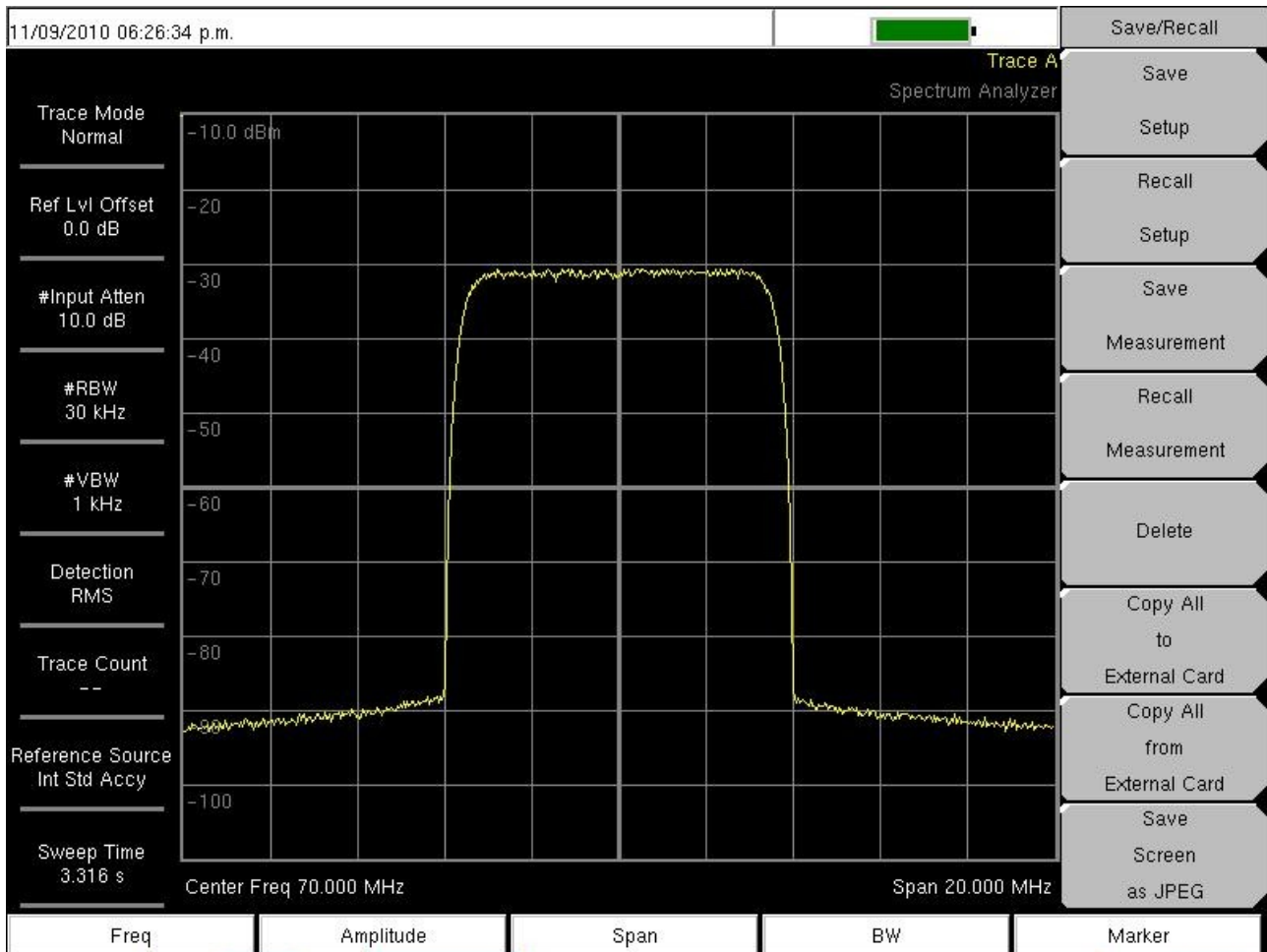


256-QAM constellation

QAM MEASURE: QAM PARAMETERS

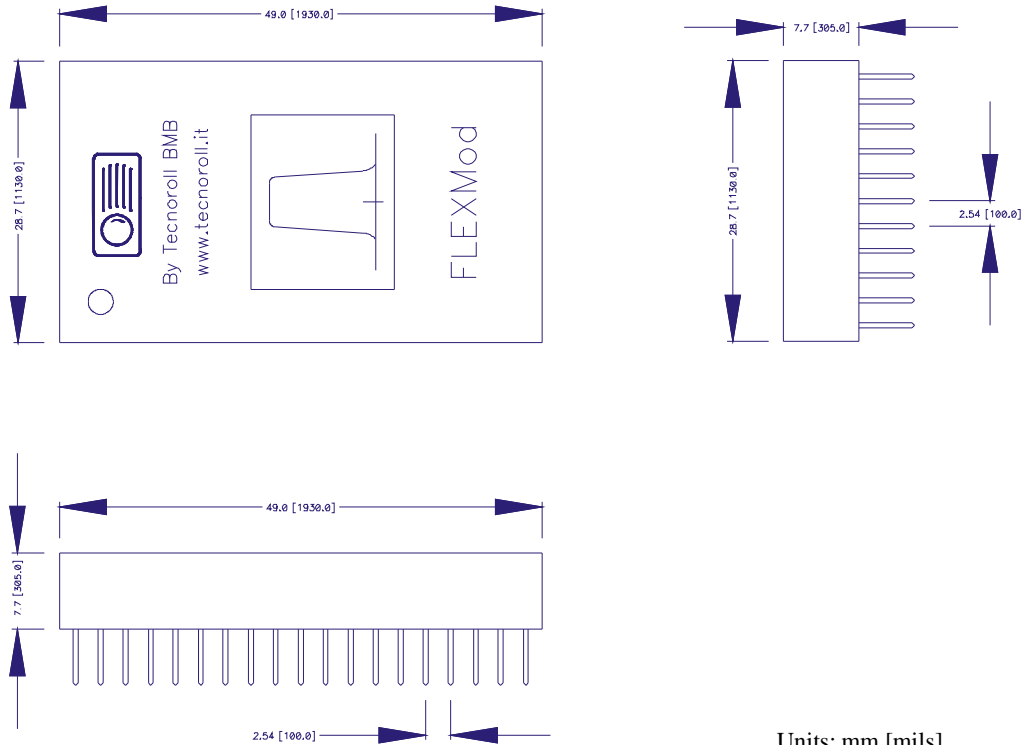
SET RF	ATTEN : 40 dB	
70.000 MHz	-7.0 dBm	
** EVALUATED PARAMETERS **		
I/Q AMPL. IMBALANCE	0.00 %	CONSTELL DIAGRAM...
I/Q PHASE ERROR	0.00 °	SPECTRUM...
CARRIER SUPPRESSION	65.8 dB	ECHO PATTERN...
PHASE JITTER	0.23 °RMS	
C/I	>34.0 dB	
SIGNAL/NOISE RATIO	45.9 dB	
MOD ERROR RATIO	0.9 %RMS	
MOD ERROR RATIO	7.7 %PK	
MOD ERROR RATIO	40.8 dB	
		ADD. NOISE OFF

QAM parameters

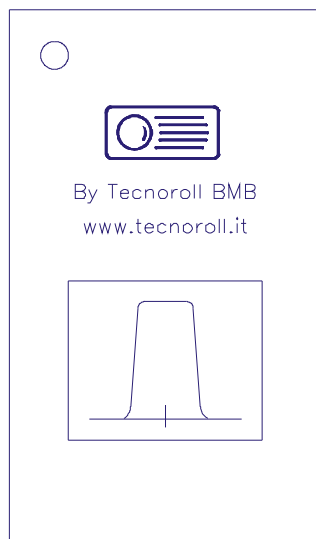


Typical output spectrum at 70MHz for a symbol rate of 6900 kSample/s

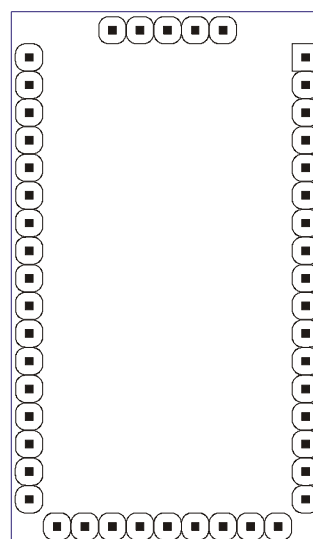
16. Packaging information



Units: mm [mils]
Controlling dimensions: mm



Top View

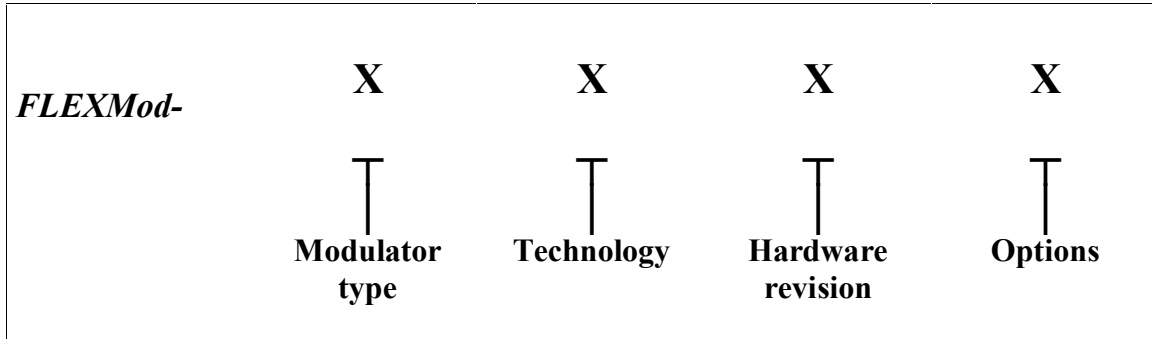


Bottom View

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	
0	Unprogrammed hardware
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.
3	DVB-C: <i>ETSI EN 300 429</i> compliant QAM modulator.
4	ATSC (A/53) compliant modulator.
5	DVB-S/S2: <i>ETSI EN 300 421/302 307</i> compliant QPSK/8PSK modulator.
6	DVB-T SFN: <i>ETSI EN 300 744/TS 101 191</i> compliant COFDM modulator.
9	Transport Stream Converter/Remultiplexer
AV1	DVB-T MFN: ETSI EN 300 744 compliant COFDM TR391AV Controller
AV2	DVB-S: ETSI EN 300 421 compliant QPSK TR391AV Controller
AV3	DVB-C: ETSI EN 300 429 compliant QAM TR391AV Controller

Technology	
0	Reference clock: 1.024 GHz.
1	Professional tunable reference clock (VCXO): 1.024 GHz.
8	Reference clock: 16 MHz.

Options	
P	Premium type.
N	Unboxed (naked) version.

Examples:

FLEXMod-AV101 DVB-T AV Controller, reference clock 1.024GHz, HW revision 1

FLEXMod-AV301 DVB-C AV Controller, reference clock 1.024GHz, HW revision 1