# MICROTUNE™

# 4737 PY5 RF Tuner Module (3x7180, 3x8568) Advance Data Sheet

# CABLE MODEM APPLICATIONS

## **1 APPLICATIONS**

The 4737 PY5 RF Tuner Module is designed for subscriber-side cable modem applications.

#### **2 FEATURES**

- EuroDOCSIS compatible
- VHF Low, VHF High, and UHF
- All functions controlled by I<sup>2</sup>C bus
- Downstream frequency range from 80 MHz to 860 MHz
- Upstream frequency range from 5 MHz to 65 MHz
- Antenna input: F-connector

#### **3 INTRODUCTION**

The 4737 PY5 RF Tuner Module covers a frequency range from 80 MHz to 860 MHz with a channel bandwidth of 6 MHz for downstream signals, and 5 MHz to 65 MHz for upstream signals.



Figure 1 4737 PY5 RF Tuner Module

The receiver uses a single-conversion approach with the reception frequency range divided into VHF low, VHF high, and UHF.

Band selection and tuning is done via the I<sup>2</sup>C -bus. An automatic gain control (AGC) input allows for external control of the output signal amplitude.





The common antenna input/output is realized by an F-connector (75 $\Omega$ ).

A digital automatic frequency control (AFC) function can also be realized — the AFC voltage generated by the IF demodulator is fed to a built-in analog/digital converter available via pin 6 and readable via the I<sup>2</sup>C bus.

## **4 MECHANICAL SPECIFICATIONS**

This section contains mechanical specifications for the 4737 PY5 RF Tuner Modules.

#### 4.1 MECHANICAL DRAWING



Figure 2 4737 PY5 Mechanical Drawing, Version 3x7180



# 4.2 MECHANICAL CHARACTERISTICS

| Characteristic                           | DIMENSIONS   |
|--|--|
| Dimensions                               | According to drawing 3x7632 GZ for 3x7180 and 3x8568 GZ  |
| Weight                                   | Approximately 41g  |
| Plug holding strength                    | Plug according to SCTE spec. IPS-sp-407  |
| F-connector mechanical specification     | The F-connector is according IPS-sp-406 and IEC 169-24   |
| Tuner connection                         | The tuner provides four pins at bottom cover for horizontal mounting and grounding   |
| Screw fixing of F-connector <sup>1</sup> | Absolute maximum torque strength: 3.39 Nm / only once<br>Absolute maximum cantilever strength: 3.39 Nm<br>Absolute maximum axial strength: 8.99N |

#### Table 1Mechanical Characteristics

<sup>1</sup> If the tuner is not mounted on the chassis, the frame may be bent during the test. Regardless of mounting, the F-connector will not be pulled out of the frame.

#### **5 FUNCTIONAL SPECIFICATIONS**

#### 5.1 ABSOLUTE MAXIMUM RATINGS

Stresses greater than those listed in Table 2 may cause permanent damage to the device. These are stress ratings only; functional operation of the device under conditions other than those listed in Table 3 is not recommended or implied. Exposure to any of the absolute-maximum rating conditions for extended periods of time may affect reliability.

#### Table 2Absolute Maximum Ratings

| Parameter            | Min | Мах | Unit |
|----------------------|-----|-----|------|
| Supply voltage (VS1) |     | 6   | V    |
| Supply voltage (VS2) |     | 35  | V    |
| AGC Voltage          |     | 6   | V    |
| Storage temperature  | -40 | +70 | °C   |



## **5.2 OPERATING CHARACTERISTICS**

The operating characteristics listed in Table 3 reflect the conditions necessary for optimal performance and operating reliability.

| Parameter                                 | Min   | Түр   | Мах   | Unit | Conditions or<br>Location                             |
|---|-------|-------|-------|------|---|
| Frequency range                           |       |       |       |      |   |
| VHF Low                                   | 80    |       | 162   | MHz  |   |
| VHF High                                  | 156   |       | 469   | MHz  |   |
| UHF                                       | 463   |       | 860   | MHz  |   |
| VHF Low                                   | 91    |       | 159   | MHz  | Referenced to   |
| VHF High                                  | 159   |       | 466   | MHz  | center frequency<br>of 8 MHz                          |
| UHF                                       | 466   |       | 857   | MHz  | bandwidth   |
| Tuning resolution                         |       |       |       |      |   |
| Standard tuning increment                 |       | 62.5  |       | kHz  | See Table 9   |
| Recommended takeover frequencies (center) |       |       |       |      |   |
| VHF Low / VHF high                        |       | 159   |       | MHz  |   |
| UHF                                       |       | 466   |       | MHz  |   |
| Intermediate frequency (IF)               |       |       |       |      |   |
| Center frequency                          |       | 43.75 |       | MHz  | Oscillator<br>operates above<br>received<br>frequency |
| Input impedance                           |       |       |       |      |   |
| VHF/UHF Common                            |       | 75    |       | Ω    | Unbalanced  |
| AGC Voltage                               |       |       |       |      | Pin 5   |
| Voltage for maximum gain                  | 3.9   | 4     | 4.1   | V    | $4V \pm 0.1V$   |
| AGC Current                               |       |       | 12    | μΑ   |   |
| VS1 Power supply voltage                  |       |       |       |      | Pins 4 and 8  |
| Voltage                                   | 4.75  | 5     | 5.25  | V    |   |
| Current                                   |       | 160   | 200   | mA   |   |
| Permissible ripple voltage                |       |       | 20    | mVpp | 20 Hz to 100 kHz                                      |
| VS2 Power supply voltage                  |       |       |       |      | Pin 7   |
| Voltage                                   | 31.35 | 33    | 34.65 | V    | 33V ± 5%  |
| Current                                   |       |       | 2     | mA   |   |
| Permissible ripple voltage                |       |       | 10    | mVpp | 20 Hz to 100 kHz                                      |
| Temperature                               |       |       |       |      |   |
| Operating temperature                     | -10   |       | +60   | °C   |   |
| Storage temperature                       | -40   |       | +70   | °C   |   |

## Table 3Operating Characteristics



## **6 TUNER MEASUREMENT TEST CONDITIONS**

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All tuner data is held under the following conditions unless otherwise noted:

- Measurement tolerance: ٠
- 10% or 1 dB
- Ambient temperature: +25°C ±3°C
  Supply voltages: +5V ±2%
  - AGC voltage:
- +5V ±2% +4V ±2%

#### 7 TUNER DATA

#### Table 4 **Electrical Characteristics**

| Parameter                | Test Conditions  | Min                        | Түр                       | Мах                      | Unit             |
|--------------------------|--|----------------------------|---------------------------|--------------------------|------------------|
| Frequency range          |  | 80                         |                           | 860                      | MHz              |
| Voltage gain             | Measured between antenna input<br>and IF1 and IF2. The input is loaded<br>with 75 $\Omega$ and the output is loaded<br>with a test circuit (see Figure 3). | 43                         | 46                        | 52                       | dB               |
| Noise figure             | See figure 3.  |                            |                           |                          |                  |
| VHF Low                  |  |                            | 7.5                       | 9.5                      | dB               |
| VHF High                 |  |                            | 7.5                       | 9.5                      | dB               |
| UHF                      |  |                            | 7.5                       | 9.5                      | dB               |
| VSWR                     | Antenna input  |                            |                           | 3                        |                  |
| AGC Range                | Varying AGC voltage from +4V to<br>+0.5V   |                            |                           |                          |                  |
| VHF Low                  | Gain reduction   | 45                         |                           |                          | dB               |
| VHF High                 | Gain reduction   | 40                         |                           |                          | dB               |
| UHF                      | Gain reduction   | 40                         |                           |                          | dB               |
| Influence of AGC on tilt | The noise figure shall not increase by n<br>reduction. The input return loss shall be<br>over the entire range of AGC voltage.                             | nore than t<br>e maintaine | the corres<br>ed within t | ponding g<br>he specifie | ain<br>ed limits |
| IF Rejection             | Measured from channel center<br>frequency to 43.75 MHz   |                            |                           |                          |                  |
| VHF Low                  |  | 50                         | 70                        |                          | dB               |
| VHF High                 |  | 60                         | 80                        |                          | dB               |
| UHF                      |  | 60                         | 75                        |                          | dB               |
| Image rejection          |  |                            |                           |                          |                  |
| VHF Low                  |  | 60                         | 70                        |                          | dB               |
| VHF High                 |  | 55                         | 65                        |                          | dB               |
| UHF                      |  | 55                         | 60                        |                          | dB               |
| RF Tilt                  | Over an 6 MHz bandwidth around center frequency  |                            |                           | 2.5                      | dB               |





## **8 TEST CIRCUITS**



Figure 3 Test Circuit

Test circuit attenuation is 22.6 dB.

For the test circuit:

- T1 = RF Transformer
- W Ratio = 1:4
- Type: MCL T4-1 or equivalent

## **8.1 TEST CHARACTERISTICS**

#### Table 5 Test Characteristics

| Parameter             | Test Conditions                              | Min | Түр | Мах | Unit   |
|-----------------------|--|-----|-----|-----|--------|
| Signal level for 1 dB | AGC deactivated with AGC=4V for maximum gain | 70  |     |     | dBµV   |
| gain compression      | With AGC set for 15 dB gain reduction        | 85  |     |     | dBμV   |
| Phase noise           |  |     |     |     |        |
| VHF Low               |  |     | -71 | -55 | dBc/Hz |
| VHF High              | Measured at 1 kHz distance<br>from carrier   |     | -60 | -55 | dBc/Hz |
| UHF                   |  |     | -58 | -55 | dBc/Hz |
| VHF Low               |  |     | -95 | -80 | dBc/Hz |
| VHF High              | Measured at 10 kHz                           |     | -85 | -80 | dBc/Hz |
| UHF                   |  |     | -85 | -80 | dBc/Hz |



| Parameter                         | Test Conditions   | Μιν  | Түр         | Мах   | Unit   |  |  |
|-----------------------------------|---|------|-------------|-------|--------|--|--|
| VHF Low                           |   |      | -102        | -90   | dBc/Hz |  |  |
| VHF High                          | Measured at 20 kHz  |      | -92         | -85   | dBc/Hz |  |  |
| UHF                               |   |      | -90         | -85   | dBc/Hz |  |  |
| VHF Low                           |   |      | -109        | -100  | dBc/Hz |  |  |
| VHF High                          | Measured at 100 kHz<br>distance from carrier  |      | -106        | -100  | dBc/Hz |  |  |
| UHF                               |   |      | -103        | -100  | dBc/Hz |  |  |
| Oscillator voltage at             | <88 MHz   | No c | scillator s | ignal |        |  |  |
| aerial terminal;                  | <860 MHz  |      |             | 5     | dBµV   |  |  |
| terminated with 75 $\Omega$       | <1740 MHz   |      |             | 40    | dBµV   |  |  |
| Intermodulation                   | With a fully loaded multi-tone signal generator (129 channels), carrier levels at +15 dBmV, and AGC set for a 15 dB reduction in gain, distortion levels shall not exceed these limits:   |      |             |       |        |  |  |
| Composite triple<br>beat          |   |      |             | 50    | dB     |  |  |
| Composite<br>second order<br>beat |   |      |             | 50    | dB     |  |  |
| Group delay                       | Over any 6 MHz bandwidth centered about the tuned frequency, and<br>for AGC over the range from maximum gain down to –25 dB below<br>maximum gain, the group delay variation as measured between the<br>antenna terminal and the IF output terminal shall not exceed these<br>limits: |      |             |       |        |  |  |
| VHF Low                           |   |      | 60          | 100   | ns p-p |  |  |
| VHF High                          |   |      | 30          | 100   | ns p-p |  |  |
| UHF                               |   |      | 20          | 100   | ns p-p |  |  |
| PLL Settling time                 | Charge pump current high  |      |             | 100   | ms     |  |  |

# 9 REVERSE CHANNEL INPUT (PIN 1)

## Table 6Reverse Channel Input (Pin 1)

| Parameter                      | Conditions                           | Min | Түр | Мах | Unit |
|--------------------------------|--------------------------------------|-----|-----|-----|------|
| Insertion loss from Pin 1 to a | ntenna terminal input                |     |     |     |      |
| 5 MHz to 65 MHz                |                                      |     |     | 2   | dB   |
| 88 MHz to < 96 MHz             | Antenna input                        | 48  |     |     | dB   |
| 96 MHz to < 180 MHz            | terminated with $75\Omega$           | 53  |     |     | dB   |
| 180 MHz to 860 MHz             |                                      | 45  |     |     | dB   |
| Antenna input to tuner part in | nput                                 |     |     |     |      |
| 88 MHz to < 96 MHz             |                                      | 48  |     |     | dB   |
| 96 MHz to < 180 MHz            | Antenna input<br>terminated with 750 | 53  |     |     | dB   |
| 180 MHz to 860 MHz             |                                      | 45  |     |     | dB   |
| Diplexer channel input VSWI    |                                      |     |     |     |      |
| 5 MHz to 65 MHz                |                                      |     |     | 2   |      |



#### 9.1 DIPLEXER GROUP DELAY VARIATION

The diplexer group delay variation in any 2 MHz bandwidth within the frequency range of 5 MHz to 65 MHz shall not exceed 60 nsec.

#### 9.2 REVERSE CHANNEL HARMONIC DISTORTION

The reverse channel path within the tuner (diplex filter) shall not generate harmonic distortion in excess of 100 dB below the level of the reverse channel signal when the level of the reverse channel signal at the antenna terminal is +58 dBmV.

#### 9.3 FULL DUPLEX OPERATION

With an upstream signal at a level of +58 dBmV and amplitude modulation of 50%, modulation transferred to the downstream signal shall not exceed 1%. In addition, the signal-to-noise ratio of the downstream signal shall not be reduced to less than 30 dB as a result of the presence of the upstream signal.

# 10 I<sup>2</sup>C BUS

#### **10.1 WRITE DATA FORMAT**

|                | MSB |                 |     |     |     |     |     | LSB              |                |
|----------------|-----|-----------------|-----|-----|-----|-----|-----|------------------|----------------|
| Address byte   | 1   | 1               | 0   | 0   | 0   | MA1 | MAO | R/W <sup>1</sup> | A <sup>2</sup> |
| Divider byte 1 | 0   | n14             | n13 | n12 | n11 | n10 | n9  | n8               | А              |
| Divider byte 2 | n7  | n6              | n5  | n4  | n3  | n2  | n1  | n0               | А              |
| Control byte 1 | 1   | CP <sup>3</sup> | T2  | T1  | TO  | RSA | RSB | OS               | А              |
| Control byte 2 | P7  | P6              | P5  | P4  | P3  | P2  | P1  | PO               | A              |

#### Table 7 Write Data Format

 $^{1}$  R/W = 0 is write mode

 $^{2}$  A = Acknowledge

 $^{3}$  CP = 1 is charge pump current high

Note: MSB is transmitted first.





#### Table 8 Address Selection

| MA1 | MAO | Address | Voltage at Pin 11            |
|-----|-----|---------|------------------------------|
| 0   | 0   | CO      | (0 to 0.1) V <sub>S1</sub>   |
| 0   | 1   | C2      | Always valid                 |
| 1   | 0   | C4      | (0.4 to 0.6) V <sub>S1</sub> |
| 1   | 1   | C6      | (0.9 to 1) V <sub>S1</sub>   |

Table 9 Oscillator Frequency and Divider Byte Calculation

| RSA | RSB | Reference Divider | Minimum Tuning<br>Step | F <sub>REF</sub> |
|-----|-----|-------------------|------------------------|------------------|
| 1   | 1   | 512               | 62.5 kHz               | 7.8125 kHz       |
| Х   | 0   | 640               | 50.0 kHz               | 6.25 kHz         |
| 0   | 1   | 1024              | 31.25 kHz              | 3.90625 kHz      |

Use the following formula to calculate oscillator frequency and divider byte.

$$f_{osc} = f_{ref} \times 8 \times SF$$

Where:

 $f_{OSC}$  = Local oscillator frequency  $f_{ref}$  = Crystal reference frequency / 512 = 4 MHz / 512 = 7.8125 kHz

SF = Programmable scaling factor

Scaling factor is SF =  $16384 \times n14 + 8192 \times n13 + 4096 \times n12 + 2048 \times n11 + 1024 \times n10 + 512 \times n9 + 256 \times n8 + 128 \times n7 + 64 \times n6 + 32 \times n5 + 16 \times n4 + 8 \times n3 + 4 \times n2 + 2 \times n1 + n0$ 

#### **10.2 CONTROL BYTES**

Table 10 Control Byte 1 Settings (Default)

|                | MSB |   |   |   |   |   |   | LSB |   |
|----------------|-----|---|---|---|---|---|---|-----|---|
| Control byte 1 | 1   | 1 | 0 | 0 | 1 | 1 | 1 | 0   | А |

Table 11 Control Byte 1 Settings Default Descriptions

| Code       | DESCRIPTION         | Settings   |
|------------|---------------------|--|
| CP         | Charge pump current | 1 = fastest tuning<br>0 = better phase noise for<br>distance < 10 kHz to the carrier |
| T0, T1, T2 | Test mode bit       |  |
| RSA, RSB   | Reference divider   | See Table 9  |
| OS         | Tuning voltage      | 0 = On   |





| BAND     | ACTIVE PORT | P7 | P6 | P5 | P4 | P3 | P2 | P1 | PO |
|----------|-------------|----|----|----|----|----|----|----|----|
| UHF      | PO          | Х  | 0  | Х  | Х  | 0  | 0  | 0  | 1  |
| VHF High | P2          | Х  | 0  | Х  | Х  | 0  | 1  | 0  | 0  |
| VHF Low  | P1          | Х  | 0  | Х  | Х  | 0  | 0  | 1  | 0  |

Table 12 Control Byte 2 (Band Selection)

Note: X = not used

#### 10.3 READ DATA FORMAT

| Table 13 | Read Data | Format |
|----------|-----------|--------|
|          | Neur Data | ronnat |

|              | MSB |    |    |   |    |     |     | LSB | АСК |
|--------------|-----|----|----|---|----|-----|-----|-----|-----|
| Address byte | 1   | 1  | 0  | 0 | 0  | MA1 | MAO | R/W | А   |
| Status byte  | POR | FL | 12 | 1 | 10 | A2  | A1  | A0  | А   |

Note: MSB is transmitted first.

#### Table 14 Read Data Format Descriptions

| Code       | DESCRIPTION   |
|------------|---|
| R/W        | 1 = Read mode   |
| POR        | Power on reset flag (POR =1 at power on)  |
| FL         | In lock flag (FL= 1 when PLL is locked)   |
| 12, 11, 10 | Digital levels for I/O ports P7, P5 and P4  |
| A2, A1, A0 | Digital output of 5-level ADC for AFC function. Value for<br>correct tuning:<br>A2 = 0<br>A1= 1<br>A0 = 0 |

# 10.4 A/D CONVERTER LEVELS

#### Table 15 A/D Converter Levels

| VOLTAGE APPLIED ON PORT P6 | A2 | A1 | AO |
|----------------------------|----|----|----|
| 0.6 VS1 to VS1             | 1  | 0  | 0  |
| 0.45 VS1 to 0.6 VS1        | 0  | 1  | 1  |
| 0.3 VS1 to 0.45 VS1        | 0  | 1  | 0  |
| 0.15 VS1 to 0.3 VS1        | 0  | 0  | 1  |
| 0 to 0.15 VS1              | 0  | 0  | 0  |



## **11 SAFETY AND RELIABILITY**

## 11.1 ELECTROSTATIC DISCHARGE (ESD) PROTECTION



: The tuner contains components that can be damaged by electrostatic discharge.

Observe these precautions:

- Ground yourself before handling the tuner.
- Do not touch the tuner connector pins without ESD protection.

#### **11.2 HIGH VOLTAGE**

The tuner meets specifications IEC 801.2 level 2.

#### **11.3 HUMIDITY**

Table 16 Local Oscillator Drift

| Test Condition | Drift | Unit | Procedure   |  |  |
|----------------|-------|------|---|--|--|
| VHF Low        | + 15  | kHz  | 1. Run 60 hours at +55°C and 20% relative humidity. |  |  |
|                |       |      | 2. Run 1 hour at +23°C and 50% relative humidity.   |  |  |
| VHF High       | ± 45  | kHz  | 3. Take first measurement.                          |  |  |
|                |       |      | 4. Run 65 hours at +40°C and 95% relative humidity. |  |  |
| UHF            | ± 75  | kHz  | 5. Take second measurement.                         |  |  |

## **11.4 VIBRATION TEST**

After applying vibration of 1.5 mm amplitude, frequency of 10 - 55 - 10 Hz (1 minute) each X, Y, Z direction for 2 hours (total 6 hours), tuner shall not have any rattling or loosening and shall comply with the variation to its initial value as listed in Table 17.

#### Table 17 Vibration Test

| Parameter      | Measurement | Unit |  |
|----------------|-------------|------|--|
| Gain variation | < ± 3       | dB   |  |
| Wave variation | < ± 30      | %    |  |



#### **11.5 MICROPHONY**

The microphony test is made with a TV set. The resolution is optimal. With maximum AF output of the TV set, the tuner is free of microphonic effects provided the unit is installed in a professional manner.

#### **11.6 LOOSE CONTACT TEST**

The loose contact test is made with a TV set. The test pattern is a color bar. The resolution is optimal. To test, knock the TV set. There must be no visible effects, provided the unit is installed in a professional manner.

#### 11.7 LOOSE CONTACT TEST OF TUNE RALONE

The test pattern is a color bar. The resolution is 3 MHz. To test, knock the edge of the tuner. There must be no interruption effects, provided the tuner is fastened with a ground contact.

#### **11.8 NATIONAL REGULATIONS**

The tuner meets the requirements of VDE 9872/7.72 and Amtsblatt DBP 069/1981 (FTZ), EN 55013, EN 55020 (if properly mounted into TV set, VCR, or converter).

#### **12 ORDERING INFORMATION**

The 4737 PY5 Tuner Modules may be ordered in the packaging units and quantities shown in Table 18 and Table 19. For packaging options and quantities other than those shown, contact one of the offices listed on the following page.

Table 18 Packaging Units

|                                 | 4737 PY5 TUNER MODELS |        |  |  |
|---------------------------------|-----------------------|--------|--|--|
| Packaging Units                 | 3x7180                | 3x8568 |  |  |
| Number of Tuner Modules Per Box | 108                   | 90     |  |  |
| Number of Boxes Per Master Box  | 56                    | 56     |  |  |





# Table 19 Order Quantities

|       | Total Number<br>Maste | of Tuners per<br>r Box |
|-------|-----------------------|------------------------|
| Boxes | 3x7180                | 3x8568                 |
| 0.5   | 3,024                 | 2,520                  |
| 1.0   | 6,048                 | 5,040                  |
| 1.5   | 9,072                 | 7,560                  |
| 2.0   | 12,096                | 10,080                 |
| 2.5   | 15,120                | 12,600                 |
| 3.0   | 18,144                | 15,120                 |
| 3.5   | 21,168                | 17,640                 |
| 4.0   | 24,192                | 20,160                 |
| 4.5   | 27,216                | 22,680                 |
| 5.0   | 30,240                | 25,200                 |

## **13 REVISION HISTORY**

| Name | Description | ECN<br>No. | Date    | Ref/Rev |
|------|-------------|------------|---------|---------|
|      |             | 71 / 00    | 14.7.00 | 01      |
|      |             | 80 / 00    | 23.8.00 | 02      |



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