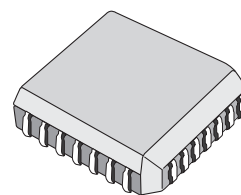


HOME AUTOMATION MODEM

- HALF DUPLEX ASYNCHRONOUS 2400bps FSK MODEM
- Tx CARRIER FREQUENCY SYNTHESIZED FROM EXTERNAL CRYSTAL
- LOW DISTORTION Tx SIGNAL
- Rx SENSITIVITY BETTER THAN 1mVRMS
- CARRIER DETECTION
- WATCH-DOG INPUT
- RESET AND MASTER CLOCK OUTPUTS FOR MICROCONTROLLER
- POWER AMPLIFIER BIAS CURRENT CONTROL (HIGH IMPEDANCE IN Rx MODE)
- SIMPLE AND ECONOMICAL APPLICATION SCHEMATICS
- COMPATIBLE WITH CENELEC EN 50065-1 AND FCC SPECIFICATION
- CARRIER DETECT CLAMPING ON Rx/D PROGRAMMABLE (ALLOWING DEMODULATION ON VERY LOW RECEIVE LEVEL, 1mVRMS TYPICALLY)



PLCC28
(Plastic Chip Carrier)

ORDER CODE : ST7537HS1

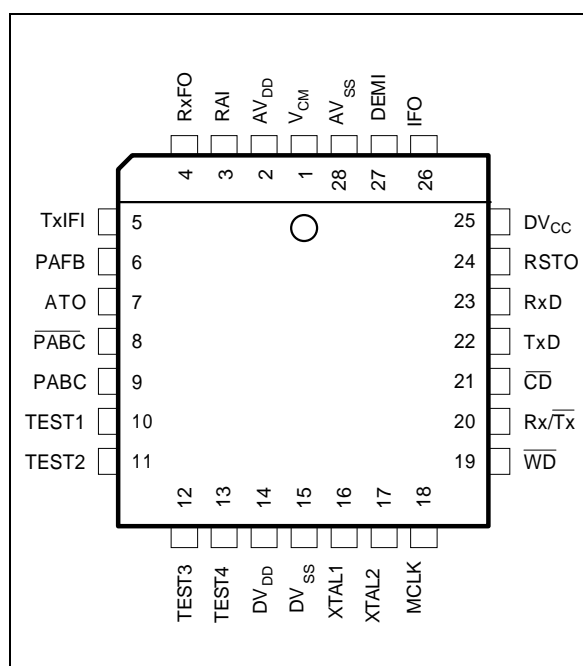
DESCRIPTION

The ST7537HS1 is a half duplex asynchronous FSK MODEM designed for home automation communication on the domestic electric mains which complies with the EN 50065-1 CENELEC standard.

It mainly operates from a 10V power supply and a 5V power supply for the microcontroller digital interface.

It is interfaced to the power line by an external driver, and a transformer (see Application Schematic Diagram). Its data transmission rate is 2400 bps and its carrier frequency is 132.45kHz.

PIN CONNECTIONS



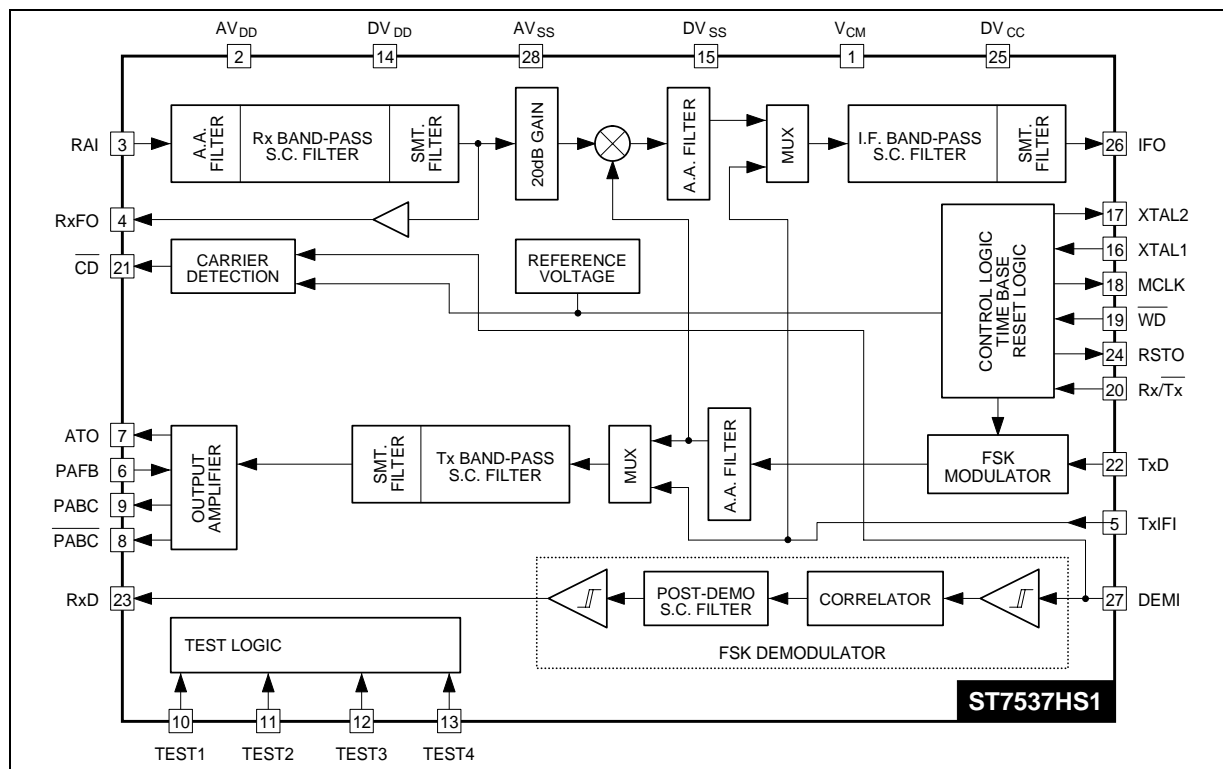
7537H-01.EPS

PIN DESCRIPTION

| Pin Name | Pin Number | Pin Type | Description |
|------------------|------------|---------------|--|
| V _{CM} | 1 | Analog | Common Mode Voltage |
| AV _{DD} | 2 | Supply | Analog Power Supply : 10V ±5 % |
| RAI | 3 | Analog | Receive Analog Input |
| RxFO | 4 | Analog | Receive Filter Output |
| TxIFI | 5 | Analog | Transmit and Intermediate Frequency Filters Test Input (mode TEST3) |
| PAFB | 6 | Analog | Power Amplifier Feed-back Input |
| ATO | 7 | Analog | Analog Transmit Output |
| PABC | 8 | Digital (10V) | Power Amplifier Bias Current Control Complementary Output |
| PABC | 9 | Digital (10V) | Power Amplifier Bias Current Control Output |
| TEST1 | 10 | Digital | Tx to Rx Automatic Mode Switching Control Input |
| TEST2 | 11 | Digital | Automatic Mode Switching Time and Watch-dog Time Reduction Control Input |
| TEST3 | 12 | Digital | TxIFI Selection Input |
| TEST4 | 13 | Digital | Undelayed Reset Input |
| DV _{DD} | 14 | Supply | Digital Power Supply : 10V ±5% |
| DV _{SS} | 15 | Supply | Digital Ground : 0V |
| XTAL1 | 16 | Digital (10V) | Crystal Oscillator Input |
| XTAL2 | 17 | Digital (10V) | Crystal Oscillator Output |
| MCLK | 18 | Digital | Master Clock Output |
| WD | 19 | Digital | Watch-dog Input |
| Rx/Tx | 20 | Digital | Rx or Tx Mode Selection Input |
| CD | 21 | Digital | Carrier Detect Output |
| TxD | 22 | Digital | Transmit Data Input |
| RxD | 23 | Digital | Receive Data Output |
| RSTO | 24 | Digital | Reset Output |
| DV _{CC} | 25 | Supply | Digital Buffers Supply Voltage : 5V ±5 % |
| IFO | 26 | Analog | Intermediate Frequency Filter Output |
| DEMI | 27 | Analog | Demodulator Input |
| AV _{SS} | 28 | Supply | Analog Ground : 0V |

7537H-01.TBL

BLOCK DIAGRAM



7537H-02.EPS

TRANSMIT SECTION

The transmit mode is set when $Rx/\overline{Tx} = 0$, if Rx/\overline{Tx} is held at 0 longer than 1 second, then the device switches automatically in the Rx mode. A new activation of the Tx mode requires Rx/\overline{Tx} to be returned to 1 for a minimum 2 microsecond period before being set to 0.

The Transmit Data (Tx_D) enter asynchronously the FSK modulator with a nominal intra-message data rate of 2400 bps.

The basic transmit frequencies are :

- $f(Tx_D=0) = 133.05\text{kHz}$
- $f(Tx_D=1) = 131.85\text{kHz}$

These frequencies are synthesized from a 11.0592MHz crystal oscillator; their precision is the same as the crystal one's (100ppm).

The modulated signal coming out of the FSK modulator is filtered by a switched-capacitor band-pass filter (Tx band-pass) in order to limit the output spectrum and to reduce the level of harmonic components.

The final stage of the Tx path consists of an operational amplifier which needs a feed-back signal (PAFB) from the power amplifier as shown on Application Schematic Diagram.

In Tx mode the Receive Data (Rx_D) signal is set to 1.

RECEIVE SECTION

The receive section is active when $Rx/\overline{Tx} = 1$.

The Rx signal is applied on RAI and filtered by a band-pass switched capacitor filter (Rx band-pass) centered on the carrier frequency and whose bandwidth is around 12kHz.

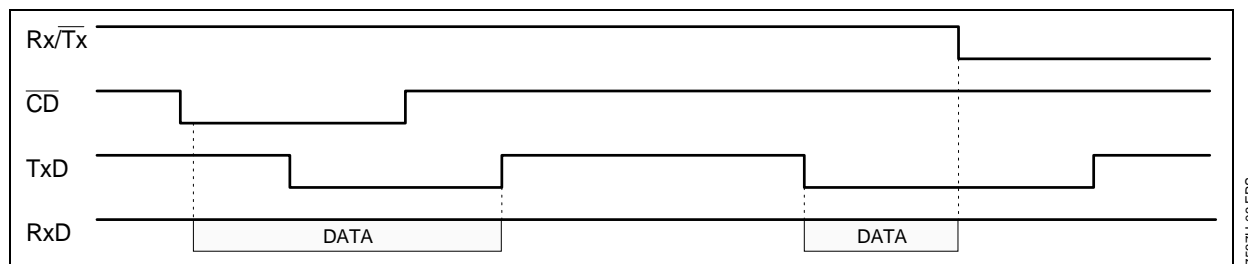
The Rx filter output is amplified by a 20dB gain stage which provides symmetrical limitations for large voltage. The resulting signal is down-converted by a mixer which receives a local oscillator synthesized by the FSK modulator block. Finally an intermediate frequency band-pass filter (IF band-pass) whose central frequency is 5.4kHz improves the signal to noise ratio before entering the FSK demodulator.

The coupling of the intermediate frequency filter output (IFO) to the FSK demodulator input (DEMI) is made by an external capacitor C5 (100nF $\pm 10\%$, 10V) which cancels the Rx path offset voltage.

The Rx_D output delivers the demodulated signal if the carrier detect (CD) signal is low and is set to high level when CD = 1.

The Rx_D output can deliver the demodulated signal whatever the level of CD (0 or 1) if $Rx/\overline{Tx} = 1$ and Tx_D = 0 (see Figure 1).

Figure 1 : Data Timing Chart



ADDITIONAL DIGITAL AND ANALOG FUNCTIONS

Time base

A time base section delivers all the internal clocks from a crystal oscillator (11.0592MHz). The crystal is connected between XTAL1 and XTAL2 pins and needs two external capacitors C3 and C4 (22pF $\pm 10\%$, 10V) for proper operation.

Reset and watch-dog

The reset output (RSTO) is driven high when the supply voltage is lower than V_{rh} (typically 7.6V) with an hysteresis $V_{rh}-V_{rl}$ (typically 300mV) or when no negative transition occurs on the watch-dog input (WD) for more than 1.5 second (see the timing chart on Figure 2). When a reset occurs RSTO is held high for at least 50ms.

Signal detection

The Carrier Detect output (\overline{CD}) is driven low when the input signal amplitude on RAI is greater than V_{CD} for at least T_{CD} (typically 6ms see the timing chart on Figure 3). When the input signal disappears or becomes lower than V_{CD} , \overline{CD} is held low for at least T_{cd} before returning to a high level. V_{CD} is the carrier detection threshold voltage which is set internally to detect 5mV_{RMS} typically.

External power amplifier bias control

Two dedicated digital output (PABC and \overline{PABC}) delivering a signal between 0V and 10V are driven

low respectively high, when the circuit is set in the receive mode ($Rx/Tx=1$) or when the transmit mode time out (1 second) is exceeded; in the same time the output ATO is put in a high impedance state.

TESTING FEATURES

- An additional amplifier allows the observation of the Rx band-pass filter output on pin RxFO.
- A direct input to the Tx band-pass filter and to the IF filter (TxIFI) is selected when TEST3 = 1.
- The 1 second normal duration of the Tx to Rx mode automatic switching is reduced to 488 μ s and the 1.5 second watch-dog time out is reduced to 46.3 μ s when TEST2 = 1.
- When TEST1 = 1 the Tx to Rx mode automatic switching is deactivated and the functional mode of the circuit is fully controlled by Rx/Tx.
- TEST4 is a reset input which allows an undelayed control of RSTO and of the internal state of the circuit.

POWER SUPPLIES WIRING PRECAUTIONS

The ST7537HS1 has two positive power supply terminals (AV_{DD} , DV_{DD}) and two ground terminals (AV_{SS} , DV_{SS}) in order to separate internal analog and digital supplies. The analog and digital terminals of each supply pair must be connected together externally for proper operation.

The V_{DD} must be protected against short-circuit for proper operation.

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|-------------------|--|--------------------------------|------|
| AV_{DD}/DV_{DD} | Supply Voltage (1) | - 0.3, + 12 | V |
| V_I | Digital Input Voltage | $DV_{SS} - 0.3, DV_{DD} + 0.3$ | V |
| V_O | Digital Output Voltage (microcontroller interface) | $DV_{SS} - 0.3, DV_{CC} + 0.3$ | V |
| V_O | Digital Output Voltage (PABC and \overline{PABC}) | $DV_{SS} - 0.3, DV_{DD} + 0.3$ | V |
| I_O | Digital Output Current | - 5, + 5 | mA |
| V_I | Analog Input Voltage | $AV_{SS} - 0.3, AV_{DD} + 0.3$ | V |
| V_O | Analog Output Voltage | $AV_{SS} - 0.3, AV_{DD} + 0.3$ | V |
| I_O | Analog Output Current | - 5, + 5 | mA |
| P_D | Power Dissipation | 500 | mW |
| T_{oper} | Operating Temperature | 0, + 70 | °C |
| T_{stg} | Storage Temperature | - 55, + 150 | °C |

7537H-02.TBL

- Notes :**
1. The voltages are referenced to AV_{SS} and DV_{SS} .
 2. Absolute maximum ratings are values beyond which damage to device may occur. Functional operation under these conditions is not implied.

GENERAL ELECTRICAL CHARACTERISTICS

($A/DV_{DD} = 10V$, $A/DV_{SS} = 0V$, $DV_{CC} = 5V$ and $0^\circ C \leq T_{amb} \leq 70^\circ C$, unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---------------------|-------------------------------|---|------------|------|------------|--------|
| AV_{DD}/DV_{DD} | Supply Voltage | | 9.5 | 10 | 10.5 | V |
| $AI_{DD} + DI_{DD}$ | Supply Current | | | 30 | | mA |
| DV_{CC} | Digital Output Supply Voltage | | 4.75 | | 5.25 | V |
| DI_{CC} | Digital Output Supply Current | | | 1.5 | | mA |
| V_{IH} | High Level Input Voltage | Digital Inputs | 4.2 | | | V |
| V_{IL} | Low Level Input Voltage | Digital Inputs | | | 0.8 | V |
| V_{OH} | High Level Output Voltage | $I_{OH} = -100\mu A$ • Digital Outputs • Digital Outputs PABC and \overline{PABC} | 4.9 9.8 | | | V V |
| V_{OL} | Low Level Output Voltage | $I_{OL} = 100\mu A$ • Digital Outputs • Digital Outputs PABC and \overline{PABC} | | | 0.1 0.2 | V V |
| DC | Duty Cycle | MCLK Output, $C_L = 15pF$ | 40 | | 60 | % |

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TRANSMITTER ELECTRICAL CHARACTERISTICS

($A/DV_{DD} = 10V$, $A/DV_{SS} = 0V$, $DV_{CC} = 5V$ and $0^\circ C \leq T_{amb} \leq 70^\circ C$, unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|--------|-------------------------------|--|------|------|------|-----------|
| VTAC | Max Carrier Output AC Voltage | $R_L = 5.6k\Omega$ $R_L(AV_{SS}) = 5.6k\Omega$ $R(ATO, PAFB) = 1k\Omega$ | 0.8 | 1.0 | 1.3 | V_{RMS} |
| HD2 | Second Harmonic Distortion | | | - 50 | | dB |
| HD3 | Third Harmonic Distortion | | | - 60 | | dB |
| FD | FSK Peak-to-peak Deviation | | | 1200 | | Hz |

7537H-04.TBL

RECEIVER ELECTRICAL CHARACTERISTICS

(A/DV_{DD} = 10V, A/DV_{SS} = 0V, DV_{CC} = 5V and 0°C ≤ T_{amb} ≤ 70°C, unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|------------------|-------------------------|---|------|------------------|------------------|-------------------|
| V _{IN} | Input Sensitivity | | | 1 | 10 | mV _{RMS} |
| V _{IN} | Maximum Input Signal | | | | 2 | V _{RMS} |
| R _{IN} | Input Impedance | | 15 | | | kΩ |
| GR _x | Receive Gain | f = 132.45kHz | | 20 | | dB |
| BER | Bit Error Rate (1) | S/N = 15dB, S = 10mV _{RMS} , N : white | | 10 ⁻⁵ | 10 ⁻³ | |
| t _{DEM} | Demodulation Time | Alternate 0 , 1 sequence | | 3 | | T bit |
| V _{CD} | Carrier Detection Level | f = 132.45kHz, sine wave | | 5 | 10 | mV _{RMS} |

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Note 1 : This parameter is guaranteed by correlation

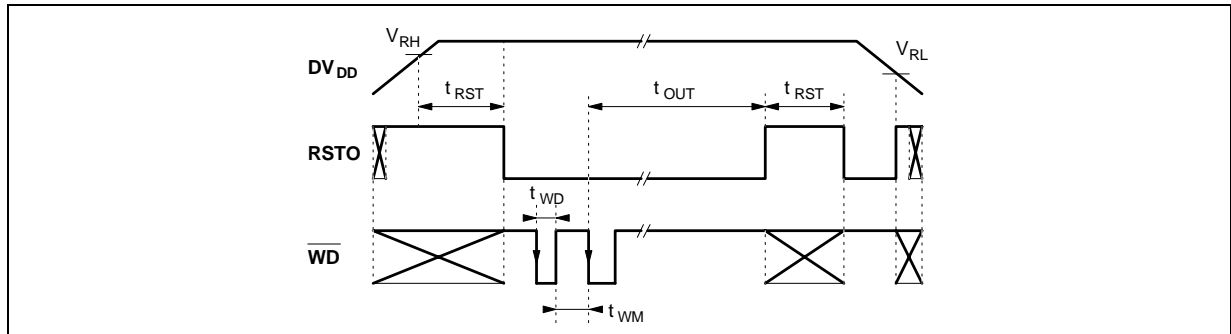
ADDITIONAL DIGITAL AND ANALOG FUNCTIONS ELECTRICAL CHARACTERISTICS

(A/DV_{DD} = 10V, A/DV_{SS} = 0V, DV_{CC} = 5V and 0°C ≤ T_{amb} ≤ 70°C, unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|------------------|--------------------------|-----------------|------|------|------|------|
| V _{RH} | High Level Reset Voltage | See Figure 2 | | 7.9 | | V |
| V _{RL} | Low Level Reset Voltage | See Figure 2 | | 7.6 | | V |
| t _{RST} | Reset Time | See Figure 2 | 50 | | | ms |
| t _{WD} | Watch-dog Pulse Width | See Figure 2 | 500 | | | ns |
| t _{WM} | Watch-dog Pulse Period | See Figure 2 | 800 | | | μs |
| t _{OUT} | Watch-dog Time Out | See Figure 2 | | | 1.5 | s |
| t _{CD} | Carrier Detection Time | See Figure 3 | 3 | | 6.5 | ms |

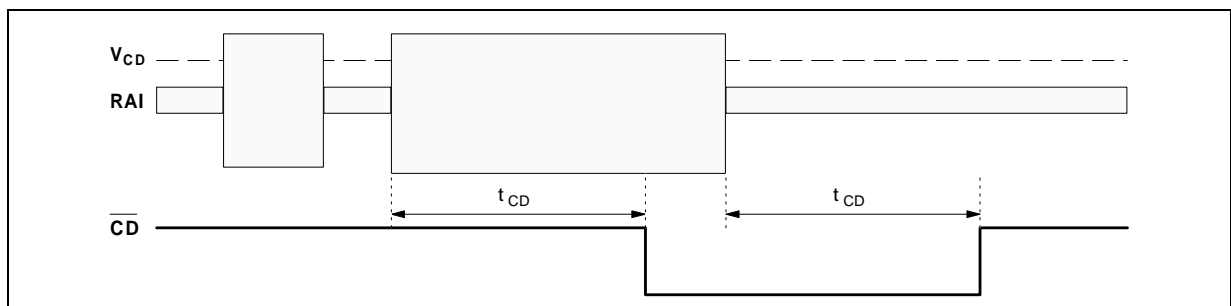
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Figure 2 : Reset and Watch-dog Timing Chart



7537H-04.EPS

Figure 3 : Carrier Detection Timing Chart



7537H-05.EPS

FILTER TEMPLATES

Receive and Transmit Filter

| Frequency (kHz) | Gain (dB) | | |
|-----------------|-----------|------|------|
| | Min. | Typ. | Max. |
| 92 | | | - 30 |
| 126.45 | - 5 | - 3 | - 2 |
| Ref 132.45 | | 0 | |
| 138.45 | - 5 | - 3 | - 2 |
| 180 | | | - 30 |

Intermediate Frequency Filter

| Frequency (kHz) | Gain (dB) | | |
|-----------------|-----------|------|------|
| | Min. | Typ. | Max. |
| 2.4 | | | - 35 |
| 4.3 | - 4 | - 3 | - 1 |
| Ref 5.4 | | 0 | |
| 6.5 | - 5 | - 3 | - 2 |
| 11.6 | | | - 35 |

7537H-07.TBL

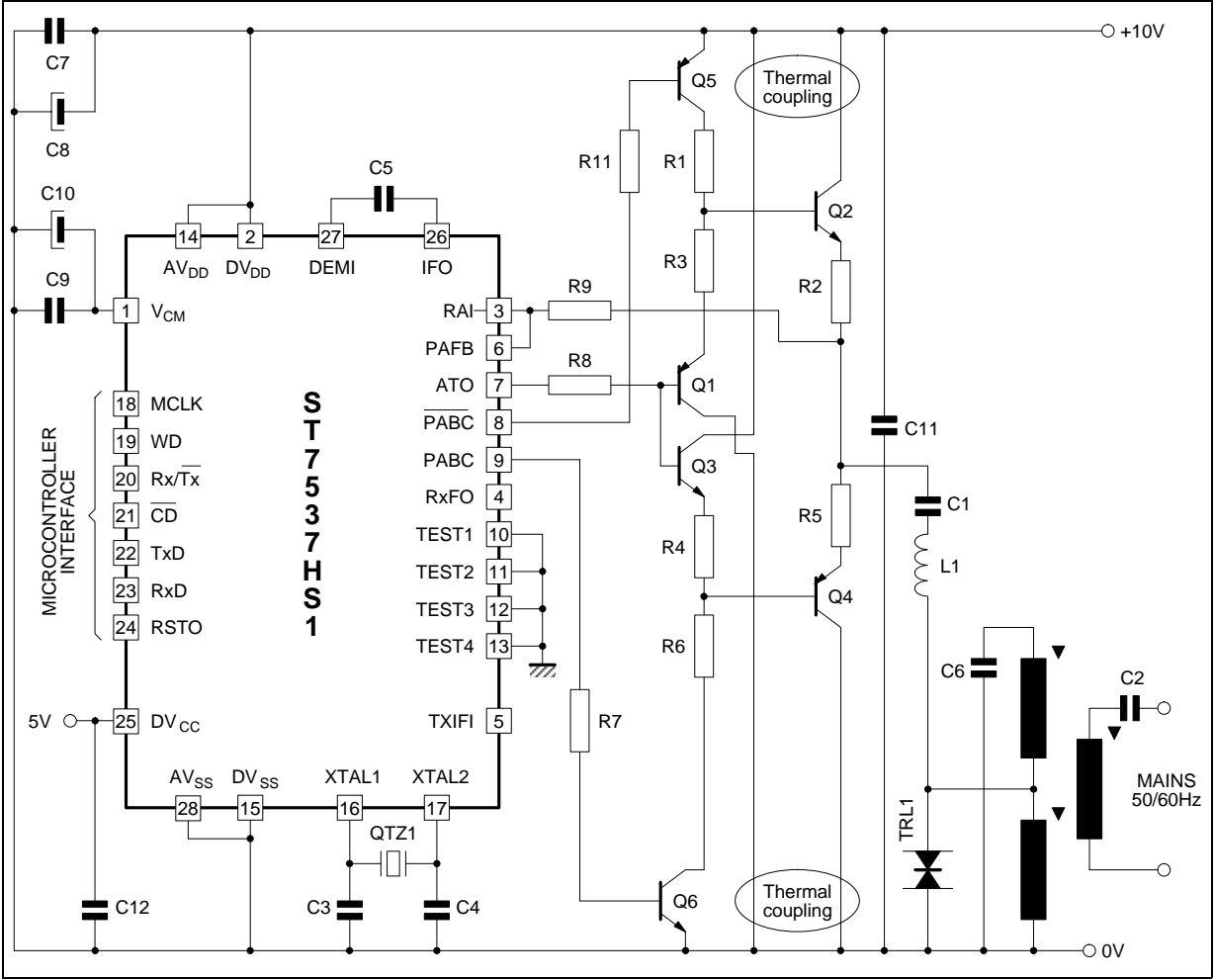
APPLICATION SCHEMATIC INFORMATIONS

| RESISTORS | | | CAPACITORS | | | |
|--|------|--------|--------------------------------------|-------|-----|------------------|
| R1 | 180Ω | | C1 | 1μF | | Ceramic 50 |
| R2 | 2.2Ω | | C2 | 470nF | | Paper, class X2 |
| R3 | 2.2Ω | | C3 (2) | 22pF | 10% | Ceramic 10V |
| R4 | 2.2Ω | | C4 (2) | 22pF | 10% | Ceramic 10V |
| R5 | 2.2Ω | | C5 | 100nF | 10% | Ceramic 10V |
| R6 | 180Ω | | C6 | 6.8nF | 5% | Plastic Film 50V |
| R7 | 47kΩ | | C7 | 100nF | | Ceramic 10V |
| R8 | 1kΩ | | C8 | 2.2μF | | |
| R9 | 1kΩ | 5% | C9 | 100nF | | Ceramic 10V |
| R11 | 47kΩ | | C10 | 2.2μF | | |
| INDUCTOR | | | C11 (1) | 100nF | | Ceramic 10V |
| L1 | 10μH | ≅ 1.5Ω | C12 (1) | 100nF | | Ceramic 10V |
| TRANSISTORS | | | TRANSIL | | | |
| Q1 : 2N2907 Q2 : 2N2222 Q3 : 2N2222 Q4 : 2N2907 Q5 : 2N2907 Q6 : 2N2222 | | | TRL1 : SGS-THOMSON P6KE6V8CP | | | |
| | | | TRANSFORMER | | | |
| | | | TR1 : TOKO T1002 N | | | |
| | | | CRYSTAL | | | |
| | | | QTZ1 : 11.0592MHz parallel resonance | | | |

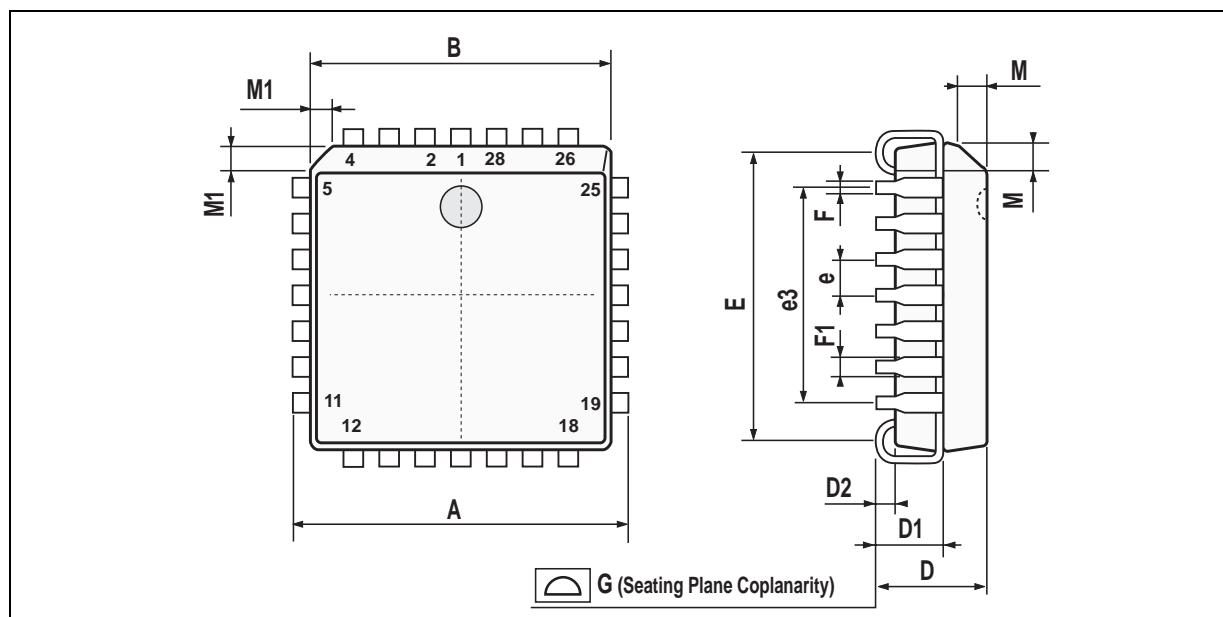
7537H-08.TBL

- Notes :**
- These capacitors might not be necessary if the overall power supplies decoupling is sufficient.
 - The value of these capacitors depends on the crystal parameters.

APPLICATION SCHEMATIC DIAGRAM



PACKAGE MECHANICAL DATA **28 PINS - PLASTIC CHIP CARRIER**



PMPLOC28.EPS

| Dimensions | Millimeters | | | Inches | | |
|------------|-------------|-------|-------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 12.32 | | 12.57 | 0.485 | | 0.495 |
| B | 11.43 | | 11.58 | 0.450 | | 0.456 |
| D | 4.2 | | 4.57 | 0.165 | | 0.180 |
| D1 | 2.29 | | 3.04 | 0.090 | | 0.120 |
| D2 | 0.51 | | | 0.020 | | |
| E | 9.91 | | 10.92 | 0.390 | | 0.430 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 7.62 | | | 0.300 | |
| F | | 0.46 | | | 0.018 | |
| F1 | | 0.71 | | | 0.028 | |
| G | | | 0.101 | | | 0.004 |
| M | | 1.24 | | | 0.049 | |
| M1 | | 1.143 | | | 0.045 | |

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