
M9606

Voice Frequency Modem

General Specifications

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Introduction

Application

M9606 modem is a voice-frequency telegraphy unit (VFT unit) which operates according to the principle of binary frequency shift keying. It is designed especially for Power Industrial applications. Easy interfaces connect to Digital PLCCs, RTUs and PCs. However it can also be connected to other data terminal equipments because it operates at the interfaces like a universal FSK-modem in the voice-band range (300-3400 Hz) according to CCITT.

M9606 Modems utilize TI's 32bits DSP with the advantages of high integrate, high performance, small size and low power consumption. It offers maximum reliability and flexibility connection for RTUs based on digital PLCC, fiber or microwave analog channels.

Key Features

M9606 modem is compatible to 5C's M9601 modem and gives more features which are highlighted with **blue words**.

- Central Carrier Frequency: 300Hz~4 kHz, Bandwidth: 120Hz~3.6KHz, user-programmable in steps of 1 Hz or setting according to CCITT R.35/R.37/R.38A/V.23. **The high selective (90dB) digital channel filters are included.**
- Support the half-duplex / full-duplex, **two-wire** / four-wire communications
- Data Interface: Synchronization/ Asynchronous RS-232
- Signal rate: 50 baud up to **2400baud** user-programmable (24 channels 50 baud, 12 channels 100 baud, 6 channels 200 baud, 2 channels 600 baud, 1 channel 1200 baud, 1 channel **2400 baud**).
- **Photo-diode isolators with DCE and transfer isolator with transmission lines. TVS diodes & Ferrite Beads provide additional protection against over-voltages, ground potential rise and ground loops beyond standard requirements in the harsh substation environment. According to IEC 61000-4-2/3/4/5.**
- **A signal quality level (SQL) LED displays modem receiving isochronous distortion.**
- **Offers an adjustable pre-distortion. It can be set in high-pass or low-pass between 0 and 10 dB.**
- M9606 modem can be connected to PC through RS232. It features a very user-friendly software management utility. All essential settings like channel, gain, line operation mode, line termination, transmission rate etc. are configured by management software.
- Power supply: Single +5 VDC.

The mechanical layout of M9606 Modem is 3inch (L) x 1.8inch (W) x 0.6inch (H). It is a daughter board mounted on a simple mother board with dual row 24 pins header. **M9606 is a**

full function modem. The mother board is just composed of the custom required dimension and connectors, not any other components are required.

In M9606 Modem, a DSP is responsible for the conversion of the binary information into the voice band and vice versa. Its high processing capacity allows beside others a high selective channel filtering (90 dB) and thereby an unrestricted channel assignment.

The channels can be assigned in the CCITT raster. Transmitter and receiver can be configured to different baud rates for transfer rates of up to 600 Bit/s. If all channels should be used in any combination and baud rate, the high channel selectivity is to configure. The normal selectivity can be used at separate assignment of transmit- and receive-channels (block configuration) and at least one channel distance between the blocks. A lower transfer time and isochronous distortion is given at normal selectivity. The M9606 modem can monitor the receiving signal for isochronous distortion and indicate by the “signal quality level (SQL)”-alarm a repeated (10x) limit exceeding (40% resp. 50%). The LED SQL indicates for at least four seconds, at greater interferences accordingly longer, the exceeding of the maximum distortion.

The audio-frequency carrier is monitored and indicated respectively alarmed by the DCD signal. The alarm signal of the modem responses at carrier drop-out (DCD direct or delayed), at SQL alarm, or at supply voltage failure. It can be output to drive an external alarm relay.

To compensate line distortion on critical transmission links the M9606 modem offers the possibility of an adjustable pre-distortion. Depending on the quality condition of the transmission link this pre-distortion can be set in high-pass or low-pass between 0 and 10 dB. The two M9606 modems of a transmission link can be configured for test-transmitter and test-receiver to adjust the correct pre-distortion. The utilized result of the transmitted test pattern indicates the LED EQZ. The flash frequency of the LED EQZ is a degree for the achieved improvement.

The M9606 modem allows connecting up to three transmission lines star-coupled as point-to-point link without repeater. The transmitter output circuit operates hereby as constant current source.

Technical data

Modulation

| | |
|--------------------|---|
| Type | Frequency shift keying (FSK) for point-to-point or multi-drop network |
| Operation modes | 4-wire or 2-wire, full duplex operation. |
| Channel assignment | According to CCITT raster |
| Channel assignment | According to CCITT raster. Or from 600Hz to 4KHz, user-programmable in steps of 1 Hz |

Serial interface to DTE

| | |
|-------------------|--|
| Signal definition | V.24 / V.28 |
| Signal lines | TxD D1 / 103 RxD C2 / 104 RTS S2 / 105 CTS M2 / 106 DCD M5 / 109 |

Interface to transmission line

| | |
|--------------------------------|---|
| Input /Output impedance | 600 ohms |
| Transmission level | -30 dBm to 0 dBm, user-programmable in steps of 0.1dB |
| Receive level | -58dBm to 0 dBm |
| Transmitter pre-distortion | In high- / or low-pass 0 ... 10 dB |
| Receiver filter characteristic | 90dB |

Signal quality level monitor

| | |
|------------------------------------|---|
| Threshold | 20% isochronous distortion |
| SQL | Shown by software and LED |
| DCD alarm at half duplex operation | if the carrier is lost for minimum n seconds (depends on baud rate): 50 baud 16 sec 100 baud 8 sec 200 baud 4 sec 600 ... 2400 bd 2 sec |

Power Supply

| | |
|---------------|--------|
| Voltage | +5VDC |
| Current | <200mA |
| Alarm contact | |

Mechanical layout

| | |
|-----------------|---|
| Dimensions | 3inch(L) x 1.8inch (W) x 0.6inch(H) |
| Mounting | daughter board |
| Connecting type | 0.1inch pitch dual row header (12*2 pins) |

Environmental conditions

| | |
|---|--------------------------------|
| Nominal operating temperature range: EN 60068-2-1, -2-2, -2-14 | 0 °C... 70 °C |
| Relative humidity EN 60068-2-30 | 5 ... 95 % (non condensing) |

Data table

| | |
|-----------------|--|
| Data format | serial, binary, asynchronous |
| Traffic mode | Point to Poit, multidrop |
| Modulation type | Frequency shift keying (FSK) with carrierswitch-off for multidrop networks |

| CCITT channel | R.35 | R.37 | R.38A | 600Bd | V.23 | 2400 Bd |
|--|-------|-------|-------|-------|-------|---------|
| Bit rate nominal (Baud) | 50 | 100 | 200 | 600 | 1200 | 2400 |
| Minimum channel distance (Hz) | 120 | 240 | 480 | 1440 | | |
| Mid-frequency lowest (Hz) | 420 | 480 | 600 | 1320 | 1700 | 2000 |
| Mid-frequency highest (Hz) | 3180 | 3120 | 3000 | 2760 | 1700 | 2000 |
| Frequency deviation (Hz) | ± 30 | ± 60 | ± 120 | ± 210 | ± 400 | ± 500 |
| Number of channels according to CCITT | 24 | 12 | 6 | 2 | 1 | 1 |
| Transmitter level according to CCITT (dBm) | -22.5 | -19.5 | -16.5 | -12 | -8.7 | -6 |
| Minimum receiving (dBm) | -53 | -53 | -52 | -51 | -55 | -46 |
| Channel transfer time (ms) | 43 | 26 | 15 | 6 | 3 | 3 |
| Isochronous distortion | <5% | <5% | <5% | <7% | <10% | <20% |
| Channel delay time | <60 | <30 | <18 | <8 | <6 | <6 |

| | | | | | | |
|--|-----|-----|-----|----|----|----|
| RTS = ON to DCD = ON (ms) | | | | | | |
| Channel delay time RTS = OFF to DCD = OFF (ms) | <10 | <10 | <10 | <5 | <5 | <5 |
| | | | | | | |
| | | | | | | |

Table 1. Technical data

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M9606 Module Hardware



Figure 1. The Management software

M9606 size: 3inch(L) x 1.8inch (W) x 0.6inch(H)

M9606 module embedded photo-isolator for RD232 port and TVS diode protection for both data and carrier terminals.

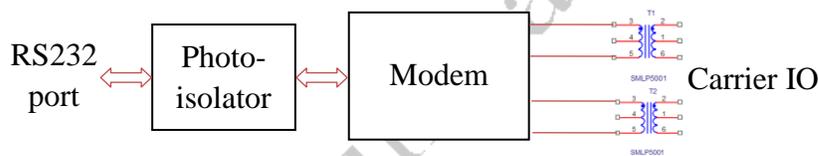


Figure 2. M9606 Block Figure

Power Supply

- Main power: +5V, <200mA
- The RS232 port: +5V, <20mA. The RS232 port power can be optionally supplied independently or simply connected to main power.

Module Connectors

M9606 module could be installed on any mother board user defined with two connector, each connector is 2rows 12*2.54mm pins.

The description of two connector (J1 & J2) are listed in following tables

| Pin No | I/O | Description |
|--------|-----|------------------|
| 1,2 | In | Carrier input + |
| 3,4 | In | Carrier input -. |



| | | |
|-------|-------|--|
| | | Note: 1,2 & 3,4 are used for Carrier IO when 2 wire mode is used |
| 5,6 | Out | Carrier output + |
| 7,8 | Out | Carrier output - |
| 9~14 | | NC |
| 15 | Power | +5V power for RS232 port |
| 16,19 | GND | RS232 port ground. |
| 17,18 | In | TxD D1 / 103 |
| 20 | In | RTS S2 / 105 |
| 21 | Out | CTS M2 / 106 |
| 22 | Out | DCD M5 / 109 |
| 23,24 | Out | RxD C2 / 104 |
| | | |

Table 2. M9606 connector (J1) Pin description

| Pin No | I/O | Description |
|---------------|--------------|---|
| 3,4,11,12 | GND | Modem Ground |
| 21,22 | Power Supply | +5V. Modem Power Supply. |
| 13 | Out | 3.3V output. I _{max} = 20mA |
| 15 | In | Used by manufacture. It should be high for normal operation. So connect it with Pin13. |
| 10,14 | In | Used by manufacture. It should be connected to ground for normal operation. |
| 16,17,18 | In | Used by manufacture. Keep them no connection for normal operation. |
| 1,2,5,6,7,8,9 | IO | General IO. TBD They can drive LED directly or a PLD for extension functions. This is dependent on mother board that M9606 is installed on. See the documents for verity of M9606 mother boards. |
| | | |
| | | |
| | | |
| | | |

Table 3. M9606 connector (J2) Pin description

Two-wire or four-wire line

The M9606 modem features a separate line interface for the transmitter and receiver. For the two-wire mode, short the jumper J2 on the bottom of M9606 module and set the “application Mode” as 1 by management software.

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Commissioning

Transmitter predistortion

Setting a transmitter predistortion to compensate for linear channel distortion on poor quality transmission lines. In this case, the level is lowered at the high or low key frequency, so that a difference in the levels between the two key frequencies of 0 dB to max.10 dB occurs. This drop means that linear channel distortion can be compensated for.

The transmitter predistortion has the greatest effect at the higher bit rates because at low bit rates the impact of the channel distortion is low.

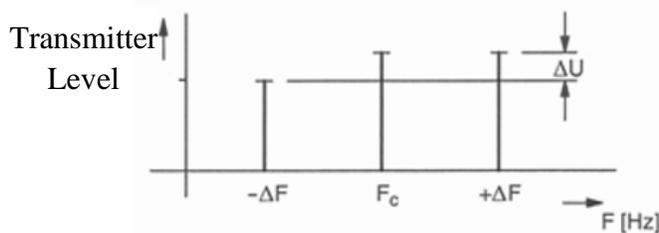


Figure 1: Transmitter predistortion

The predistortion has either a high-pass or lowpass characteristic, depending on which key frequency is influenced.

- Normal $U_{-\Delta F} = U_{+\Delta F}$
- High-pass $U_{-\Delta F} > U_{+\Delta F}$
- Low-pass $U_{-\Delta F} < U_{+\Delta F}$

It is necessary to determine which key frequency should be lowered and by what extent.

To do this, the two M9606 modems can be configured as test transmitter and test receiver.

Determining the transmitter predistortion

Build a communication through object transmissions line for both M9606. Connect the RS232 port of one side of M9606 to PC. Run management software. Set “PN Code Test” as 4 and Switch the M9606 to PN code testing mode. Check the value of Rx.SQL. If it is too large (20, 25 or more), Set transmitter predistortion from 0 to +/-1, +/-2..., make Rx.SQL as low as possible.

Quality check

The M9606 modem allows the received signal to be monitored for isochronous distortion during operation and indicate by the signal quality level (SQL).

If the management software is connected with modem, you can read SQL in status windows. The second method to read SQL without PC is based on SQL LED. There are two colors LED to show SQL information. When LED is solid RED, it means SQL reach the alarm value. The SQL alarm threshold can be set by management software (See modem configuration please).

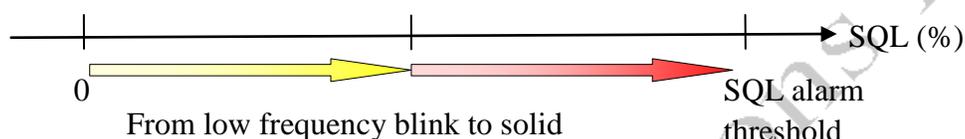


Figure 1: SQL LED status indicates SQL value.

Error bit rate testing

A pair of PN Code Generator and Tester embedded in M9606 module for on-line Error Bit Rate testing. They supports 2^9-1 (511), $2^{15}-1$ and $2^{23}-1$ PN code test.

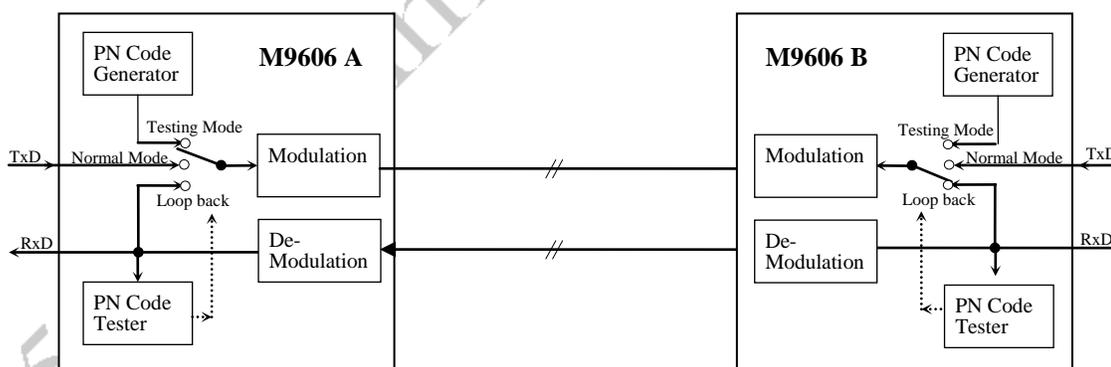


Figure 1: Error Bit Rate testing

The M9606 modulation input switch condition

- **Testing Mode:** Set parameter “PN Code Test” with non-zero by management software.
- **Normal Mode:** Clear “PN Code Test” with 0
- **Loop back:** When modem is under normal mode (PN Code Test=0) and PN Code Tester assign the receive data is $2^{23}-1$ PN Code, it auto switch to loop receive data back to modulation.

Testing steps:

Any side of M9606 can test error bit rate without other side human operation.

When M9606 A is connected with management software, shown as above figure, set M9606 A “PN Code Test” as 4, then it transmit $2^{23}-1$ PN code to M9606 B. The PN Code Test in M9606 B assign the receive data is $2^{23}-1$ PN Code, it auto loop back the data to transmitter. Then Tester of M9606 A can test error bit rate during the transmission line and show the result in status window.

Some M9606 mother boards with a test button and LEDs on front panel support a simpler bit error testing without PC. Push and hold the test button for seconds on M0606 A, then it enter $2^{23}-1$ PN code testing mode. Another side M9606 B will auto loopback the data to its transmitter. You can select the testing duration by test button hold time. If the hold time is n seconds, the testing duration is n minutes.

Under PN testing mode, the TxD, RxD, RTS and CTS LEDs are temporally used to show test status.

- The TxD LED will flash per second to show modem enter the testing mode. If M9606 A received the loopback data correctly,
- RxD LED will also flash per second.
- Each received bit error will make CTS LED flash.
- Any bit error in testing duration will make RTS LED solid light.

After the testing duration passed, everything will recover to normal mode for both sides.

Note that SQL LEDs during testing still keep original functions. It is also important to check transmission quality.

M9606 Management Software

The M9606 Modem features a very user-friendly Human Machine Interface software utility which uses the Microsoft Windows operating system. It provides the collection of operational status information and configuration for the modem.

The connection for management software

The serial data communication and management software use same RS232 port on M9606 module. The modem can distinguish them automatically by baud rate. The management software use 115.2kbps to connect with modem and the regular serial data baud rates are lower than 10kbps. When configure and test modem through RS232 port, the regular serial communication will be broken. After the modem is installed, you generally configure and test it through testing cable until the data channel is built well. Remove testing cable finally. And the modem will switch to normal transmission. The LEDs on the panel continue to show the operational status of Modem.

Management software

The name of management software is “M9606.exe”, which can run under the following operate system.

- Win8
- Win7
- WinXP

The icon of management software “M9606.exe” is . After run this program, the following window appears.



Figure 3. The Management software

Each M9606 has its unique product ID. The management software can automatically communicate with the connected Modems, and list all of their IDs.

The software menu includes “monitor”, “system setup”, “Windows”, and “about”. You can select the language by the menu “language” under “windows”. The menu “about” is for the software version.

The initial file for management software and configuration files for Modems

The initial file for management software is used to the definition of port number & baud rate of RS232 port, the name, unit, grid and limitation of Modem parameters. The parameter name will be shown in the dialog windows of management software. They are supported by multi-languages.

Each M9606 has its configuration file named as “ID of modem.cfg”. This file records the modem’s configuration. The M9606 can be setup easily with its configuration file, and the total configuration of a Modem can be saved to its configuration file for backup.

All of the management initial file and the M9606 configuration files are under the direction “m9606\Data\”. The documents are managed automatically by “M9606.exe”. However, all of the initial and configuration files are text style and can be read and written easily.

The status monitor for M9606

Click the menu “Monitor”, the following dialog will appear.

The left table shows the name list of MODEMS which are connected currently. If the table does not list all of PLCs connected, click key “Fresh” to refresh the name list.

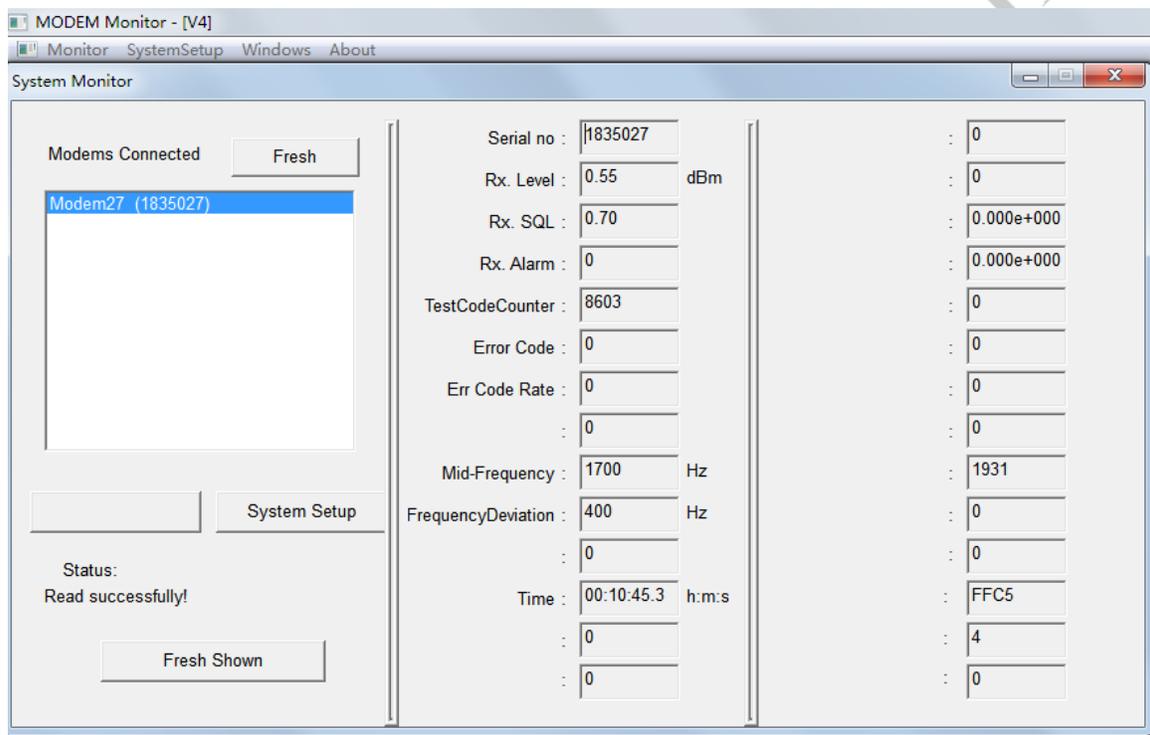


Figure 4. The status monitor dialog window

Click the Modem ID, its status variables are shown in the right part of dialog window. The management software refreshes the data automatically per second.

The descriptions of status variables are listed here:

| Variable Name | Range | Unit | Description |
|---------------|--------|------|--|
| Serial No. | | | The number is unique for each M9606 module |
| Rx. level | +3~-15 | dBm | Modem receive level. Default value: -30dB |

| | | | |
|---|----------------|------|---|
| Rx. SQL | 0~50 | % | <p>The M9606 modem can monitor the receiving signal for isochronous distortion and indicate by the "signal quality level (SQL)".</p> <p>Default value: 20%</p> <p>Note: when the data is equal to "1" for long time, the modem cannot get any test result for isochronous distortion. Then RX. SQL = 0 is shown. For real transmission, isochronous distortion = 0 is impossible, so SQL = 0 just means "No test result". Generally, 0<SQL<3 means "perfect transmission".</p> |
| Rx. Alarm | 0, 1, 10 or 11 | dBm | <p>There are 2 bits for receiver alarm. The first bit = 1 means that Rx. SQL is over SQL alarm threshold</p> <p>The second bit = 1 means the receive signal level is lower than Rx. alarm level.</p> <p>Note: the SQL alarm threshold and RX. Alarm level can be set in setup window (See configuration please).</p> |
| <p>Testing status</p> <p>The following 3 variables are for Pseudo-random Noise (PN) Code Test. M9606 Modem includes a PN code generator and tester. When M9606 enter testing mode, the error code rate can be shown to determine transmission quality.</p> | | | |
| TestCodeCounter | 0~ | bits | The received PN code number. |
| Error Code | 0~ | bits | The received error code |
| Error Rate | | % | = ErrorCode/TestCodeCounter*100 |

Table 4. The description of M9606 status variables

M9606 Configuration

Click the menu "System Setup", the following dialog will appear.

The left table shows the Modem ID which are connected currently. If the table does not list all of PLCs connected, click key “Fresh” to refresh the name list.

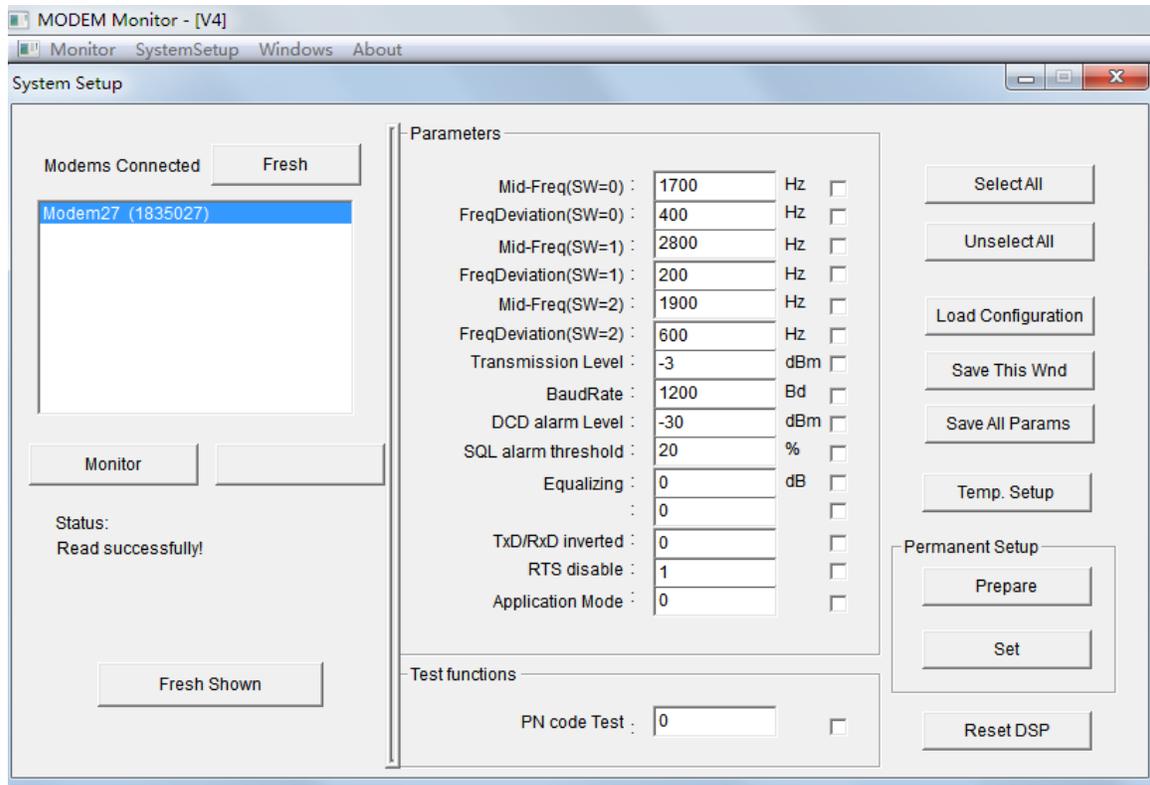


Figure 5. The Dialog for System Setup

The dialog functions are listed below:

- Click the Modem ID and press the key “Fresh Shown”, the configuration parameters of Modem are displayed in the right part of dialog.
- Click the key “Save All Param”, all of parameters and status variable will be read from the Modem and saved to the file “ID of modem.cfg”. It is recommend that save the files after Modems are installed in field for recording.
- Users can use the configuration file saved before to setup or recover Modem module. To click the key “load configure”, the parameters are read and shown in the setup dialog.
- Modem can be setup by two methods, the temporary setup and permanent setup. The temporary setup will be invalid after reset DSP. The permanent setup is always valid even if the power is off.

The setup should be done as the following steps:

1. Select the parameters that you wish to be edited. All parameters are selected if click the key “Select all”;
2. Click the key “temp setup”.

3. If wish to setup permanently, continue click the key “Prepare” in the frame “Permanent Setup”, then the key “Set”; click the key “Reset DSP” finally, PLC will run again as the new parameters.
4. Click the key “Fresh shown”, you can confirm if the new configuration parameters are updated in M9606.

The description of M9606 configuration parameters.

| The name of parameter | Range | Unit | Description |
|--------------------------------|-------------|------|---|
| Mid-Freq (SW=0,1 or 2) | 100~3900 | Hz | There are three sets of Middle-Frequency and Frequency-Deviation can be configured in M9606. The address switcher on M9606 module will determine which set of frequency is used for transmission. Switcher on M9606: bit3/bit4 = OFF/OFF, frequency 0 is used bit3/bit4 = ON/OFF, frequency 1 is used bit3/bit4 = OFF/ON, frequency 2 is used |
| FreqDeviation (SW=0,1 or 2) | 30~800 | Hz | |
| Transmission Level | -60~+3 | dBm | The output carrier level of Modem. Step as 0.1dBm |
| BaudRate | 50~2400 | bps | The transmission data baud rate. |
| DCD alarm level | -20~-60 | dBm | When the receiver level of Modem is lower than DCD alarm level, the DCD alarm will assigned. Default value: -30dBm |
| SQL alarm threshold | 10~40 | % | When the receiver isochronous distortion is higher than SQL alarm threshold, the SQL alarm will assigned. DCD or SQL alarms will make alarm output through alarm relay. If you wish disable SQL alarm, you can set “SQL alarm threshold”=100. |
| Tx. Predistortion | -10~10 | dB | When the transmission line is high frequency distortion and makes SQL higher than 20, try to set transmitter predistortion from -10 to 10, make SQL as low as possible. |
| TxD/RxD inverted | 00,01,10,11 | | Two bits, the first is for TX and the second for RX 0: CCITT standard definition. Character |

| | | | |
|------------------|-----------|--|--|
| | | | zero position = MARK = 1 = -12Volt 1: Character zero position = SPACE = 0 = +12Volt |
| RTS Disable | 0,1 | | 0: Enable RTS signal, which means to support half duplex for star communications. 1: Disable RTS signal input and the carrier of modem always is "ON", which is for point to point communications. |
| Application Mode | 0,1,2,3 | | 0: independent voice modem, four-wire line connection. 1: independent voice modem, two-wire line connection. 2: the modem module installed in 5C UPLC-100 GI mother board. 3: the modem module installed in 5C APLC-3 GI mother board. |
| PN Code Test | 0,1,2,3,4 | | 0: Normal transmission mode. Non-zero: The M9606 Modem enter testing mode. The input serial data (TxD) will be cut and a internal PN code stream will be modulated and output. In testing mode, the output carrier should be remote loop back. The receiver will compare the received code with transmitter code. The error code will be counter and error bit rate will be shown. 1: Two bits "zero" and one bit "one" (2:1) period signal. 2: 511 (2 ⁹ -1) PN code testing 3: 2 ¹⁵ -1 PN code testing 4: 2 ²³ -1 PN code testing |

Table 5. The description of M9606 configure parameters