QV381m0 –Record/Playback Module

User's Manual

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Features

- **Totally dynamic message recording allowing messages to be of variable length.**
- **Intelligent message allocation recording and playback algorithm**
- **255 discrete message capacity**
- **Individual message erase function**
- **Digital volume control - 8 discrete steps**
- **User selectable sampling rate 4.0 kHz, 5.3 kHz, 6.4 kHz, 8.0 kHz**
- **Serial interface -simple RS232 (TXD & RXD)**
- **Controlled using simple 2 byte commands**
- **User controllable /PWR and AUX outputs to control external amplifiers.**
- **Sleep function for very low power applications**

General Description

The QV381m0 is the latest in a family of speech recording and playback modules designed to complement the existing range of Quadravox speech products.

The QV381m0 module employs a sophisticated micro-controller running a dynamic message allocation algorithm, which in-conjunction with the ISD 5008 device offers the user considerable quality and flexibility.

The module permits messages to be to be recorded at different sampling rates. The sampling rate selected will depend very much on the desired quality of the sound being reproduced and also the length of the required message/messages. The sampling rate can be varied from message to message as required. After having selected a suitable sampling rate the user can record, playback and erase individual messages on command.

The user can select a unique message number to record in the range 1-255, which can be of any length within the limits of the ISD total storage capacity; e.g. one long message or hundreds of short messages, which fill the device to capacity.

The user has the ability to remotely control the playback volume and also has control over an external amplifier (if required) via the /PWR and AUX pins. For battery powered applications the module can be put into a sleep mode to conserve power.

QV381m0 command set

Command	Description
234 (0xea)	Query module identification
235 (0xeb)	Query current volume level
236 (0xec)	Query current sampling rate
237 (0xed)	Query next available message number
238 (0xee)	Query number of clusters available
239 (0xef)	Query duration of recorded message
240 (0xf0)	Play to speaker
241 (0xf1)	Play to auxiliary output
244 (0xf4)	Record from microphone
245 (0xf5)	Record from auxiliary input
246 (0xf6)	Toggle /PWR pin
247 (0xf7)	Toggle AUX pin
249 (0xf9)	Set sampling rate
250 (0xfa)	Sleep mode
251 (0xfb)	Erase message
252 (0xfc)	Set volume
253 (0xfd)	Format device
230 (0xe6)	Stop playback or record

Error/ Response Codes	
220 (0xdc)	Invalid number
221 (0xdd)	Message number does not exist
222 (0xde)	Message number to record already exists
223 (0xdf)	No free message numbers
224 (0xe0)	ISD device is full; no free clusters
254 (0xfe)	OK –Confirmation

The table above lists all the command and error/response codes that are required to control the module and correctly interpret its response. All commands sent to the module consist of two bytes. The first byte send will always be one of the above commands. The value of the second byte sent will depend on the command. The function of each of these commands will be described in detail below.

The following examples assume that a PC (Personal computer) is being used to control the module.

If an LED is connected to the /LED output of the module it will illuminate for the duration that a task is being carried out. The /BUSY line on the module will also go low for the duration that it is carrying out a task and is unable to respond to serial commands. For commands of very short duration the LED will only 'flicker'.

Formatting the module

Before the module can be used to record messages, it must first be formatted by sending the following two bytes: -

First Byte   **Second Byte**

253 (0xfd)   **don't care**

The module will send the **OK** code **(254 - 0xfe)** back to the PC to confirm the function has been completed.

The /Busy and /LED lines will go low for the duration of this command.

Setting the sampling rate

Sampling Rate (kHz)	Duration (minutes)
8.0	4
6.4	5
5.3	6
4.0	8

The table above shows the range of possible sampling rates. The choice of sampling rate will depend on the desired quality of recording and playback and also the required recording duration; e.g. a higher sampling rate will produce a more faithful reproduction of the original sound but will reduce the available recording time accordingly.

To alter the sampling rate the following two-bytes must be sent to the module:

First Byte	*Second Byte*
249 (0xf9)	**n**

Where n = 0 = 8.0 kHz
**   1 = 6.4 kHz**
**   2 = 5.3 kHz**
**   3 = 4.0 kHz**

Once the module has received the packet it will send either the code **254 (0xfe)** 'OK' back to the PC, acknowledging the change of sampling rate or the code **220 (0xdc)** 'Invalid Number', signifying the value of the requested sampling rate is out of range. If the requested sampling rate is out of range it will remain at its previous value.

The /Busy and /LED lines will go low for the duration of this command.

Recording a message

The module can record from either a microphone or via its auxiliary audio input. The source of the record is selected by sending the appropriate first command byte.

The recording function has the form:

> ***First Byte***   ***Second Byte***
>
>   **244 (0xf4) -**record from microphone   **n**
> **or   245 (0xf5) -** record from auxiliary audio in

Where n is the message number (which refers to a particular message)
Valid message numbers are 1 to 255 inclusive.

When the module receives the packet, it first determines if it can carry out the recording. The module tests for each of the following conditions. If one of the conditions is true the module will return the appropriate response and leave the record routine.

1) **Message Number To Record Already Exists –**returns **222 (0xde)** to the PC.

2) **No Free Clusters-**returns **224 (0xe0)** to the PC.

3) **No Message Numbers Available –**returns **223 (0xdf)** to the PC.

4) **Invalid Number** –returns **220 (0xdc)** to the PC.

As soon as the module is ready to record it will send code **254 (0xfe)** 'OK', to the PC. The PC should then commence playback of the audio file to be stored in the ISD device. The recording can be stopped at any time by sending the code **230 (0xe6)** 'Stop' to the module. When the module receives the code **230 (0xe6)** 'Stop' it will confirm that it has stopped recording by sending the code **254 (0xfe)** 'OK' back to the host PC.

If the module is not stopped whilst recording it will fill the ISD device to capacity and stop the recording function itself. Should this stage be reached, the module will send the code **224 (0xe0)** 'No Free Clusters' to the PC.
 After having reached the stage where the ISD device is full, any future attempts to record other messages will result in the module sending the code **224 (0xe0)** 'No Free Clusters' to the PC.

The /Busy and /LED lines will go low for the duration of this command.

Playing a message

The module can playback messages to either a speaker or to its auxiliary audio output. The destination of the playback is chosen by selecting the appropriate command byte, as shown below.

The playback function has the form:

	First Byte	*Second Byte*
	240 (0xf0) play to speaker	n
or	241 (0xf1) play to auxiliary audio output	

Where n = the message number (which refers to a particular message)

Valid message numbers are 1 to 255 inclusive.

When the module receives the packet, it determines if it can proceed with playback.

The module tests to see if any of the following conditions are true. In the event that one of them is found to be true, the module returns the appropriate response and leaves the playback routine.

1) **Message Number Does Not Exist-** returns **221 (0xdd)** to the PC.

2) **Invalid Number-** returns **220 (0xdc)** to the host PC.

If the requested message to playback does exist the module will send code
254 (0xfe) 'OK' to the host PC, to acknowledge that playback will start.

At any time playback can be stopped by the host PC, by sending code
230 (0xe6) 'Stop'.

The module will then stop playback and send code **254 (0xfe)** 'OK' back to the PC to acknowledge.

If the message is allowed to playback to the end, the module will send code
254 (0xfe) 'OK' to the PC.

The /Busy and /LED lines will go low for the duration of this command.

Erasing a message

To erase a stored message the following two byte packet should be sent to the module:

First Byte   *Second Byte*

251 (0xfb) erase message   **n**

Where n is the message number to erase (1-255) inclusive.

When the module receives the packet it first determines if it can carry out the erase function. The module tests for the following condition. If the condition is true it sends the appropriate response and leaves the erase routine.

1) **Message Number Does not Exist –**returns code **221 (0xdd)** to the PC.

If the message exists the module will carry out the erase cycle and upon completion, send code **254 (0xfe)** 'OK' to the PC.

The /Busy and /LED lines will go low for the duration of this command.

Changing the playback volume

The volume of the playback can be altered by sending the following two-byte packet to the module.

First Byte	*Second Byte*
252 (0xfc) set volume	**n**

Where n has the value 0 to 7   (0<=n<=7).

'n' represents volume attenuation; a value of n=0 will provide the loudest playback, while a value of n=7 will provide the quietest.

If the value of 'n' is outside of the acceptable range, the module will return code **220 (0xdc)** 'Invalid Number'**,** the volume will remain unaltered and the module will leave the set volume routine.

If the requested volume level is in range, the module will adjust the playback volume and then send code **254 (0xfe)** 'OK' to the host PC to confirm the request.

The /Busy and /LED lines will go low for the duration of this command.

External control lines

Two digital control lines are provided, to allow the user to control external equipment, e.g. an amplifier.

These lines are /PWR -which is active low and AUX -which is active high. (NB. The AUX line has nothing to do with the auxiliary audio output or input; it is a digital output line.)

The user can toggle the control lines by sending the following two byte packets.

First Byte	*Second Byte*
246 (0xf6) toggle /PWR line	**don't care**

First Byte	*Second Byte*
247 (0xf7) toggle AUX line	**don't care**

The /Busy and /LED lines will go low for the duration of this command.

Putting the module to sleep

For battery powered applications, the module can be put to **SLEEP** by sending the following two-byte packet.

First Byte	*Second Byte*
250 (0xfa) go to sleep	**don't care**

Having been powered down the module will not respond to commands over the serial link.

The /BUSY and /LED lines will go low for the duration of the command, Signifying the ISD device has been powered down. The microcontroller will then shut down. At this point the /BUSY and /LED lines will be inactive.

In order to wake up the module, its /Reset line must be toggled low-high. The module will them power up and be ready to respond to serial commands.

Query module identification

The Identity of the module can be verified by sending the following two-byte packet.

First Byte   **Second Byte**

234 (0xea) Query identity   **don't care**

The module will send two bytes back to the PC in response.

 The first byte returned is the ------ *module series number* - 38
 The second byte returned is the ---*software revision number -* 00

NB: The software revision number may vary.

The /Busy and /LED lines will go low for the duration of this command.

Query the current volume level

The module can be requested to return the current volume setting without altering its level.

To query the current volume level the PC must send the following two-byte packet.

First Byte	Second Byte
235 (0xeb) Query volume level	don't care

The module will return a single byte, corresponding to the current volume attenuation level. The byte will have a value that lies in the range (0 to 7) decimal.

The /Busy and /LED lines will go low for the duration of this command.

Query the current sampling rate

The module can be requested to return the current sampling rate, without altering its value.

To query the current sampling rate setting, the PC must send the following two-byte packet.

First Byte	*Second Byte*
236 (0xec) Query sampling rate	**don't care**

The module will return a single byte corresponding to the current sampling rate. The byte will contain one of four possible values, corresponding to the sampling rate as shown below.

80 (0x50) = 8.0 kHz sampling
64 (0x40) = 6.4 kHz sampling
53 (0x35) = 5.3 kHz sampling
40 (0x28) = 4.0 kHz sampling

N.B.
A knowledge of the sampling rate and the number of free clusters makes it possible to determine the amount of recording time remaining.

The /Busy and /LED lines will go low for the duration of this command.

Query the next available message number

Since messages can be given any random number within the range 1 to 255 (inclusive), It is easy to lose track of the next available message number.

The module can be requested to return the next available (unassigned) message number.

To query the next available message number, the PC must send the following two-byte packet.

First Byte   *Second Byte*

237 (0xed) Query next available message number   don't care

The module will return a number in the range 0 to 255 inclusive. A value of zero signifies that there are no free message numbers available. Any other value in the range 1-255 can be used as the next message number.

Example:
If the following messages have been recorded with message numbers as shown below.

Message No 1
Message No 3
Message No 4

The 'query next available message number' command would return 2, signifying that message number 2 is the next free number.

If a new message is then recorded and given the number 2, as shown below;

Message No 2

and the 'query next available message number' command is executed, the module would return 5 as the next free message number that can be used, etc. The module will always return the next lowest free message number available.
N.B. If there are no free message numbers available it is not possible to record any more messages, even if there are free clusters available within the ISD device.
The /Busy and /LED lines will go low for the duration of this command.

Query the number of clusters available

The module records sound in small segments known as clusters.
Each cluster (segment) can hold a fixed duration of audio information. The duration depends on the sampling rate setting.

@8.0 kHz sampling – A single cluster can record 400ms of audio
@6.4 kHz sampling – A single cluster can record 500ms of audio
@5.3 kHz sampling – A single cluster can record 600ms of audio
@4.0 kHz sampling – A single cluster can record 800ms of audio

The lower the sampling rate the longer the amount of recording time per cluster, but at the expense of reduction in the quality of the recorded sound.

There are 600 clusters available to record audio.

The ISD device can record a message with a maximum duration of 8 minutes @ 4.0 kHz sampling rate.

At 4.0 kHz sampling rate each cluster can record 800ms of audio, If all 600 clusters are used then the message will be 600 x 800ms =480s (8 minutes) in duration.

As the sampling rate is changed, so is the amount of audio record time per cluster as shown above. If the number of available clusters are known, along with the sampling rate, the remaining time available to record any new messages can be determined.

The module can be requested to return the number of available clusters by sending the following two-byte packet.

First Byte	*Second Byte*
238 (0xee) number of free clusters available	**don't care**

The module will respond to the request by sending two bytes back to the PC.
The bytes together contain the number of clusters as a 16 bit number.
The module returns the low-byte first followed by the high-byte. The high and low bytes can be combined to form a single 16 bit number as shown below.

number of free clusters = (hi-byte x 256) + low-byte

 The /Busy and /LED lines will go low for the duration of this command.

Query the duration of a recorded message

The module can return the duration of a message previously recorded.

To query the duration of message, The PC must send the following two-byte packet:

First Byte   **_Second Byte_**

239 (0xef) Query duration of recorded message   n

Where n is the message number (1-255 inclusive).

The module will return two bytes corresponding to the duration of the recorded message.

If the duration of a non-existent message is requested, the module will return two zero bytes.

The bytes are returned as low byte followed by hi-byte.

The bytes together form a 16 bit number, which corresponds to the duration of the recorded message in seconds.

The received bytes must be combined and adjusted to give the duration in seconds.

The bytes can be combined and adjusted as follows.

duration (seconds) = ((hi-byte x 256) + low-byte) /100

The /Busy and /LED lines will go low for the duration of this command.

QV381M0 Record/Playback Module
Incorporating the ISD5008 and PIC16F876 Microcontroller.

The QV381M0 incorporates a PIC16F876 microcontroller directly powered from +5V applied to the external connector. The ISD5008 has its own +3V linear regulator, which also derives power from this connector. The microcontroller is clocked at 4Mhz.

The table below describes the function of each pin on the external connector.

Pin Descriptions

Pin No.	Pin Name	Description	Level
1	RXD	RS232 Receive line 5V (See note 1*)	-
2	TXD	RS232 Transmit line 5V (See note 1*)	-
3	/BUSY	Indicates system is busy (See note 2*)	low
4	Mic+	Electret microphone connection + terminal (See Note 3*)	-
5	Mic-	Electret microphone connection – terminal (See Note 3*)	-
6	/RECLED	Active low LED line (See Note 4*)	low
7	+5V	+5V System power (See Note 5*)	+5
8	GND	System ground	0
9	ANA IN	Audio in - line level analogue input for recording (See Note 6*)	-
10	ANA OUT	Audio out put - line level to external amplifier (See note 7*)	-
11	GND	System ground	-
12	/PWR	Active low controllable otput (See Note *8)	low
13	AUX	Active high controllable output (See Note *8)	high
14	/RESET	Active low input, resets the module (See Note 9*)	low
15	SP-	Direct connection to 8ohm speaker (See Note 10*)	-
16	SP+	Direct connection to 8ohm speaker (See Note 10*)	-

Note 1* The module communicates via RS232 serial interface at (9600 Baud, no parity, 1 stop bit), RXD and TXD control lines are 5V level.   The module can be directly plugged into the QV430P programming interface, which incorporates a MAX232 line driver to interface directly to a personal computer.

Note 2* The active low /BUSY output indicates the module is busy performing another task. When active the module will not respond to command requests from the serial interface.

Note 3* The MIC+ and MIC- pins allow the direct connection to an electret microphone.
Typically (2 to 20mVp-p), Input impedance of ISD5008 MIC+/- pins, typically 10Kohm. On board coupling capacitors 100nF.

Note 4* /RECLED – is an active low output from the module. It is connected directly to the PIC16F876 microcontroller. A suitable LED may be connected via a current limiting resistor to 5V, to provide an indication of module activity.

Note 5* The power supply must rise rate must be > 0.05 V/ms to ensure that internal power on reset functions correctly. Power supply +5V nominal, 5.5V Max

Note 6* This pin is capacitively coupled to the ISD5008 Auxiliary input via 100nF capacitor. This input has a nominal level of 250mVp-p.

Note 7* This pin is capacitively coupled to the ISD5008 Auxiliary output pin via 10uF capacitor. It is capable of driving a minimum load of 5Kohm up to a maximum of 1Vp-p.

Note 8* These pins are driven directly from the PIC 16F876 microcontroller.

Note 9* The microcontroller can be reset externally by pulling this pin to 0V for pulse width duration (Low) of 2us min. This pin is pulled up to +5V via a 10Kohm resistor onboard. The microcontroller is ready after 72mS+1024Tosc, where Tosc=250nS, when power is first applied to the module.

Note 10* These pins allow direct connection to an 8ohm loudspeaker. The speaker output is differential and provides a maximum power of 23.5mW RMS. The pins are biased to 1.2VDC. (If a single ended configuration is chosen the pin must be capacitively coupled to the load. The unused pin should be left unconnected.)

Stresses above the maximum level must not be exceeded, please refer to the specific data-sheets for the PIC16F876-04SP and ISD5008P devices for more detailed information.

Electrical Characteristics

PIC16F876 microcontroller

Stresses above these limits may cause permanent damage to the PIC16F876 microcontroller.

Commercial operating temperature range   0deg C to + 70degC

Voltage on Vdd with respect to Vss   -0.3V to 7.5V
Total power dissipation   1W
Maximum current out of Vss pin   300mA
Maximum current out into Vdd pin   250mA
Input clamp current Iik (Vi<0 or Vo >Vdd)   +-20mA
Output clamp current Iok (Vo<0 or Vo>Vdd)   +-20mA

Maximum current sunk by any I/O pin   25mA
Maximum current sourced by any I/O pin   25mA

Supply voltage   max 0 to +5.5V
Supply current   1.6 mA typical   , 4mA Max

ISD 5008 -'ChipCorder'

Stresses above these limits may cause permanent damage to the ISD5008 device.

Commercial operating temperature range   0deg C to + 70degC

Supply voltage (Vcc)   +2.7V to 3.3V
Ground voltage (Vss)   0V
Voltage applied to any pin   (Vss-0.3V) to (Vcc + 0.3V)

General QV381M0 module data

Maximum number of messages		255
Minimum message duration	@ 8.0 kHz sampling rate	400ms
	@ 6.4 kHz sampling rate	500ms
	@ 5.3 kHz sampling rate	600ms
	@ 4.0 kHz sampling rate	800ms