

GPAR12x-DEV

Audio Recorder Development System

(for GPAR12A & GPAR12B recorder modules with v5.04 firmware)

User Guide

DISCLAIMER: The products described in this user guide are supplied in good faith on the basis that appropriate testing will be carried out by the user to verify their suitability. In the event they do not perform as expected, or their use results in injury, loss or damage, RHDC Services Ltd may not be held liable.

AUDIO LEVELS: The GPAR series of audio recorder modules have no internal audio level limiting. Users are advised that even when used with the recommended headphones, incorrectly adjusted gain settings, overloaded input or fault conditions may produce sounds that exceed safe listening levels.

BATTERIES: The GPAR series of audio recorder modules are currently only approved for use with alkaline batteries. If they are to be used with lithium batteries, the user must bear full responsibility for ensuring all necessary safety audits, production control processes and testing are carried out by suitably qualified personnel.

ESD: The GPAR12x audio recorder module supplied with this product should be treated as an ESD sensitive device.

1 Scope

This document describes how to use the GPAR12A-DEV or GPAR12B-DEV development systems which include either the GPAR12A or GPAR12B audio recorder modules respectively. For convenience, either system will henceforth be referred to as the "Development System" or the GPAR12x-DEV.

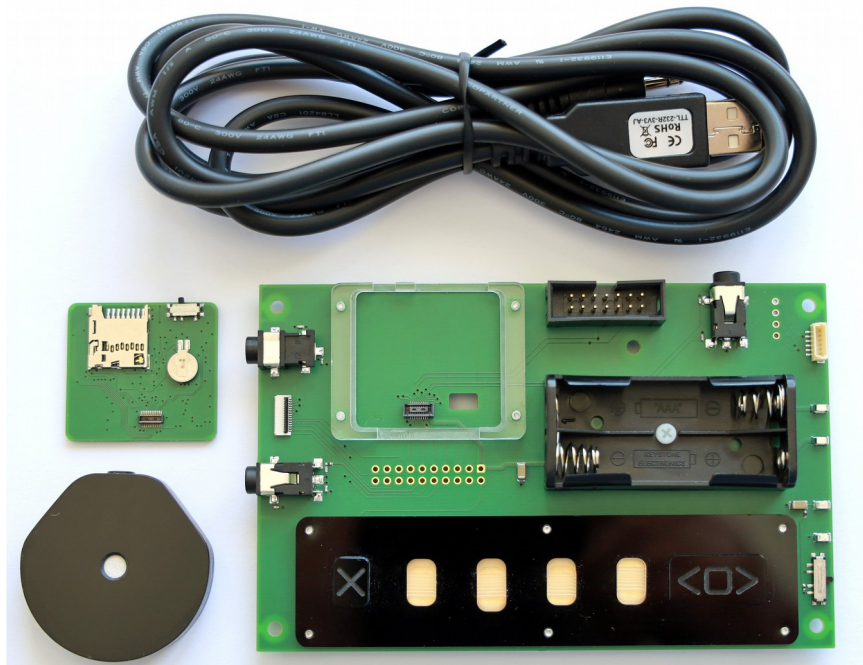


Figure 1. GPAR12x-DEV Audio Recorder Development System (with GPAR12x module)

2 Important Notes

Please read the following important notes before using the development system.

1. Observe ESD precautions when handling the GPAR12x modules or connecting to the GPAR12x-DEV.
2. Support will only be provided when the GPAR12x modules are used with recommended media.
3. Memory cards must be formatted with the REAF filesystem before they can be used for recording.
4. Audio output is calibrated for use with Sennheiser HD 25 professional monitoring headphones.
5. To avoid damage to the connectors, when removing a GPAR12x module from the GPAR12x-DEV, lift using a fingernail under the edge farthest away from the card socket as shown below.

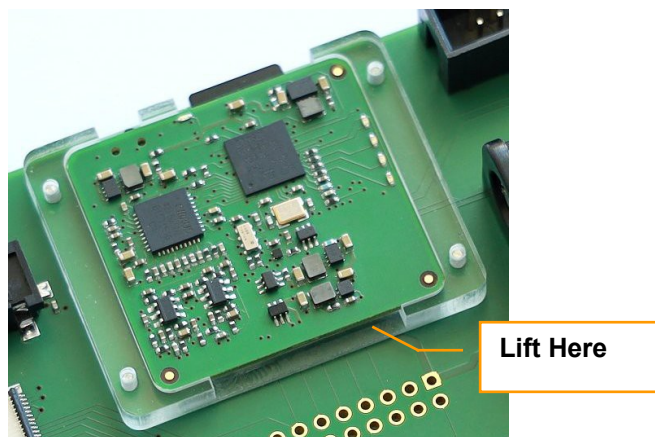


Figure 2. Lift where shown to remove the recorder module from the GPAR12x-DEV board

3 Hardware and Software Requirements

In addition to the GPAR12x-DEV system, this user guide requires the following hardware and software.

1. Windows PC with FTDI Virtual COM Port (VCP) driver from website <http://www.ftdichip.com/>
2. Terminal emulation software such as HyperTerminal or CoolTerm (freeware).
3. 2 x Energizer E91 AA Alkaline batteries or equivalent.
4. Sennheiser HD-25 Professional Monitoring Headphones or equivalent.
5. Recommended Micro SD card such as a Samsung EVO 64GB.

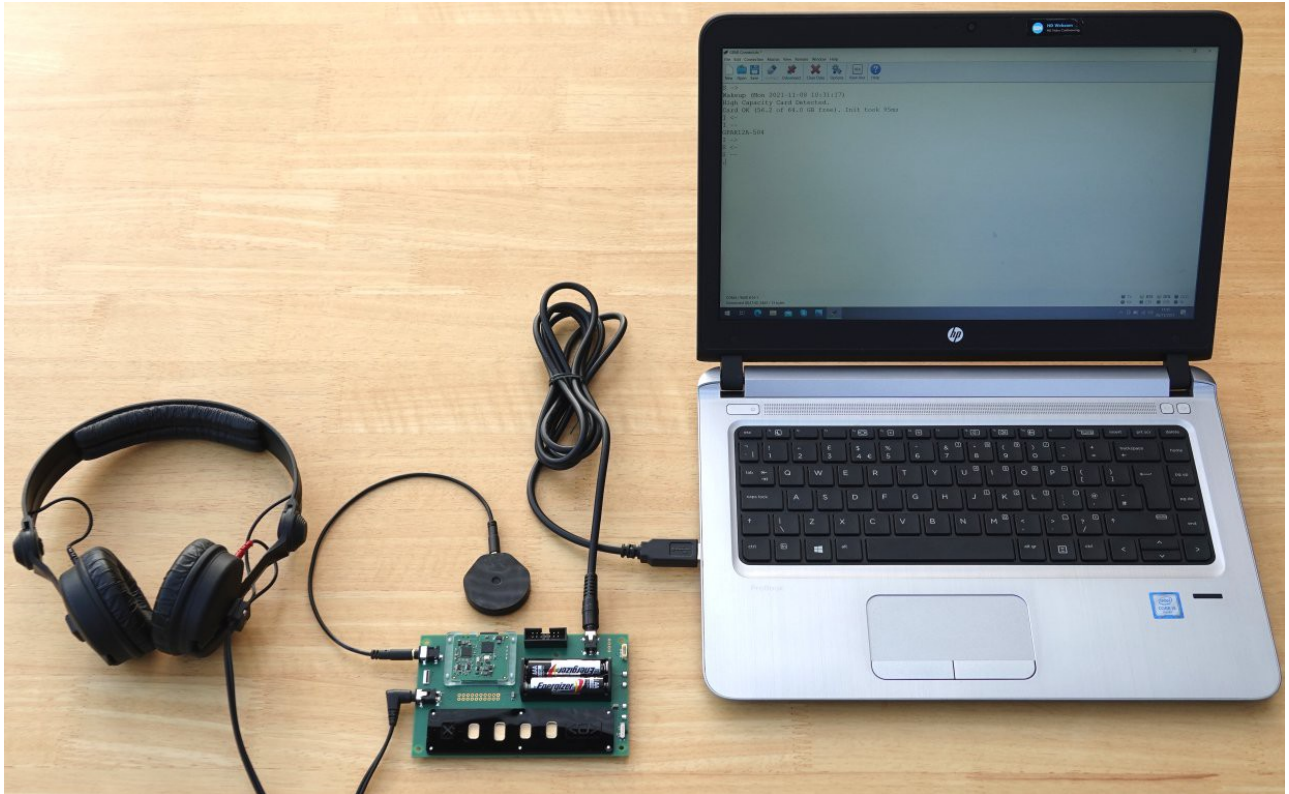


Figure 3. Typical Hardware and Software Setup

3.1 Laptop Supply and Mains-Hum

The TTL-232R-3V3-AJ USB to RS-232 adapters are not galvanically isolated. Depending on the mains filtering arrangement inside the PC's power supply, strong 50Hz mains-hum can be present on the USB ports with respect to Earth which can in turn produce mains-hum at the recorder output. Where possible, the use of a laptop or PC supply that is properly Earthed (i.e. has a 3-pin input connector) will normally ensure there are minimal 50Hz voltages on the USB ports and thus avoid any mains-hum related problems.

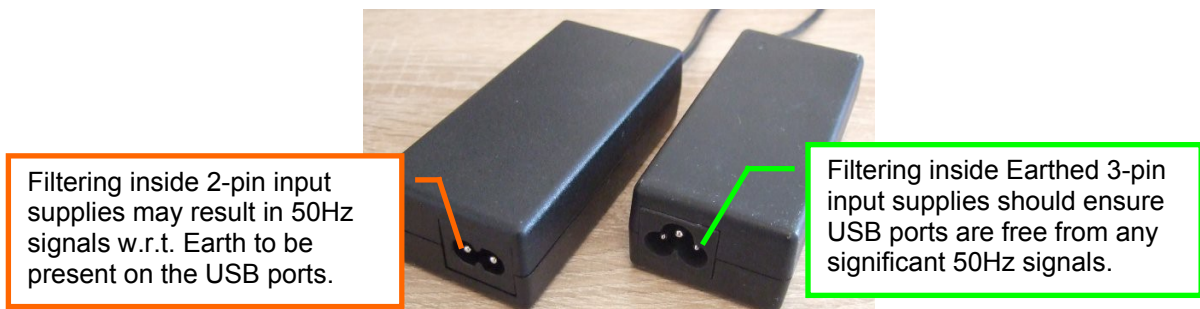


Figure 4. 2-Pin vs 3-Pin Laptop Power Supplies

3.2 Serial Terminal ASCII Setup

Configure the ASCII setup of the terminal emulation software so that line feeds are appended to each incoming line end. If using HyperTerminal, navigate to File -> Properties then select the Settings Tab, check the option as shown below then click OK. Other software should offer a similar option.

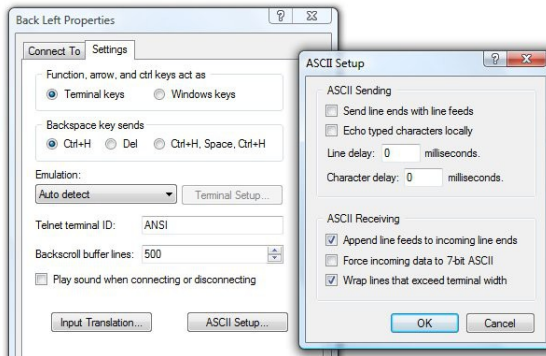


Figure 5. ASCII Setup when using HyperTerminal

4 Preparation

This procedure shows how to prepare the recorder hardware.

1. Insert a recommended Micro SD card into the card socket of the supplied GPAR12x module.
2. Clip the GPAR12x module onto the module holder of the Development System.
3. Set the GPAR12x-DEV switches as shown in the image below.
4. Insert 2 x E91 batteries into the battery holder (module LEDs may flash briefly).
5. Connect the FTDI USB to RS232 cable to the Serial Control Port (top right) of the GPAR12x-DEV.
6. Connect a 1.6V microphone (supplied) to the 3.5mm audio input jack of the GPAR12x-DEV.
7. Connect a pair of headphones to the 3.5mm audio output jack of the GPAR12x-DEV.
8. Open a serial connection to the relevant COM port with the following parameters: 9600 BAUD, no handshaking, 8 data bits, no parity, 1 stop bit.

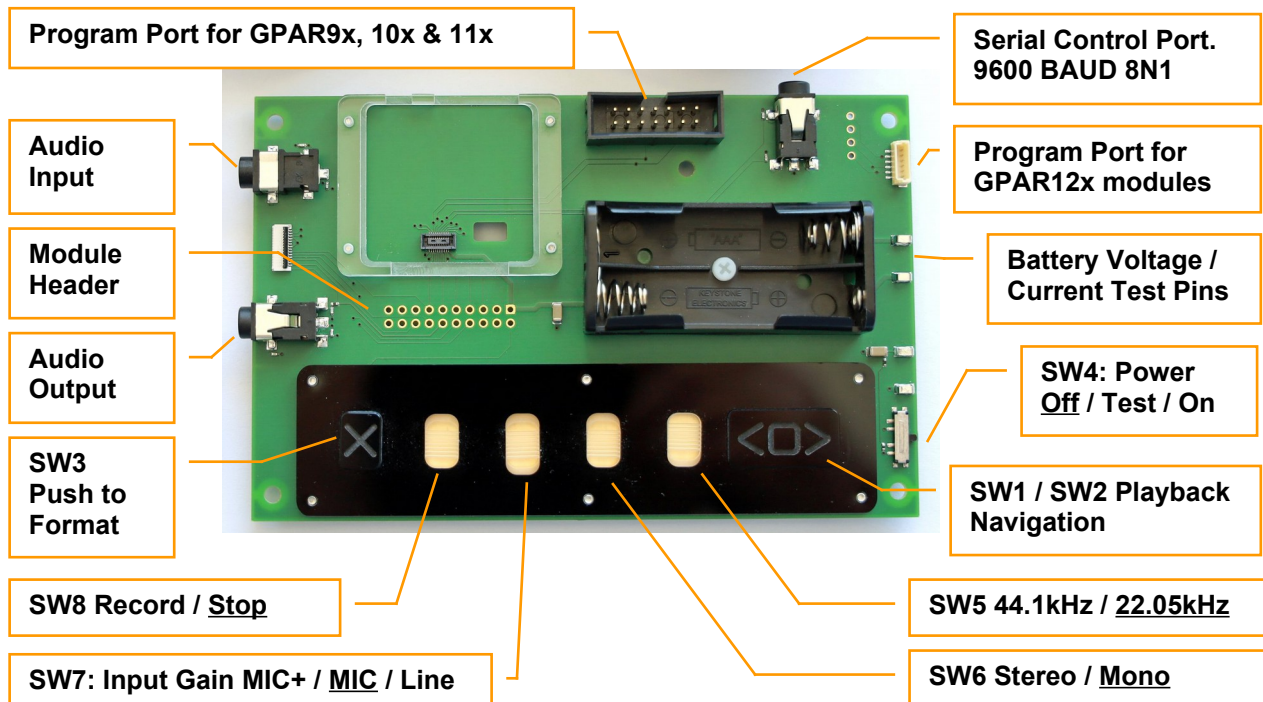


Figure 6. GPAR12x-DEV Development System Controls

Note. In the image above, the currently selected switch positions are indicated with underlined text.

5 Development Features

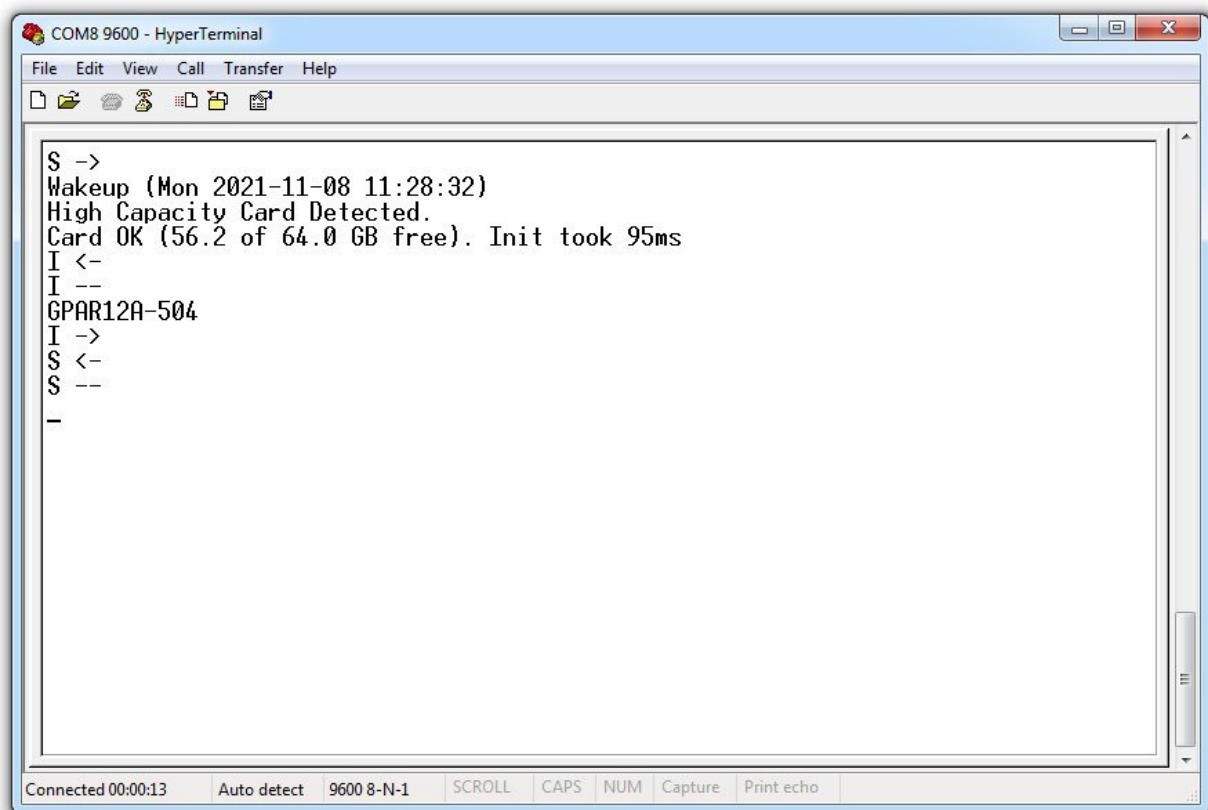
The GPAR12x-DEV is intended to be used as a development platform for systems based on a GPAR12x module and provides the following features.

1. All pins of the GPAR12x module are brought out to the 20-way 0.1" (Module Header). This allows module signals to be probed and connections to be made to other devices.
2. A variety of connectors to support custom firmware programming of GPAR9x to GPAR12x modules *.
3. SW1 / SW2 for basic playback navigation.
4. SW3 to allow media to be erased and formatted.
5. SW4 for battery on/off. In the TEST position, a 1 Ω series resistor is inserted in the battery negative terminal along with 10k/100 μ F RC filtering to facilitate more accurate supply current measurements.
6. Switches SW5, SW6 and SW7 to set recording parameters.
7. SW8 to start and stop recording.

* Note. Access to the GPAR firmware requires the separate purchase of a GPAR Design Licence. Contact RHDC Services Ltd for more information.

6 Serial Port Test

Send the recorder an ASCII carriage return character by pressing Return or Enter in the active Terminal window. The unit should output a response similar to the example below then after approximately 10 seconds return to sleep.



```
COM8 9600 - HyperTerminal
File Edit View Call Transfer Help
S ->
Wakeup (Mon 2021-11-08 11:28:32)
High Capacity Card Detected.
Card OK (56.2 of 64.0 GB free). Init took 95ms
I <-
I --
GPAR12A-504
I ->
S <-
S --
-
Connected 00:00:13 Auto detect 9600 8-N-1 SCROLL CAPS NUM Capture Print echo
```

Figure 7. Recorder output in response to an ASCII Carriage Return character.

6.1 Module Response and Meaning

The following explains the output generated by a module in SLEEP state responding to a carriage return.

S ->	Module has started to leave SLEEP state
Wakeup (Mon 2021-11-08 11:28:32)	Module outputs day, date and time of wakeup
High Capacity Card Detected	Indicates card is larger than 2GB
Card OK (56.2 of 64.0 GB free). Init took 95ms	Card has been initialised & checked
I <-	Module has started to enter IDLE state
I --	Module is now in IDLE state
GPAR12A-504	Output of version info in response to CR command
after approximately 10 seconds of inactivity, module will return to SLEEP state to save power	
I ->	Module has started to leave IDLE state
S <-	Module has started to enter SLEEP state
S --	Module is now in SLEEP state

As shown above, the module reports state transitions using a letter code followed by ->, -- or <-. Thus the controlling application can follow module activity as it transitions between its four basic states:-

SLEEP	Card, CODEC and Preamplifiers are switched off for minimum power consumption
IDLE	Card, CODEC and Preamplifiers are powered up for fast response but are not active
RECORD	module is making a recording
PLAY	module is playing back a recording

7 If The Module Does Not Respond

If there is no response from the module at all, please try the following...

1. Check the batteries have a minimum off-load voltage of 1.3V each.
2. Check the switches are in the correct position including the SW1 power switch.
3. Check the correct COM port has been selected as USB to RS-232 adapters can change COM port.
4. Check serial port handshaking is off and the other settings are as specified in Preparation.
5. Use an oscilloscope to probe pins 10 and 8 of the 20-Way header and verify that pressing Enter results in activity on the recorder module's RXD and TXD lines respectively.

8 If The Module Briefly Flashes One or More LEDs

In order to indicate a fault without the need for a serial connection, the module may briefly flash one or more LEDs if the requested command cannot be executed. This may happen after a reset or if recording is attempted without a card being inserted.

9 If The Module Slowly Flashes One or More LEDs

If an active recording that was initiated by the switch contact interface (physical record switch set to on rather than a serial command) cannot proceed due to an error writing to the memory card, the module may slowly flash one or more LEDs until the fault is cleared or the record switch is switched off.

10 REAF Filesystem

The GPAR series of recorder modules are based on a proprietary filesystem called REAF which stands for Robust Evidential Audio Filesystem. The filesystem was developed by RHDC Services Ltd specifically for use with FLASH memory cards and is key to achieving low power consumption. In addition, the REAF filesystem includes special provisions to make it robust against unexpected power loss and to facilitate accurate playback synchronisation across multiple recordings.

10.1 Formatting a Memory Card for the REAF Filesystem

In order to use a newly purchased memory card in the recorder it must first be erased and formatted for the REAF filesystem. For simplicity, this will henceforth be referred to as "formatting".

Unlike the formatting procedure for a conventional filesystem, where it might be possible to recover some or all of the data using specialist software, with the REAF filesystem, formatting is performed using a mass erase on the FLASH memory itself. Thus a card is effectively "wiped clean" filling the memory contents with either "all zeros" or "all ones" as dictated by the SD standard.

Therefore, before performing the formatting procedure, please ensure that any contents of the memory card you wish to preserve have been securely backed up.

10.2 Card Formatting Procedure

The card formatting procedure can be performed using either of the methods described below.

10.2.1 Card formatting using the switch interface

WARNING. Formatting a memory card with the REAF filesystem will permanently erase all data on the card at the FLASH cell level, after which there will be no known way of recovering the contents.

To initiate formatting and permanently wipe the card contents using the switch interface, press and hold SW3 on the GPAR12x-DEV board (or its equivalent on your own hardware) until the group of four LEDs light up.

As soon as the four LEDs light up, release the switch immediately, after which the recorder will perform the formatting procedure.

Formatting usually takes between 1 and 20 seconds depending on the card technology and how much capacity has been used. Whilst the formatting procedure is ongoing, the four LEDs will flash rapidly. When formatting is complete, all LEDs will switch off and the module will enter the SLEEP state.

Note. If SW3 is released before the four LEDs light, or SW3 is held for more than 1 second after they light, the erase procedure will not be started. This ensures a fault with SW3 cannot accidentally erase the card.

10.2.2 Card formatting using the serial interface (firmware versions 4.47 or later)

WARNING. Formatting a memory card with the REAF filesystem will permanently erase all data on the card at the FLASH cell level, after which there will be no known way of recovering the contents.

To initiate formatting and permanently wipe the card contents using the serial interface, proceed as follows.

1. Unlock the advanced command interface using command 'U'.
2. Request card formatting using command 'X' (not shown on the help menu).
3. The module responds by requesting a confirmation code be entered.
4. Enter the required confirmation code followed by Enter to start the formatting process.

Formatting usually takes between 1 and 20 seconds depending on the card technology and how much capacity has been used. Whilst the formatting procedure is ongoing, the four LEDs will flash rapidly. When formatting is complete, all LEDs will switch off and the module will enter the SLEEP state.

Note. The confirmation code emitted by the module in step 3 is currently hard-coded as "1234" in all current versions of firmware. However, in case the confirmation code needs to be changed or becomes dynamic (so a different confirmation code would be required each time formatting is requested), when designing automated control software, it is recommended that the confirmation code is parsed from the module's response in step 3 which will avoid any potential for incompatibility in the future.

11 GPAR12x User Interface

There are two ways to control the GPAR12x module, via the serial port or via switches as discussed below.

11.1 Serial Port Control

The GPAR12x serial interface is the recommended control interface. With the exception of memory card formatting for v4.13 or earlier firmware, it provides access to the complete recorder functionality that would otherwise be too cumbersome to implement with simple switches. To assist with development, sending the module a '?' character will cause it to output a help page showing the available commands as shown below.

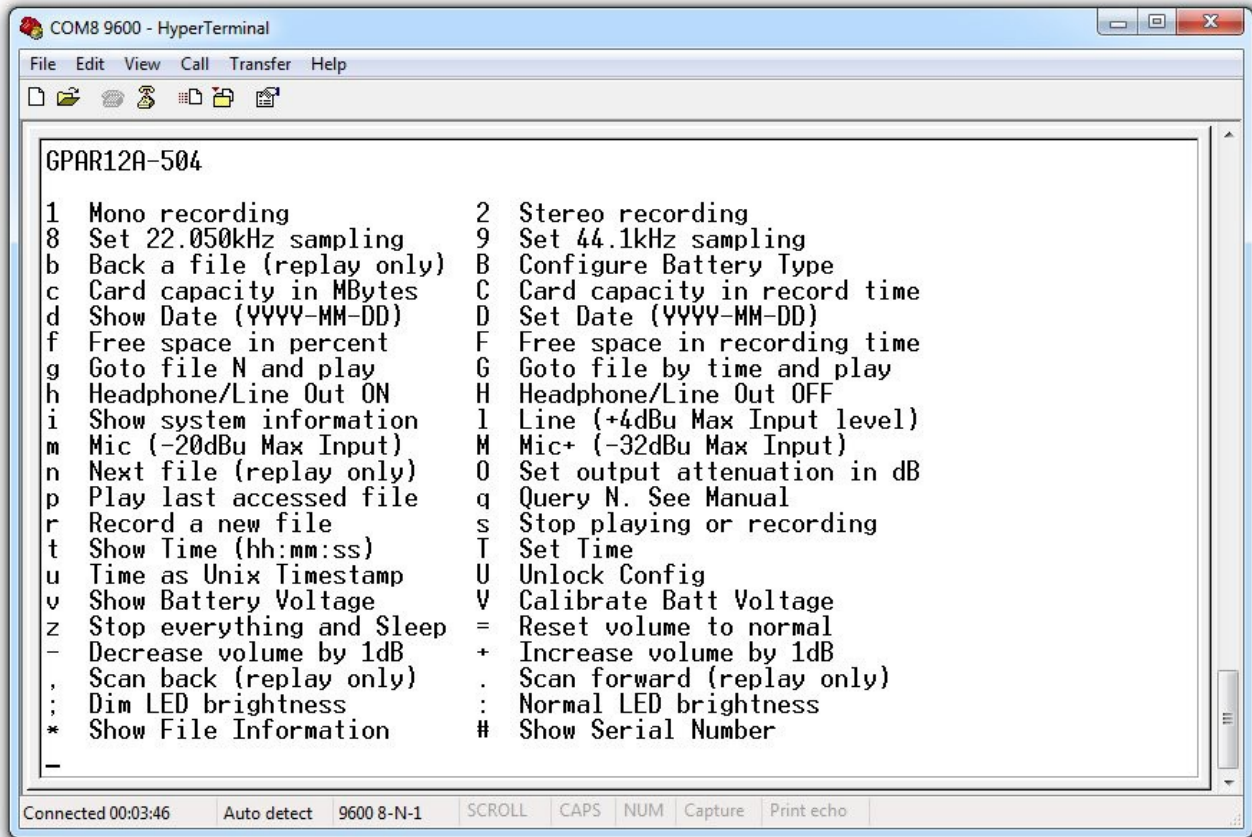


Figure 8. Recorder module output in response to a ? character.

11.2 Making a Test Recording

With headphones and microphone attached to the recorder, try the following three commands in sequence to record and play a file. The test should produce a high-quality recording at a comfortable listening level.

r	Start a recording. Note. Pressing r during a recording starts a new recording without a gap
s	Stops recording or playback
p	Plays the most recent recording then stops automatically

As can be seen from the help page, most commands including the primary record and replay functions require only a single-character, thus simplifying system design and debug considerably.

11.3 Query Commands

The serial port user interface supports a number of 'query' commands which may be used to obtain additional information and status. The currently available query commands are shown below.

0	Outputs the current module state. E.g. 'Current State = R' means the module is in RECORD.
1	Outputs the current file position as an absolute time and date. Useful when playing long recorded files
2	Outputs the current file position as a cluster number. Useful for checking recording or replay progress.
3	Outputs the card's free space in Mbytes. Can be used to monitor free space during recording.
4	Outputs a list of the last 10 recorded files. Intended for debug and laboratory testing only.
5	Outputs memory card parameters. Intended for debug and laboratory testing only.

The text below shows an example output of Query 4 where a number of recordings are present on the card.

```
File      Start Time                End Time                Duration
  3      Tue 2021-11-02 18:14:26 Tue 2021-11-02 18:23:32 0d 0h 9m
  2      Tue 2021-11-02 18:07:49 Tue 2021-11-02 18:14:15 0d 0h 6m
  1      Tue 2021-11-02 17:43:54 Tue 2021-11-02 18:07:38 0d 0h 23m
```

Warning. Do not use query 4 whilst recording. To do so may result in gaps in the recorded file and a corresponding "SLOW CARD!" or "LOST SAMPLES" warning to be issued.

11.4 Switch Control

To allow the GPAR12x module to be used as a stand-alone recorder, a secondary user interface is provided based on hardware switches. See the table below for specific switch functions.

SW1 SW2	Navigation	Push <> to start or stop playback or to start a new recording if currently recording Click Right to skip to next file. Click Left to skip to previous file Hold Right to jog forward. Hold left to jog backwards
SW3	Format	Press and hold until LEDs light then release immediately to permanently erase card contents and format with the REAF filesystem
SW4	Power	Switches battery power on or off. Nearby test points allow the easy connection of a multimeter for average power consumption and battery voltage measurements
SW5	Rate	Selects either 44.1kHz or 22.05kHz recording
SW6	Channel	Switches between Mono or Stereo recording
SW7	Gain	Sets the input gain for use with microphone or line level inputs
SW8	Record	On / Off recording control

Note 1. Changes to SW5 and SW6 require recording to be stopped and restarted in order to take effect.

Note 2. Recording parameters are set according to the position of the switches ...

- When the unit is first powered up
- If a switch position is changed (see note 1)

11.5 GPAR12x Module LEDs

To provide user feedback when the module is being used without a serial port, the GPAR12x module has five LEDs with functions as indicated below.

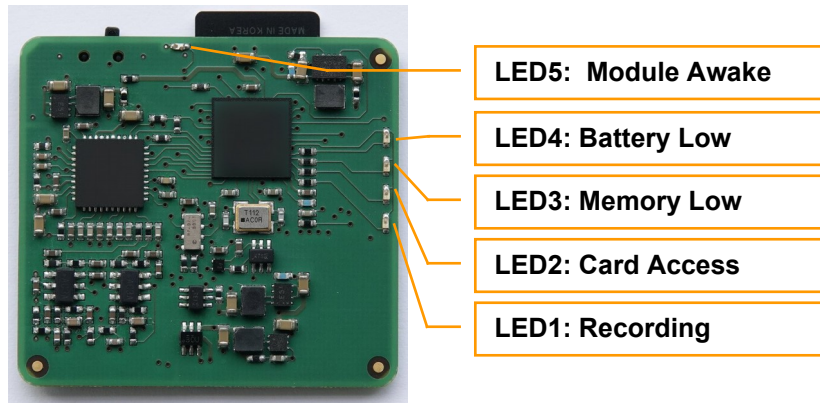


Figure 9. GPAR12x Module LEDs

12 GPAR12x System Integration

The following notes are for designers wishing to integrate the GPAR12x module with another system.

12.1 Power Supply

The module power supply should be capable of delivering up to 500mW peak power at between 1.9V and 4.5V, right up to the end of its intended service life and over the intended operating temperature range. Modern FLASH memory cards can become permanently unusable if their internal controllers lose power whilst they are performing critical functions. So it is essential to ensure the supply will meet these demands.

12.2 Physical Mounting

The GPAR12x-DEV board uses a plastic spacer that was specially designed to align the GPAR12x module with mating connector DF40HC(2.5)-20DS-0.4V(51) and provide reliable mechanical support. The mating connector can be purchased from Digi-Key using Order Code H11909CT-ND. On request, GPAR12x spacers or a custom designed alternative can be purchased from RHDC Services Ltd.

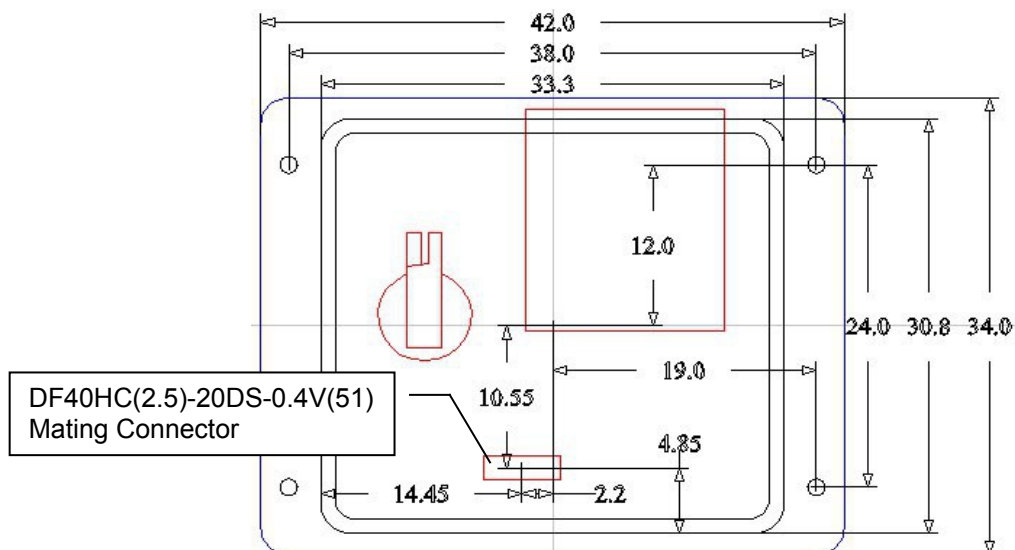


Figure 10. GPAR12x_SPACER drawing showing location of mating connector

12.3 PCB Layout Considerations

Given the high peak supply currents, great care must be taken with the PCB layout to ensure the sensitive analogue inputs are not affected by digital noise. In order to ease development, the PCB layout of the GPAR12x-DEV board can be made available to owners as a reference to assist with module integration.

12.4 Command Set

To prepare for integration of the GPAR12x module with another system, it is strongly recommended that users first become familiar with the command set they intend using and their responses. This is best achieved by using the recorder and PC terminal to work through each command in turn.

13 Optimising Dynamic Range

Assuming the recorder is being used in a typical office environment with the provided test microphone and recommended headphones, for normal demonstration and testing purposes, the highest gain setting (MIC+) should produce recordings at a convenient listening level and with a dynamic range of over 80dB. However, by selecting the mid (MIC) gain position, dynamic range can be extended to more than 90dB without increasing the system noise and with the added benefit of a reduction in power consumption.

Note. When recordings are made at the lower gain setting, an external headphone amplifier and headphone limiter may be required in order to restore comfortable and safe listening levels when replaying.

14 Achieving Low Power Consumption

Starting with the most significant, the following measures can be used to reduce power consumption.

14.1 Sample Rate and Number of Channels

Reducing the sample rate from 44.1kHz to 22.05kHz and selecting mono rather than stereo recording will reduce the recorded data rate by a factor of four with a near proportional effect on power consumption.

14.2 Disable the Headphone Amplifier during Recording

If an audio jack is connected to the GPAR12x-DEV Audio Output Port, the HEADPHONE_SENSE pin of the GPAR12x module will be grounded causing its headphone amplifier to be switched on during recording. This is done so that users can check microphones are working and audio quality is satisfactory. However, to save power, if the GPAR12x-DEV Audio Output Port is left unconnected, the GPAR12x's headphone amplifier will be disabled during recording. In addition to the above method, the headphone amplifier can be disabled using the 'H' command once a new recording has started, though a change on the HEADPHONE_SENSE pin will override this command.

14.3 LED Brightness

The GPAR12x module LEDs can be switched off using the ';' command. However, this setting is lost after a power loss or reset.

14.4 Memory Card Selection

Module power consumption is dominated by the energy required to record data to the FLASH memory card. By using more recent memory card technology with moderate capacity, additional power may be saved.

14.5 Input Gain Reduction

Reducing the input gain will save power by automatically disabling any unnecessary amplification stages.

14.6 Power Saving Summary


When all of the above measures are implemented, the GPAR12x will achieve its lowest power consumption of around 11mW for a line-level input, 22.05kHz mono sampling and a carefully selected memory card.

15 Media Selection Guide

The GPAR12x is able to buffer around 64k bytes of audio which amounts to around 360ms for 44.1kHz 16-bit stereo sampling or around 1.45 seconds for 22.04kHz mono sampling. On very rare occasion, some memory cards can become busy for long periods of time, which is thought to be due to their internal wear levelling algorithms. In order to avoid buying unsuitable cards, please review the sections below.

15.1 Recommended Media

The GPAR12x module should work with any modern HC or XC Micro SD card that has adequate sustained write performance when used in SPI mode. The recommended cards listed in the table below are currently available online and have been extensively tested with the GPAR12x at 22.05kHz mono recording.

Manufacturer	Name	Size	Image	Comments
Samsung	EVO Select	32GB		Excellent standby and active power consumption. Highly Recommended.
Samsung	PRO	32GB		Excellent standby and active power consumption. Highly Recommended.
Samsung	EVO	64GB		Excellent standby and active power consumption. Highly Recommended.
Samsung	PRO Plus	64GB		Very good standby and active power consumption. Recommended.
Samsung	EVO+	128GB		Very good standby and active power consumption. Recommended.
Sony	SR-32UY3	32GB		Operates perfectly up to 44.1kHz stereo sampling. However, power consumption during our tests was higher than other cards, with around 30% less record time compared to the Samsung EVO PRO 32GB.
Transcend	Premium 400x	128GB		When used with the GPAR12x module, on several occasions did not achieve acceptable sustained write performance at 44.1kHz stereo sampling. However, perfectly fine for 22.05kHz mono sampling.

Note 1. This above list does not completely guarantee compatibility because manufacturers can change the internal construction and firmware of their cards without changing the name and card performance can change over time. Thus it is vital that users of the GPAR12x recorder module should implement their own media compatibility verification strategy which can be accomplished by a test recording to the entire card.

Note 2. Many other cards have been tested and found to work well with the GPAR12x. However, in the rapidly evolving memory card market these have since become obsolete and are therefore not included in the above list.

16 Error Messages

The following sections detail potential error messages that can be output by the module.

16.1 Data Block Rejected

During recording, data is written to the memory card in 512 byte blocks using a single attempt. This process should be error free.

However, there is provision within the SD standard for memory cards to reject a data block, if for some reason they are unable to program it. For example, if they are not ready or have become read-only.

To account for this, the GPAR12x checks that it receives the expected confirmation from the card after each data block is written, to verify they are being properly stored. In the event that the GPAR12x detects a problem during this process, for example if whilst recording, the media card is physically removed or the connections are momentarily disrupted, the GPAR12x will output an error message such as the one below then attempt to restart and resume recording. In the example below, recording was restarted successfully.

```
Recording File 3 (Tue 2016-09-13 08:42:30)
R --
ERROR in mmc_SendPayloadBlock(). Data block rejected.
Data Response=0x03 on round 1
ERROR in mmc_WriteCluster() on block 4 of 32
mmc_DataResponse value after calling mmc_SendBlock() = 0x03
during cluster write to card address 79999
ERROR in record_Run(), reaf_RunRecordingSystem() did not return OK
Attempting recording restart...
Card OK (26.6 of 31.9 GB free). Init took 18ms
Wakeup (Tue 2016-09-13 11:11:17)
I <-
I --
I ->
R <-
Recording File 4 (Tue 2016-09-13 11:11:17)
R --
```

Figure 11. Data Block Rejection Error

Note. This issue is not expected to occur unless a physical fault develops with either the media card or the GPAR12x module itself. The above example was generated by inducing such a fault condition.

16.2 Slow Card or Lost Samples

When using the recorder for mono recording at 22.05kHz, data storage rate is reduced by a factor of four compared to 44.1kHz stereo sampling and even the slowest cards should have adequate performance. However, at higher rates, some cards may struggle to meet the requirements for uninterrupted sustained write speed. If the module is unable to buffer sufficient audio to overcome periods when the memory card is unavailable, the module may output one of the messages below.

Message	Meaning
SLOW CARD! Write took 64ms	Whilst no samples have been lost on this occasion, writing took longer than expected indicating poor card performance.
LOST SAMPLES! Card too slow. Mon 2016-09-19 12:01:38	Samples were potentially lost because writing took too long. The time at which the error occurred is appended to the message.

If a "LOST SAMPLES! Card too slow" warning is issued, it may mean some samples have been lost at the time indicated. However, since the REAF filesystem applies a timestamp to each and every 16384 byte cluster stored to the card, any gaps in a recording can be detected and quantified by detailed analysis of the card contents.

Tip. By soak-testing each memory card whilst monitoring the serial port output, they can readily be checked for compatibility with the GPAR12x.

17 Additional Command Information

The following section provides additional information about a number of specific commands.

17.1 Information Command

Using the 'i' command, users can determine how many files are recorded, the day, date and time that the last recording ended plus other useful status information as shown in the example below.

```
Battery           = 63% (assuming Alkaline batteries)
Sampling Rate    = 44.1kHz (of next recording)
Playback Rate    = unavailable
Recording Mode    = Stereo
Playback Volume  = -3dB (Max=0dB)
Input Selection  = Mic+ (-32dBu Max)
Free Space       = 87%
Number of files  = 6
End of Last File = Tue 2021-11-02 16:03:39
```

Figure 12. Example 'i' Command Response

17.2 GoTo Command

The GPAR12x module stores files sequentially starting with file 1 up to a theoretical limit of around 2 billion. In order to navigate to a specific recording when there are a large number of files, the following commands are provided.

g	When prompted, enter the required file number of the recording you wish to listen to
G	When prompted, enter the required time and date of the recording you wish to listen to

Note. The 'G' command search algorithm assumes that file timestamps are ascending.

In the event that it is necessary to set the clock backwards, it is strongly recommended that the media card is either changed or reformatted, otherwise the 'G' goto command may not work correctly.

17.3 Disk Catalogue Command

In order to help analyse the contents of a memory card, the GPAR12x provides a disk catalogue command. Typing '*' followed by a file number will display details of the requested file. In addition, a range may be entered to display up to 20 files at once. E.g. entering '*' followed by '1-9' will display the details of files 1 through to 9 as shown in the example below.

Information for files 1 to 9

File	Start Time	End Time	Duration
9	Sat 2016-09-17 11:21:15	Sat 2016-09-17 11:32:02	0d 0h 10m
8	Fri 2016-09-16 14:54:52	Fri 2016-09-16 18:55:27	0d 4h 0m
7	Fri 2016-09-16 13:00:10	Fri 2016-09-16 14:44:20	0d 1h 44m
6	Thu 2016-09-15 21:18:06	Thu 2016-09-15 21:18:08	0d 0h 0m
5	Thu 2016-09-15 19:24:09	Thu 2016-09-15 21:14:04	0d 1h 49m
4	Thu 2016-09-15 16:31:04	Thu 2016-09-15 19:21:50	0d 2h 50m
3	Thu 2016-09-15 12:17:57	Thu 2016-09-15 16:28:19	0d 4h 10m
2	Thu 2016-09-15 12:16:02	Thu 2016-09-15 12:17:57	0d 0h 1m
1	Thu 2016-09-15 12:15:44	Thu 2016-09-15 12:15:49	0d 0h 0m

Warning. Use of the Disk Catalogue Command whilst recording is not recommended. Depending on how many files need to be displayed, doing so may result in gaps in the recorded file and a corresponding "SLOW CARD!" or "LOST SAMPLES" warning to be issued. Gaps may also be produced if the command is used during replay. However, in practice, up to 10 files can normally be displayed without a problem.

17.4 Globally Unique ID / Serial Number Command (firmware versions 4.47 or later)

In order to help manage recorder inventory, the GPAR12x will output a Globally Unique ID in response to the '#' command. The GUID is hard-coded and cannot be altered.

18 Battery Considerations

This section provides additional information relating to battery capacity measurement and selection.

18.1 Battery Technology Selection and Configuration

The GPAR12x is currently approved for use with Alkaline batteries only. It estimates the remaining battery capacity on the basis of on-load battery voltage, i.e. the battery voltage when measured during moments of peak power consumption such as when writing data to the memory card. When the GPAR12x is manufactured, its internal battery algorithm is normally configured for Energizer E91 AA Alkaline batteries. However, bearing in mind the safety warning below, using the 'B' command, the battery algorithm can be reconfigured for use with Lithium batteries instead.

**** IMPORTANT **. Use of Lithium batteries requires a user to perform their own safety audit and testing. RHDC Services Ltd have not audited or approved the recorder for use with Lithium batteries and may not be held liable if their use with this equipment should result in injury, loss or damage.**

18.2 Battery Voltage Measurement Calibration

The GPAR12x monitors its input supply voltage during high peak loads such as writing data to the memory card. If the module detects that the voltage has fallen below the 0% voltage, it will end any current operation and enter SLEEP mode. When the GPAR12x is manufactured, the 'v' command is used to calibrate the voltage measurement to within 50mV so recalibration should not normally be necessary.

For reference, the table below details the battery voltage thresholds that are used to determine minimum and maximum capacity for on-load voltage measurements.

E91 AA Alkaline Battery 100% Capacity Voltage	3.0V or higher
E91 AA Alkaline Battery 0% Capacity Voltage	2.0V or lower
Lithium Battery (not currently approved) 100% Capacity Voltage	4.0V or higher
Lithium Battery (not currently approved) 0% Capacity Voltage	3.0V or lower

**** IMPORTANT **. Use of Lithium batteries requires a user to perform their own safety audit and testing. RHDC Services Ltd have not audited or approved the recorder for use with Lithium batteries and may not be held liable if their use with this equipment should result in injury, loss or damage.**

19 Reliability and Risk

Whilst every effort has been made to ensure the GPAR12x module will operate flawlessly and over long periods of time, there will always be some risk that it may be forced to terminate recording. For example, if the input voltage falls below the minimum allowed or the memory card becomes full. Therefore, the following recommendations are made when working with any of the GPAR series recorder modules.

1. The host system should ideally capture messages output by the module into a non-volatile circular buffer as examination of the contents will usually provide valuable diagnostic information.
2. The host system should use the provided commands to periodically check operation is as expected. For Example, in Record or Play mode, Query 2 can be used to check the File Cluster Number is increasing indicating the module is operational and recording or playback is proceeding as expected.
3. In the event that the module does not respond as expected, or does not respond at all, the host system should include error handling procedures. For example, in the event that the module stops responding for more than 10 seconds, a suitable response might be to reset the module by switching off its power supply for 1 second before trying again.

20 Known Issues for GPAR12x with v5.04 Firmware

No issues have been identified with the GPAR12x module running firmware version 5.04.

21 GPAR12x-DEV Reference Design

The GPAR12x-DEV schematic, bill of materials and PCB layout can be made available to selected paying customers as a separate document.

22 Audio File Extraction Software

RHDC Services Ltd do not currently supply software that can directly read the contents of a REAF formatted memory card.

However, recordings can easily be played back using the GPAR12x-DEV platform.

For customers who do need to extract and export recordings as WAV files etc, one option is for them to obtain a GPAR12x design licence. This includes access to a document describing the REAF file structure, which would then enable them to commission their own file extraction software.

RHDC Services Ltd would also be happy to quote for the development of custom software to do the extraction, should this need arise.