3.3 Changing Operator Menu parameter values

When changing an operating parameter, line 2 describes the parameter and line 3 offers the available choices:

```
RF OUTPUT POWER
OFF LOW MID HIGH MAX
```

The cursor (underscore) shows that the transmitter output is switched off.
The operator can change the current condition (displayed line 3) by using the Left Arrow < ← > or Right Arrow < → > keys, moving the cursor under the desired transmit output power level, followed by pressing the < OK > key to accept the chosen parameter. If the user doesn't confirm his choice by pressing the < OK > key, or uses the Up Arrow < ↑ > or Down Arrow < ↓ > keys, the operating parameter change is cancelled; the current parameter is not modified. This is a convenient "escape" feature.

Certain operating parameters are entered values (not multiple choice). For example, the frequency is displayed as follows:

```
FREQUENCY
2454.25 MHz
```

To change the current value of this parameter, the operator presses < **OK** >, entering the Menu Edit mode, so the cursor appears under the first figure of the displayed frequency, as follows:

```
FREQUENCY
2454.25 MHz
```

The frequency value is changed by the following steps: (1) move the cursor to the appropriate figure using the < ← > and < → > keys; (2) increment or decrement the selected figure using the < ↑ > and < ↓ > keys. For example:

```
FREQUENCY
2450.25 MHz
```

The frequency value to the right of the decimal point is a fractional MHz value, selected in steps of 250 KHz (.25 MHz). Repeat the operation (previously described) to increment or decrement this value. To increment to a frequency of 2450.50 MHz, move the cursor to the right of the decimal point, then press the < ↑ > one time:
:

```
FREQUENCY
2450.50 MHz
```

After modifying all of the necessary digits, the operator must validate the chosen frequency by pressing < **OK** >, closing the Menu Edit mode, changing the operating frequency.

```
FREQUENCY
2450.50 MHz
```

If you make a mistake while setting a number and you want to restore the previous value, don't validate your modifications: simply wait during 30 seconds without touching the keypad. The system will automatically exit the edit mode without saving the modifications; the display returns to the status screen.

3.4 Setting Transmitter Operating Frequency

CARRY-CODER II using direct frequency entry: the RF frequency is set as follows:

2454.25 MHz
FREQUENCY
2454.25 MHz

The frequency display is expressed in MHz with 250 kHz tuning steps. The frequency value corresponds to the center of the 8 MHz RF channel that is used for transmission. If the user tries to enter a value which is not in the operating frequency range, an "Out of range" message is displayed and the current frequency value is not changed.

CARRY-CODER II for Broadcast , the RF operating frequency is set using the channel plan with frequency offset::

CH 3- 2029.25 MHz
FREQUENCY
2101.50 MHz

The US channels table and corresponding frequencies is the following :

Channel	Frequency
CH 1 -	1994.75 MHz
CH 1 c	1999.00 MHz
CH 1 +	2003.25 MHz
CH 2 -	2012.25 MHz
CH 2 c	2016.50 MHz
CH 2 +	2020.75 MHz
CH 3 -	2029.25 MHz
CH 3 c	2033.50 MHz
CH 3 +	2037.75 MHz
CH 4 -	2046.25 MHz
CH 4 c	2050.50 MHz
CH 4 +	2054.75 MHz
CH 5 -	2063.25 MHz
CH 5 c	2067.50 MHz
CH 5 +	2071.75 MHz
CH 6 -	2080.25 MHz
CH 6 c	2084.50 MHz
CH 6 +	2088.75 MHz
CH 7 -	2097.25 MHz
CH 7 c	2101.50 MHz
CH 7 +	2105.75 MHz
CH 8 -	2454.25 MHz
CH 8 c	2458.50 MHz
CH 8 +	2462.75 MHz
CH 9 -	2471.25 MHz
CH 9 c	2475.50 MHz
CH 9 +	2479.75 MHz
CH 10 -	2487.75 MHz
CH 10 c	2492.00 MHz
CH 10 +	2496.25 MHz

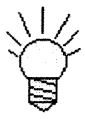
3.5 Setting Transmitter Output Power

The RF power is set through the following menu:

RF OUTPUT POWER
OFF LOW MID HIGH MAX

The following table gives the RF power (real average COFDM power) corresponding to each setting, accompanied by the resulting power supply consumption :

Choice	RF Power	Power Consumption
OFF	Muted	Low (about 30 W)
LOW	50 mW	Low (about 30 W)
MID	100 mW	Low (about 30 W)
HIGH	250 mW	Normal (about 40 W)
MAX	1 W	Normal (about 40 W)



When the CARRY-CODER is close to the receiving antenna (< 25m) you can try to reduce the RF output power to MIN or MID level. It saves the batteries and can improve reception (avoiding receiver overload).

3.6 Setting Transmission Mode and Robustness

The CARRY-CODER II includes 3 pre-defined modes, characterized by defined transmission robustness.

These 3 pre-defined modes have been configured to provide the best trade-off between transmission robustness, video quality and end-to-end delay for typical applications of the CARRY-CODER.

These modes can be selected through the following menu:

ROBUSTNESS
LOW MID HIGH

The detailed characteristics of these modes are:

Mode (Tx Robustness)	LOW	MID	HIGH
COFDM Guard Interval	1/16	1/8	1/16
COFDM Constellation	64QAM	16QAM	QPSK
COFDM Code Rate	1/2	½	1/2
Video bit rate (Mbps)	15.0	11..0	4.9
Audio bit rate (kbps/channel)	192	128	128
Resolution	720 x 576	720 x 576	720 x 576
GOP structure	IP	IP	IBBP
GOP size	12	12	12
End to end delay (ms)	100 ms	100 ms	140 ms

When changing to the < HIGH > robustness condition, take the following steps: (1) Select < HIGH > mode, then press < OK >; < 2 > wait for the system to re-initialize then press < OK > once again.

The following table suggests which (factory defined) robustness mode to use certain applications:

Mode (Tx Robustness)	Preferred applications	Characteristics
LOW	Studio .	Short transmission range. Maximum video quality.
MID	News, sports, entertainment.	Medium transmission range. High video quality.
HIGH	Mobile & airborne transmission (with. walls or buildings in the path.	Long and/or difficult transmission. Normal video quality.

The operator can define specific operating parameters (compression and transmission) via the EXPERT mode. When the CARRY-CODER II is in the EXPERT mode, the "Robustness" menu is disabled and the 3 pre-defined modes are replaced by a message saying: "Expert Config".

3.7 Recalling and Saving Operating Configurations

The CARRY-CODER II provides the operator with the ability to save and recall 8 user-defined presets (configurations). These configurations are non-volatile (saved in an EEPROM) and are not lost when the system power is switched off.
Each configuration contains all of the CARRY-CODER operating parameters, so that recalling a user-defined configuration will restore the system exactly in the same state as when it was saved.

Preset (stored) configurations are recalled using the following menu:

```
RECALL CONFIGURATION
1 2 3 4 5 6 7 8 9
```

To recall a configuration the user should select one of the preset memories, as above, then press < **OK** >.

Custom configurations are saved to memory using the following menu:

```
SAVE CONFIGURATION
1 2 3 4 5 6 7 8 9
```

To save a configuration the user should first set the appropriate operating parameters to the desired state, then select one of the preset (configuration) memories. In the following example, preset memory 2 is selected.:

```
SAVE CONFIGURATION
1 2 3 4 5 6 7 8 9
```

Then, press < **OK** > to save the configuration to the selected preset (memory): The Menu Edit mode is completed.

```
SAVE CONFIGURATION
1 2 3 4 5 6 7 8 9
```

.

Be careful when recalling configurations: If a preset configuration includes RF OUTPUT POWER active, the CARRY-CODER II finishes ts initialization and transmits on the RF frequency that is saved in memory! In order to follow accepted practice and to avoid unwanted transmission, good practice recommends that the preset configurations are saved with the <RF Output Power> setting in the < OFF > condition.

3.8 Setting Video Input Parameters and Video Mode

The video input type is set through the following menu :

VIDEO INPUT
CVBS YUV SDI ASI

The operator can choose:

- CVBS : Composite Video Baseband Signal
- YUV : Component video
- SDI: Serial Digital Video
- ASI: Transport

If there is no signal on the selected input, the CARRY-CODER II displays a “No video” warning message and will not transmit..

The video input standard is set through the following menu :

VIDEO MODE
PAL NTSC

The user can choose between :

- PAL (625 lines, 50 Hz)
- NTSC (525 lines, 60 Hz)

3.9 Setting Audio Input Parameters and Audio Level

The audio input mode is set through the following menu :

AUDIO INPUT
ANALOG AES SDI

Operator choice includes:

- ANALOG: analog audio (line level)
- AES: digital audio (AES/EBU format)
- SDI: (to be enabled)

The Operator can adjust the left and right audio level from –10 dBu to +4 dBu, via the following menus :

AUDIO LEVEL LEFT
+ 3 dBu

AUDIO LEVEL RIGHT
- 6 dBu

For instance, setting a value of –6 dBu means that the CARRY-CODER II is adjusted for a nominal input level of -6 dBu. This ensures headroom for A:D (analog-to-digital) conversion of approximately 18 dBFs (relative to full scale).

When the nominal audio input level is below the value that is set, the system will operate correctly, but the signal-to-noise ratio will be degraded and the nominal audio output level on the receiving side will, in like manner, be low.

If the nominal audio input level exceeds the set value, expect digital clipping to occur.

If the nominal audio input level exceeds the absolute maximum value of +4 dBu, the audio signal will be heavily clipped and there will be significant loss of audio quality.

3.10 Configuring Data Input (RS-232)

The CARRY-CODER II provides an RS-232 input port that can be used for asynchronous user data transmission (i.e. for sending the transmitter's GPS-derived location data to a receiver tracking antenna system).

The RS-232 input is configured through the following menu:

DATA PORT BAUD RATE
1.2 4.8 9.6

3.11 Configuring Transmission privacy

The CARRY-CODER II offers the choice of encrypting the transmitted signal in order to ensure the privacy of the link. This feature is controlled through the following menu:

ENCRYPTION
OFF ENTER PIN

To activate signal encryption, the operator selects this menu function then presses < **OK** > to enter the Menu Edit mode. This operation uses a 6 digit encryption code. Both the transmitter and the receiver must have the same PIN encryption code in memory. If not, the DC II receiver will indicate <BAD ENCRYPTION>: the receiver will demodulate the signal, but it will not provide valid audio, video or data output. Once an encryption code is stored, the operator cannot read the setting of the code: if the code is not on record, the operator must change to a new encryption code or set Encryption to < **OFF** >.

The PIN code is only visible when you enter it. If you forget the PIN code of one device, the simplest solution is to enter a new PIN code for both the transmitter and the receiver. All six digits set to < 0 > result in no encryption

The (first generation) CARRY-CODER I (CC I) and the DE-CODER I (DC I) receiver uses four digit PIN encryption. When the CARRY-CODER II transmitter is used with the DE-CODER I receiver, the CARRY-CODER II encryption is compatible if the PIN encryption setting has the first two PIN digits set to <0> (i.e., PIN setting <001234> on the CC II or DC II will work with PIN setting <1234> on the CC I or the DC I>.

4. USING EXPERT MODE

The CARRY-CODER II has two modes of operation. (1) The NORMAL mode provides the operator with control of system functions that are needed in routine portable camera situations. Section 3 of this manual describes these functions, including three factory preset configurations. (2) The EXPERT mode enables the operator to selectively adjust key (audio and video) compression and COFDM transmission parameters.

⚠ The EXPERT mode should be used carefully because specific parameter settings are required to ensure proper operation of the system. This mode should be reserved to advanced users.

The expert mode is activated through the following menu :

USER MODE
NORMAL EXPERT

\
The Expert Mode gives access to the expert audio-video and COFDM parameters that are described in the next sections.

4.1 Expert audio-video parameters

Recommendations

The video quality mainly depends upon the allocated video bit rate and is closely linked to picture resolution and Group Of Picture structure.

The following table describes recommendations for realistic combinations for video encoding parameters :

Video Bit Rate	GOP structure	Resolution	Video quality	Typical end-to-end Delay
2-3 Mb/s	IBBP	1/2 or 2/3	Low	Approximately 140 ms.
3-5 Mb/s	IBP or IBBP	2/3 or 3/4	Medium	Approximately 100 ms.
5-8 Mb/s	IBP or IBBP	3/4 or 1/1	High	Approximately 100 ms.
8-11 Mb/s	IP	1/1	High	Approximately 100 ms.
11-15 Mb/s	I or IP	1/1	Maximum	Approximately 100 ms.

Other combinations can be derived by the operator using the expert video parameters that are described below:.

Resolution (D1)

RESOLUTION
1/1 ¾ 2/3 1/2

This parameter controls digital picture resolution (pixels per line) used for MPEG-2 encoding. A high MPEG-2 encoding Bit rate provides greater resolution for the best video quality. A low MPEG-2 encoding Bit rate provides lower resolution, reducing the quality of the picture. Decreasing the resolution setting is useful for a low encoding Bit rate in order to reduce Pixelization when dealing with highly detailed fast moving scenes.

GOP Structure

GOP STRUCTURE
I IP IBP IBBP

This parameter controls the structure of picture groups used in the MPEG-2 encoding process. These groups are based on three possible picture types:

- I: Intra-frames (completely encoded).
- P: Predicted-frames (using motion estimation).
- B: Bi-directionally estimated frames (using motion estimation).

This parameter has a direct affect on video encoding delay. For a given Bit rate:

- IBBP and IBP frame modes offer good video quality in difficult transmission conditions.
- IP frame mode offers a good compromise between video quality and "near-line-of-sight" conditions.
- I-frame mode offers the same encoding delay as IP mode, with high Bit rates to ensure the greatest video quality.

GOP Length

GOP LENGTH
6 12 18 24

This is a secondary parameter involving a trade-off between video encoding efficiency and transmission error tolerance. A high value slightly improves the video quality at the expense of an increased worst-case recovery time required by the MPEG2 decoder when a transmission error occurs.

The value is expressed in terms of full frame pictures. The typical value is 12.

4.2 Expert COFDM parameters

You can find some information about COFDM modes characteristics in Annex A.

The COFDM mode is controlled by adjusting certain COFDM parameters, described below.

Constellation

CONSTELLATION
QPSK 16QAM 64QAM

This represents the constellation scheme that is used to individually modulate each sub-carrier of the COFDM signal.

The characteristics corresponding to the 3 possible choices are summarized in this table :

Constellation	**Nb of points**	**Nb of bits per Sub-carrier**	**Relative Bit rate**
QPSK	4	2	x 1
16QAM	16	4	x 2
64QAM	64	6	x 3

Guard Interval

GUARD INTERVAL
1/32 1/16 1/8 ¼

The Guard Interval corresponds to the idle time that exists between each COFDM symbols, in order to avoid inter-symbol interference in a Multipath environment. Guard Interval is expressed as the ratio of the idle time divided by the useful part of the COFDM symbol.

5. INPUT/OUTPUT CHARACTERISTICS

5.1 Composite video (CVBS)

Type	Composite Video Baseband Signal (CVBS)
Systems	NTSC 525 lines / 60 Hz / Fσχ = 3.58 MHz PAL 625 lines / 50 Hz / Fsc = 4.43 MHz
Standard	ITU-R BT 470-6
Impedance	75 Ohms

5.2 Component video (YUV)

Type	YUV (formerly Y / Pb / Pr)
Systems	NTSC 525 lines / 60 Hz PAL 625 lines / 50 Hz
Standard	ITU-R BT 470-6
Impedance	75 Ohms

5.3 Analog audio

Type	Balanced Line
Channels	2 separate channels (Left and Right)
Nominal input level	Adjustable from –10 dBu to +4 dBu (0 dBu = 775 mV)
Headroom	12 dB (analog) – 18 dBFs (digital)
Sampling frequency	48 kHz – 20 bits
Frequency response	30 Hz – 20 kHz (+/- 1dB)
Signal-to-Noise Ratio	65 dBA
Diaphony	60 dBA
Total Harmonic Distortion	< 0.1 % @ 1kHz
Impedance	> 10 kOhms

If a low impedance input (600 Ohms) is required, the user can make a specific interface cable with 600 Ohm resistors between the +/– lines of balanced audio conductors.

5.4 Data input

Type	RS-232-DCE
Possible Bitrates	9600, 4800 and 1200 bauds (selectable)
Format	N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no parity)
Protocol	None (no XON/XOFF)

Since the RS-232 port of the CARRY-CODER is of DCE type, RS-232-Rx is an output and RS232-Tx is an input (as specified by the X.21 standard). So, the user data source has to be connected to the RS-232-Tx pin of the CARRY-CODER.

5.5 Remote control port

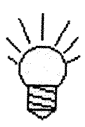
Type	RS232
Bit rate	9600 Bps
Format	N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no parity)
Maximum cable length	100 m
Format and protocol	Proprietary

It is recommended to use a shielded DB9 cable in order to increase reliability.

5. RF output

Type	S-band
Frequency range	1.99 to 2.50 GHz
Channel bandwidth	8/7/6 MHz
Format	COFDM (2K carriers)
Standard	ETS 300 744 (DVB-T)
Output power	50 mW, 100 mW, 250 mW and 1W (selectable)
Shoulders at +/- 4.2 MHz	> 30 dB for 1W > 35 dB for 250 mW or less
Harmonic and spurious	< -60 dBc (DC to 6 GHz)
In-band ripple	< +/- 1dB
Return Loss	18 dB (typical)
Impedance	50 Ohms
Connector	N - Female

Never use the CARRY-CODER without 50 Ohms load or antenna properly connected to the RF output, since this could damage the RF output stage.



The system can operate with several COFDM signals located on 8 MHz adjacent channels. When analog transmissions are active in-band, it is recommended to leave a free 8 MHz channel between COFDM signals and the active analog signals.

5.9 Power supply input

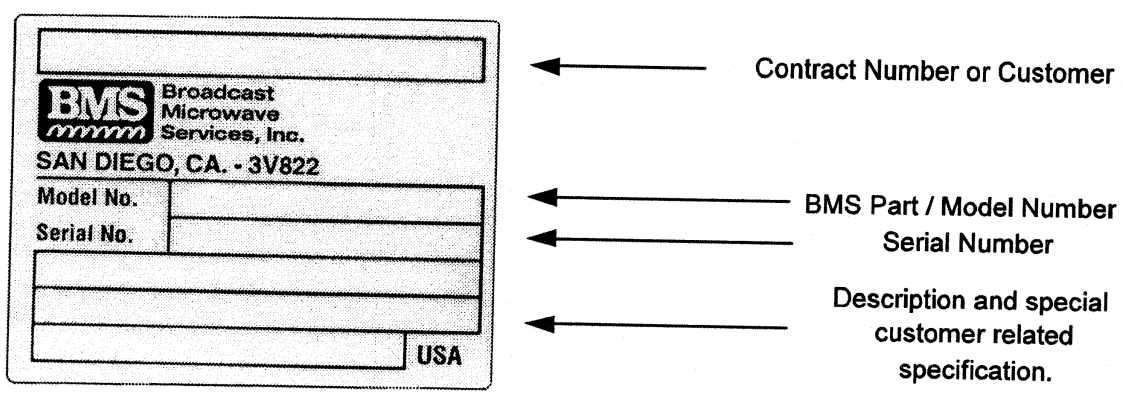
The CARRY-CODER can be powered either with a battery pack or through a 4 pins connector. This enables the use of an external power source such as a battery belt or any appropriate power supply (+11 to 32 VDC - 4A).

6. WARRANTY AND RETURN TO FACTORY

The CARRY-CODER is warranted for a 2 years period, starting from delivery date.

In case of CARRY-CODER failure, please use the following process:

- First have a look at the troubleshooting section of this manual in order to see if an immediate solution can be found.
- Before contacting BMS with questions about units, be sure to have the following information with you so we will be better able to help you.



- Customer Name
- Contract Number
- BMS Model Number
- Serial Number
- Description of problem with as much detail as possible.
- Name of person to contact who might have further information on the failure.
- Contact information such as phone number and/or email address.
- Return Information

- Contact BMS technical support.
- If the technical support cannot solve the problem, please send the unit at your expenses to BMS. Include all necessary explanations about the failure. Always use original packing for transport.
- Warranty position will be established upon receipt of inoperative equipment. If equipment is confirmed defective and is the responsibility of BMS, repair action will be initiated immediately. When the malfunction is determined to be the responsibility of the user, repair will be initiated after confirmation with the user's buying authority.
- BMS will send back the unit at its expenses.

There are no user serviceable parts inside the CARRY-CODER. Trying to open the device without prior authorization from BMS will cause the warranty loss.

7. CONTACT INFORMATION

Broadcast Microwave Services, Inc.

Phone:	+1.858.391.3050
Fax:	+1.858.391.3049
Shipping address:	12367 Crosthwaite Circle Dock 10 Poway, CA 92064
Website:	http://www.bms-inc.com
Email:	support@bms-inc.com sales@bms-inc.com

ANNEX A : COFDM modes characteristics

The main COFDM modulation parameters are :

- Number of sub-carriers (about 2.000 in our case)
- Guard interval (GI) duration between COFDM symbols
- Constellation scheme used for individual sub-carrier modulation
- Data redundancy code rate used for error correction

The transmission robustness mainly depends on constellation scheme and code rate.

The following table gives the useful transmission bit rate for each COFDM mode. It also specifies the Carrier-to-Noise operation limit in the case of a perfect line-of-sight (Gaussian) channel and in the case of a typical multipath terrestrial (Raylegh) channel.

Constellation Scheme	Code Rate	Useful Bitrate (Mb/s)				C/N for perfect channel (dB)	C/N for typical channel (dB)
		GI=1/4	GI=1/8	GI=1/16	GI=1/32		
QPSK	1/2	4,98	5,53	5,85	6,03	3.1	5.4
	2/3	6,64	7,37	7,81	8,04	4.9	8.4
	3/4	7,46	8,29	8,78	9,05	5.9	10.7
	5/6	8,29	9,22	9,76	10,05	6.9	13.1
	7/8	8,71	9,68	10,25	10,56	7.7	16.3
16-QAM	1/2	9,95	11,06	11,71	12,06	8.8	11.2
	2/3	13,27	14,75	15,61	16,09	11.1	14.2
	3/4	14,93	16,59	17,56	17,10	12.5	16.7
	5/6	16,59	18,43	19,52	20,11	13.5	19.3
	7/8	17,42	19,35	20,49	21,11	13.9	22.8
64-QAM	1/2	14,93	16,59	17,56	18,10	14.4	16.0
	2/3	19,91	22,12	23,42	24,13	16.5	19.3
	3/4	22,39	24,88	26,35	27,14	18.0	21.7
	5/6	24,88	27,65	29,27	30,16	19.3	25.3
	7/8	26,13	29,03	30,74	31,67	20.1	27.9

Grey lines correspond to COFDM modes which have few interest for our application. These modes either provide unnecessary bitrate (> 15 Mb/s) or don't offer the best performances for a given bitrate.

We can notice that a low code rate (= high data redundancy) is necessary to insure a good efficiency in multipath environment.

The guard interval determines the maximum echoes length dispersion that the system can tolerate. From this figure, we can estimate the maximum transmission range that the system might offer for a typical terrestrial channel (with adequate RF power).

The following table summarizes the results that come out from the 4 possible guard interval values :

Guard Interval Ratio	Guard Interval Duration (us)	Maximum echoes dispersion (km)	Maximum transmission distance (km)
1/32	7	2.1	2-6
1/16	14	4.2	4-12
1/8	28	8.4	8-24
1/4	56	16.8	16-48

Maximum transmission distances can be increased when using directive antennas, but signal break-ups can nevertheless occur when long echoes occasionally enter into the receiving antenna diagram.