

BCLINK COMMUNICATION PROTOCOL

Issue 2N *PRELIMINARY*

Revision History

Issue	Date	Author	Details
2N	24.10.02	T Vegeby	General corrections. Addresses 4-7 deleted. Changed <i>Calibrate Bittime</i>
2M	24.09.02	T Vegeby	Mainly provisions for 16 card digits
2L	04.06.02	T Vegeby	Changed timing, misc. changes
2K:1	25.03.02	T Vegeby	Some reformatting
2K	11.03.02	M.Beronius	Added PR500 Prox reader.
2J	14.02.01	M.Beronius	Added new product types; 00011 5291 Prox reader 00100 SM501 Smartcard reader 00101 SM501K Smartcard w/ keypad
2I	14.10.99	J.Erngren	Corrected mistake at product type in 5.4. 00001=M43 and 00010=5298.
2H	30.07.99	J.Erngren	Added product type in 5.4.
2G	28.01.97	T Woolvin / P.Clark	Corrected mistake in protocol in 4.6 Backlight control bit = 0 Sounder control bit = 1
2F	10.01.97	T Woolvin / P.Clark	Added command where the YELLOW LED will wink and the sounder will beep when a successful card read has been performed.

Changes since revision 2L is marked in the right column with a black bar.

2E	8.12.96	T Woolvin/ P.Clark	Added feature where by the Tamper status is transmitted from the BC43 when ever it's state changes.
2D	10.9.96	T.Woolvin/ P.Clark	Added commands for Short Wink of any LED and configuration that either the buzzer or YELLOW LED will sound or light while a key is held pressed. Card reading parameters converted to binary from BCD, software revision added to the Tamper status message.
2C	9.7.96	T.Woolvin/ P Clark	Corrected some mistakes in revision 2B, added more detail on card data and data position. Re-titled document as BC43
2B	5.6.96	T.Woolvin/ P Clark	Added software revision number after tamper status
2A	20.5.96	T.Woolvin/ P.Clark	First issue, from revised BC42 protocol (T.Woolvin) with extra commands for BC43.
1.00	6.6.95	T.Woolvin	Original protocol design T.Woolvin

1. Introduction

This document is an up date to the original BC42 Communication Protocol. It describes the operation of the protocol for a unit called BC43, which is an up dated BC42. A BC43 will be compatible with a BC42.

The protocol allows for up to four parallel connected keypads to be connected to one master unit, each keypad being allocated a unique address in the range 0 to 3, however only addresses 0 and 1 are in use.

The term “Keypad” is used for any type of reader connected to BcLink.

The keypad is connected to the master unit with four wires, one for supplying power, one for system ground and two for serial data. (If the keypad is powered locally then only three wires are necessary and the supply wire is omitted) The data lines comprise of one input line for receive data and one tri-state output line for transmit data. The transmit line is normally high impedance and goes low impedance when any keypad transmits it's data.

The BC43 can receive and transmit data simultaneously, i.e. full duplex.¹

The system allows the master unit to:

BC42/43:

- ✍ Set, flash or wink the keypad LEDs.
- ✍ Produce timed multi-frequency tones from the keypads's sounder.
- ✍ Enable/disable the keypad background warning tone.
- ✍ Reset the keypad.

BC43 only:

- ? Set up card reading parameters.
- ? Enable or disable the sounder.
- ? Switch ON or OFF the background lighting.
- ? Request the status of the tamper switch.
- ? Switch ON or OFF the lock relay.

and the remote keypad to:

BC42/43

- ? Send key depressions to the master.
- ? Send card reads to the master.

BC43 only

- ? Send Tamper status to the master

The data messages transmitted and received take the form of a leading command byte followed by the data bytes, the message being terminated with a checksum byte. The command byte contains the start bits for the message, the keypad address the message is coming from or going to and the command itself. The data bytes contain information relevant to the command, some commands are inherent

¹ The DC21/DC11 does NOT have full duplex capability.

and hence have no need for data bytes. The checksum is the 1's complement of the sum of the command byte and all the data bytes modulo 256.

The communication protocol caters for the corruption of messages by acknowledging the receipt of all message. If no acknowledge is received within a defined period of time then the message is re-transmitted. If an acknowledge is not received after three attempts then the data is thrown away. The time between tries is a function of the address of the keypad.

An instance of when data can get corrupted is when two keypads transmit messages at the same time, because they are asynchronous with each other. Each keypad will corrupt each others transmit data resulting in no acknowledges from the master unit. In this case the keypads will re-transmit but because the time between retries is different for each keypad then the retried messages should not clash with each other.

2. System timing

Important timings are:

Serial data time/rate	640 uS / 1562.5 bps ²
Transmit retry time	<p>Two retransmissions are made if an ACK is not properly received.</p> <p><u>BC43</u>: The idle time preceding a retransmission is approx 67 mS for address 0, 72 mS for address 1.</p> <p><u>DC21/DC11</u>: Time start-start is approx 50 mS.</p>

Any unit should delay at least two bittimes before sending an answer.

²: The original value was 644.5 uS/1551.5 bps. The timing derives from the PIC processor having an instruction cycle of four clock periods, 0.8138 uS @ 4.9152 MHz. The bit time, $1/1551.5 = 644.54$ uS, corresponds to 792 cpu instruction cycles. Measurements show that the BC43 is one cycles faster. Bittime with crystal is 643.7 uS.

BC43 is however manufactured with a 4.91 MHz resonator. Measurements has shown the actual mean bit time to be 640.15 uS. The standard is changed to reflect this fact.

3. Address setting

Two addresses are currently in use, 0 and 1.

0 is used and referred to as “ENTRY”.

1 is used and referred to as “EXIT”.

In the command descriptions the meaning of “AA” is:

AA =	keypad address the message is for/from:	
	00 = keypad-0	Generally in use, “Entry”
	01 = keypad-1	Generally in use, “Exit”
	10 = keypad-2	Used only by BC640, but no readers available
	11 = keypad-3	Used only by BC640, but no readers available
	(100 .. 111 ³)	

4. Receive commands

The keypad can receive 16 message types. The receive input is sampled to find a start condition, if one is found it continues reading in the first byte, the command byte. It interrogates this command and decides how many data bytes are associated with the message. If the command was invalid it ignores it and reverts back to looking for a start condition. The required number of data bytes are then read in together with the checksum. The message address is compared against the keypad address and if it does not match then the message is ignored.

The checksum is next calculated and compared with the received checksum, if it is correct then an acknowledge is sent to the master via the transmit output. (Not if the received message was an acknowledge.) The message is again ignored if the checksum was found to be wrong.

The command is now executed and the receiver reverting back to looking for a new start condition.

Logic “0” means approx 0 volts, “1” means approx 5 volts (depending of the IC:s used and I/O networks).

4.1 Sounder control

The sounder control message enables the master to produce sounds on the keypad of 16 different frequencies with 14 different durations, it can also turn on and off a fixed frequency background warning tone.

The sounder message contains one data byte which details the frequency and duration of the sound to be produced.

The structure of the message is:

Command	1	0	0	A	A	0	0	0
Data 1	F	F	F	F	D	D	D	D

³ Addresses omitted since not in use. The reason is to enable future command expansion.

Checksum

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Where:

AA =	keypad address.
DDDD =	duration of sound where: 0000 = turn off warning tone 0001 = 30.9 msec 0010 = 61.9 msec 0011 = 92.8 msec 0100 = 123.8 msec 0101 = 154.7 msec 0110 = 185.6 msec 0111 = 216.6 msec 1000 = 247.5 msec 1001 = 278.4 msec 1010 = 309.4 msec 1011 = 340.3 msec 1100 = 371.2 msec 1101 = 402.2 msec 1110 = 433.1 msec 1111 = turn on warning tone
FFFF =	frequency of sound where: 0000 = 2327.3 Hz 0001 = 1163.6 Hz 0010 = 775.8 Hz 0011 = 581.8 Hz 0100 = 465.5 Hz 0101 = 387.9 Hz 0110 = 332.5 Hz 0111 = 290.9 Hz 1000 = 258.6 Hz 1001 = 232.7 Hz 1010 = 211.6 Hz 1011 = 193.9 Hz 1100 = 179.0 Hz 1101 = 166.2 Hz 1110 = 155.2 Hz 1111 = 145.5 Hz FFFF = don't care when DDDD = 0000 or 1111

The BC42/43 sounder has the following characteristics:

1. The warning tone has a fixed frequency of 290.9 Hz.
2. If a timed duration sound message is received whilst the warning tone is on then the sound output will changed to that of the message, when the timed sound finishes the warning tone is re-instated.
3. When a warning tone off message is received the warning tone will cease 493.1 msec later.
4. If a timed sound has not yet finished and another timed sound message or warning tone message is received then it will cancel the old sound and immediately start the new sound.

4.2 LED control

The LED control message enables the master to turn on, turn off, flash or wink one or more of the LEDs within the keypad. The wink feature inverts the status of the LEDs selected for a fixed period of time irrespective of it's previous state.

The LED message contains one data byte which details the operation to perform on the LEDs and colours of the LEDs to which it applies.

The structure of the message is:

Command	1	0	0	A	A	0	0	1
Data 1	G	Y	R	X	X	L	L	L
Checksum								

Where:

AA =	keypad address
G,Y,R =	green, yellow and red LEDs respectively where: 0 = leave LED status unchanged 1 = change LED status to that defined by LL
LLL =	operation on LEDs selected by G,Y,R where: 000 = turn off LEDs 001 = wink LEDs 010 = flash LEDs 011 = turn on LEDs 100 = short wink LEDs(approx 15 mS)
X =	don't care

The BC42/43 LEDs operate with the following characteristics:

1. The flash rate is fixed at 2.02 Hz.
2. The wink duration is fixed at 123.8 msec.
3. The short wink duration is fixed at 15mS

4.3 Acknowledge

The acknowledge message is sent to the keypad by the master unit on validation of the last message it was sent by the keypad. This message must be fully received by the keypad within the retry time otherwise the last transmitted message will be re-sent. The retry time for each of the keypads is given in section-2, "System timing".

The acknowledge message has no data bytes, the data is inherent in the command.

The structure of the message is:

Command	1	0	0	A	A	0	1	0
Checksum								

Where:

AA =	keypad address
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4.4 Reset keypad

The reset message is used by the master unit to set the keypad to the same condition as if power had just been applied to the unit.

The structure of the message is:

Command	1	0	0	A	A	0	1	1
Checksum								

Where:

AA =	keypad address
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On receipt of this message the following will occur:

1. All sounds will be terminated.
2. All LEDs will be extinguished.
3. The transmitter and the receiver will both be reset.
4. A rising tone sequence will be sounded.

4.5 Card reading parameters (Not BC42)

The card reading parameter control selects which part of the card data is to be transmitted back to the master unit.

The message consists of a start position and a data length in characters. If no card reading parameter message is received the unit will revert to the default card reading parameters.

Default parameters, also called *Bewator Standard* :

- ✍ If card data is more than 16 characters long, data from positions 9 - 16 should be read.
- ✍ If card data is less than 16 characters long, the least significant (rightmost) 8 characters should be read.
- ✍ If card data is less than 8 characters, the most significant characters should be filled with zeros.

Eg. Card data 12345678901234567890, will be read as 90123456
 Card data 1234567890, will be read as 34567890
 Card data 12345, will be read as 00012345

The card reading parameters may also be specified with the following values,

- ? If the start character position is 0 *Bewator Standard* reading is to be used
- ? Start character position, 1 to 40
- ? Card data length, 1 to 16

The structure of the message is:

Command	1	0	0	A	A	1	0	0
Start position	S	S	S	S	S	S	S	S
Character length	0	0	0	L	L	L	L	L
Checksum								

Where:

AA =	keypad address
Start Position =	SSSSSSSS = Start position in binary ie. 0000 1000 will give a start position of 8 after the start sentinel (note character positions start from 1) 00000000 Means <i>Bewator Standard</i> as described above
Character length =	LLLLL = Character length in binary ie. 00111 will send 7 characters of card data.

4.6 Enable/disable sounder, Enable/disable backlight, enable YELLOW LED and sounder sound while key is held (Not BC42), enable YELLOW wink and short beep on successful card read

This command controls whether the sounder is active or inactive in normal operation. If the sounder is deactivated it will not sound even if it is instructed to do so by the master unit.

The default setting will be active. ie. Sounder sounds

In the same message there is also control over the operation of the backlighting ON or OFF.

The default setting will be backlighting ON

The default parameters for keypress response are short beep of the sounder and a wink of the YELLOW LED.

The default state for cardreader response is OFF ie. the keypad will not internally generate Wink of LED and short beep on a successful card read.

The structure of the message is:

Command	1	0	0	A	A	1	0	1
Command	X	X	X	C	Y	T	S	B
Checksum								

Where:

AA =	keypad address
Backlight control	B = 0 backlight OFF B = 1 backlight ON (default)
Sounder control	S = 0 sounder inactive S = 1 sounder active (default).
Tone while key is held	T = 0 no internal response on keypress T = 1 continuous sound while key is held
YELLOW LED while key is held	Y = 0 no internal response on keypress Y = 1 continuous light while the key is held
YELLOW wink and short beep on successful card read	C = 0 no internal response to successful card read C = 1 internally generated YELLOW LED wink and short beep.

4.7 Tamper and software revision request (Not BC42)

This command requests the status of the tamper switch in the keypad.

The structure of the message is:

Command	1	0	0	A	A	1	1	0
Checksum								

The keypad will reply with an ACK as normal, followed by the status of the Tamper switch (detailed in the Transmit commands)

4.8 LCD Write⁴

This command writes to a LCD-display attached to the reader. The command has variable length.

Command details are to be determined.

The structure of the message is:

Command	1	0	0	A	A	1	1	1
Data	d	d	d	d	d	d	d	d
Checksum								

Where:

AA =	keypad address
Data =	Multiple data bytes. Details to be determined and released on an later occation.

4.9 Calibrate Bittime

The purpost with this command is to give any keypad opportunity to calibrate it's bittime. May be used with keypads using microcontrollers with internal, low accuracy, oscillators.

The command is implemented as an extended command, i.e. bit5 = 1. Older readers interpret this as ACK to address 7.

The structure of the message is:

	(bit 5)							
Command	1	0	1	1	1	0	1	0
Data	1	0	1	0	1	0	1	0
Checksum	1	0	0	1	1	0	1	1

⁴ Replaces the *Lock Release* command which was never implemented.

5. Transmit Commands

The keypad can transmit four types of message, three send data to the master unit with the forth used for acknowledging received data. The information is sent to the master after a successful card read, the depression of a key or a request for tamper status. If any events occur simultaneously the following priority is used:

1. Acknowledge a received message.
2. Card message.
3. Key depression message.
4. Product type, Tamper status and software revision

The transmission is started by seizing the transmit line, holding it low for at least one half bittime, and then sending the command byte, eventual data bytes and the checksum⁵. The transmit line is released (tri-stated) after the last stop bit. An acknowledge is now expected from the receiver, if one does not appear before the retry time then the message is sent again. If after three attempts no acknowledge has been received then the message is discarded.

If the received command implies an answer, as in “Tamper Request”, do NOT release the line after sending the ACK. Hold the line low for at least tree bittimes, then send the reply.

5.1 Acknowledge

The acknowledge message is automatically sent to the master unit by the keypad upon receiving a valid message from the master. This message is sent immediately the transmitter is available and has priority over all other messages.

The acknowledge message has no data bytes, the data is inherent in the command.

The structure of the message is:

Command	1	0	0	A	A	0	0	0
Checksum								

Where:

AA =	keypad address
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⁵ The following text has been deleted: “ The data bytes are sent next followed by the checksum and three stop bits. If the last bit of the checksum was a zero then another ‘1’ is sent followed by two stop bits. This enables master units to be designed using the input capture feature of many different microprocessors. (An edge change being required to determine the size of a bit or bits) The extra ‘1’ and stop bits are not included in the checksum. ”

5.2 Key depression

This message is sent after a key has been detected as pressed and debounced.

The key message has one data byte only.

The structure of the message is:

Command	1	0	0	A	A	0	0	1
Data 1	0	0	0	0	K	K	K	K
Checksum								

Where:

AA =	keypad address
KKKK =	value for key just pressed where: 0000 = key-0 0001 = key-1 0010 = key-2 0011 = key-3 0100 = key-4 0101 = key-5 0110 = key-6 0111 = key-7 1000 = key-8 1001 = key-9 1010 = key-A 1011 = key-B

5.3 Card read

This message is sent after a card has been passed through the reader with no errors.

The card message has four data bytes of packed BCD containing eight digits from the recorded card number.

The structure of the message is:

Command	1	0	0	A	A	0	1	0
Data 1	M	M	M	M	...	...	...	...
Data 2	...	...	...	...	...	...	...	...
Data 3	...	...	...	...	...	...	...	...
Data 4	...	...	...	...	L	L	L	L
Checksum								

Where:

AA =	keypad address
MMMM =	most significant digit of card data where: 0000 = '0' 0001 = '1' 0010 = '2' 0011 = '3' 0100 = '4' 0101 = '5' 0110 = '6' 0111 = '7' 1000 = '8' 1001 = '9'
LLLL =	least significant digit of card data

The card reading has the following default characteristics:

1. The entire track is read from the card.
2. All card data is checked for parity.
3. The LRC recorded at the end of the track is also used for validation.
4. The last eight digits up to the sixteenth digit will be used for the data that is sent to the master.
5. Alpha characters recorded will be converted to 9's before sending.
6. If there are less than 8 digits on the card, the card data will be padded out with leading zeros to make the data up to 8 digits.

5.4 Product type, Tamper status and software revision (Not BC42)

This message is sent after a request for a Tamper Status has been made by the Master unit and the keypad has responded with an ACK.

The message is also sent automatically whenever the status of the Tamper changes.

The structure of the message is:

Command	1	0	0	A	A	0	1	1
Data 1	0	P	P	P	P	P	P	T
Data 2	R	R	H	H	L	L	L	L
Data 3	H	H	H	H	L	L	L	L
Checksum								

Where:

AA =	keypad address
Data1: PPPPPP =	Product type: 000000 = BC43 000001 = M43 000010 = 5298 Pin & Proximity Reader 000011 = 5291 Prox reader 000100 = SM501 Smart card reader 000101 = SM501K smart card w/pin pad 000110 = PR500 Prox reader
Data1: T =	Status of the Tamper switch 1 = Contacts Closed, Reader OK, still mounted on the wall 0 = Contacts Open, Reader has been tampered with !
Data2: RR =	Card read capability 00 = Bewator standard read capability 01 = 16 digits read capability (includes Bewator standard capability)
Data 2: HLLLLL	Tens and units of software issue in BCD format
Data 3	Tenths and hundredths of software issue in BCD format

e.g. Software revision 01.23 would show as Data 2: RR000001, Data 3: 00100011

5.5 Card long read

This message is sent after a card has been passed through the reader with no errors, and one of the following conditions is fulfilled:

1. The number of digits specified in *Card Parameters* is 9 to 16.
2. The *Card Read* command isn't implemented

The card message has eight data bytes of packed BCD containing 16 digits from the recorded card number.

The structure of the message is:

Command	1	0	0	A	A	1	0	0
Data 1	H	H	H	H	h	h	h	h
Data 2 –7	...	...	...	...	...	...	...	...
Last Data	e	e	e	e	E	E	E	E
Checksum								

Where:

AA =	keypad address
HHHH =	The most significant digit (or padded zero) of card data
hhhh =	The <i>next</i> most significant digit of card data
... =	further digits
eeee =	The <i>next</i> least significant digit of card data
EEEE =	The least significant digit of card data

The number of sent digits is always 16, packed in 8 bytes. If less than 16 digits are available, the digits are padded to the left with leading zeroes.

The reader shall convert Alpha characters to 9's before sending.

The digits are BCD-coded with one exception:

0 (zero) is coded binary 1100

The reason for this is that this message is very long, 80 bits. Frequency tolerances does not allow free running messages that long, so the receiver needs to calibrate the sampling point during the message. The '1100' encoding for zero ensures that there is at least one level transition in each byte.

BcLink Communication Protocol

Summary of the command set

(Note: Checksum has been omitted. All address fields now two bits, AA).

Command	Type	Direction KeyPad - Master	Main Command Byte	Data or Control information
Sounder Freq/Dur	All	<<==	100AA000	FFFFDDDD
LED Control	All	<<==	100AA001	GYRXXLLL
ACK Master receive	All	<<==	100AA010	none
RESET	All	<<==	100AA011	none
Card reading parameters	Not 42	<<==	100AA100	SSSSSSSS 000LLLLL
Sounder/Backlight disable/enable	Not 42	<<==	100AA101	XXXXYTBS
Tamper request	Not 42	<<==	100AA110	none
LCD Write ⁶	?	<<==	100AA111	variable format
Calibrate Bittime	Any	<<==	10111010	10101010

ACK keypad receive	All	==>>	100AA000	none
Key Depression	All	==>>	100AA001	0000KKKK
Card read	All	==>>	100AA010	MMMMLLLL [3 more bytes]
Product type, Tamper status and software revision	Not 42	==>>	100AA011	0PPPPPT RRHHLLLL HHHHLLLL
Card long read	LR	==>>	100AA100	HHHHhhhh [7 more bytes]

Note: LR denotes an yet unnamed reader type with “*card long read*” capability.

⁶ Replaces the *Lock Release* command which never was implemented.