

# DATA SHEET

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# KS8701

## FLEX™ Roaming Decoder II

March, 2000



**ELECTRONICS**

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# KS8701

## FLEX™ ROAMING DECODER II

### DATA SHEET

#### FEATURES

- FLEX™ paging protocol decoder
- 16 programmable user address words
- 16 fixed temporary addresses
- 16 operator messaging addresses
- 1600,3200,and 6400bps(bits per second) decoding
- Any-phase or single-phase decoding
- Uses standard Serial Peripheral Interface (SPI) in slave mode
- Allow low current STOP mode operation of host processor
- Highly programmable receiver control
- Real time clock time base
- FLEX fragmentation and group messaging support
- Real time clock over-the-air update support
- Compatible with synthesized receivers
- SSID and NID Roaming support
- Low Battery Indication(External detector)
- 28 used pins (32-pin package standard)
- Backward compatible to the standard and roaming FLEX decoder ICs
- Internal demodulator and data slicer
- Improved battery savings via partial correlation and intermittent receiver clock
- Full support for revision 1.9 of the FLEX protocol
- 32-pin LQFP package

#### DESCRIPTION

This FLEX™ Roaming Decoder II data sheet describes the operation of the KS8701.

The KS8701 simplifies implementation of a FLEX™ paging device by interfacing with any of several off-the-shelf paging receivers and any of several off-the-shelf host microcontroller/microprocessors. Its primary function is to process information received and demodulated from a FLEX radio paging channel, select messages addressed to the paging device and communicate the message information to the host.

The KS8701 also operates the paging receiver in an efficient power consumption mode and enables the host to operate in a low power mode when monitoring a signal channel for message information.

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**ORDERING INFORMATION**

Device Name	Supply Voltage	Operating Frequency	Operating Temperature	Package Type
KS8701	1.8V ~ 3.6V	76.8kHz or 160kHz	-25jÉ~ 85jÉ	32-LQFP-0707

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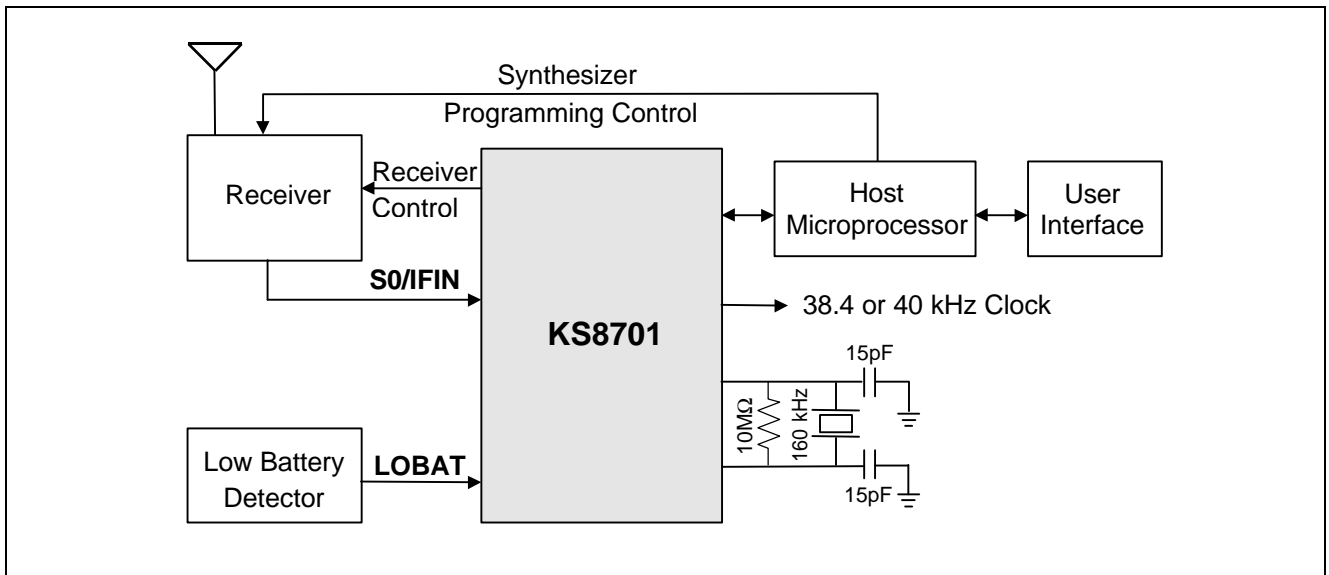
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## INTRODUCTION

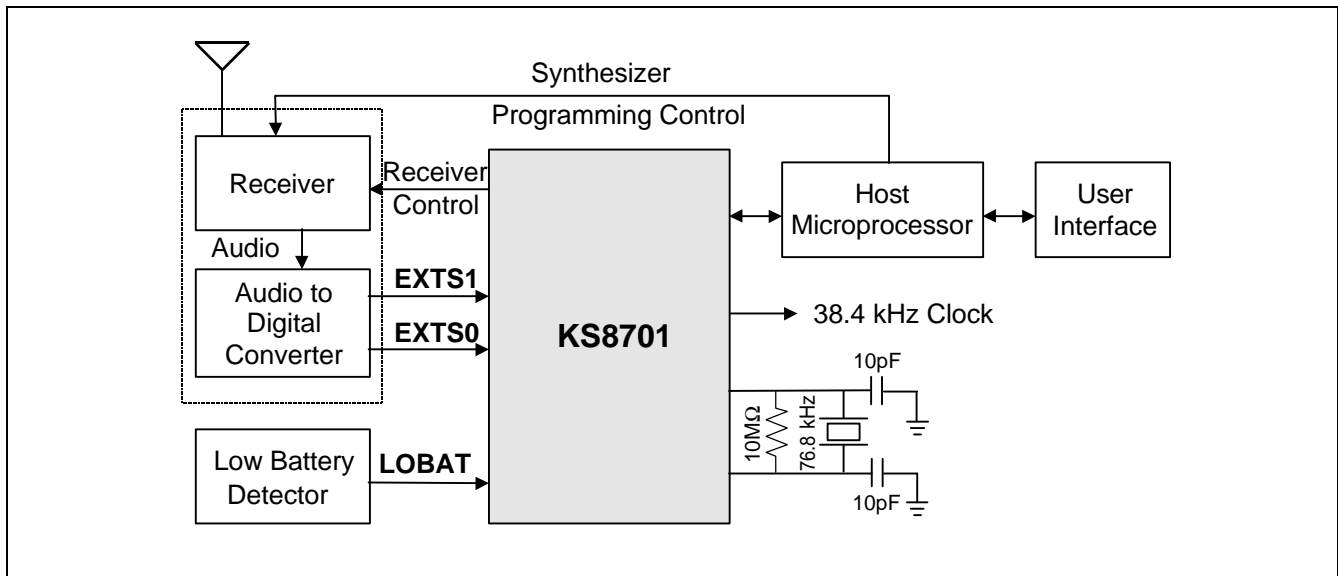
### SYSTEM BLOCK DIAGRAM



**Figure 1 : Example Block Diagram Using Internal Demodulator**

When configured to use the internal demodulator, the KS8701 connects to a receiver capable of generating a limited (i.e. 1-bit digitized) 455 kHz or 140 kHz IF signal. In this mode, the KS8701 has 7 receiver control lines used for warming up and shutting down a receiver in stages. The KS8701 has the ability to detect a low battery signal during the receiver control sequences. It interfaces to a host MCU through a standard SPI. It has a 1minute timer that offers low power support for a time of day function on the host.

When using the internal demodulator, the oscillator frequency (or external clock) must be 160 kHz. The **CLKOUT** signal can be programmed to be either a 38.4 kHz signal created by fractionally dividing the oscillator clock, or a 40 kHz signal creating by dividing the oscillator clock by 4.



**Figure 2 : Example Block Diagram Using External Demodulator**

The KS8701 can also be configured to connect to a receiver capable of converting a 4 level audio signal into a 2 bit digital signal. In this mode, the KS8701 has a 8 receiver control lines used for warming up and shutting down a receiver in stages. It also includes configuration setting for the two post detection filter bandwidths required to decode the two symbol rates of the FLEX signal. Also when using an external demodulator, the oscillator frequency (or external clock) must be 76.8 kHz and the **CLKOUT** signal (when enabled) is 38.4kHz clock output capable of driving other devices.

**FUNCTIONAL BLOCK DIAGRAM**

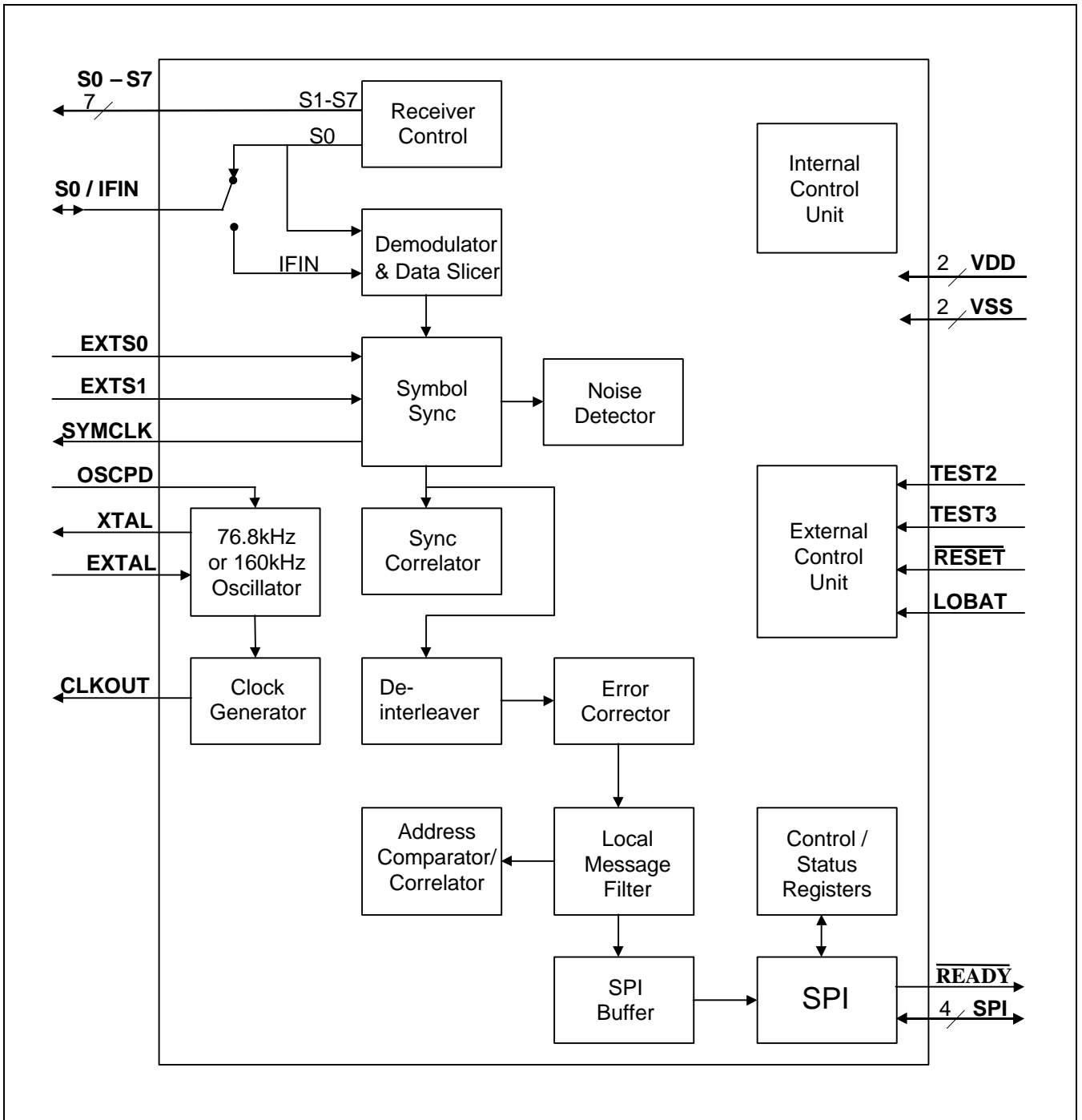


Figure 3 : Block Diagram



## PIN DESCRIPTION

PIN NAME	PIN	TYPE	DESCRIPTION
<b>Power</b>			
V <sub>DD</sub>	3,13		Power
V <sub>SS</sub>	7,29		Ground
LOBAT	10	I	Low battery detect input
<b>Reset</b>			
$\overline{\text{RESET}}$	24	I	Active low reset to the KS8701.
<b>External Symbol Input Signals</b>			
EXTS1	11	I	MSb of the symbol currently being decoded
EXTS0	12	I	LSb of the symbol currently being decoded
<b>SPI Signals</b>			
$\overline{\text{SS}}$	27	I	Slave Select for SPI communications
SCK	28	I	Serial Clock for SPI communications
MOSI	30	I	Data input for SPI communications
MISO	31	O	Three-state data output for SPI communications
$\overline{\text{READY}}$	26	O	Driven low when the IC is ready for an SPI packet
<b>Clock Signals</b>			
CLKOUT	32	O	38.4 kHz or 40 kHz clock output(derived from oscillator)
SYMCLK	14	O	Recovered symbol clock
EXTAL	6	I	76.8 kHz or 160 kHz crystal input or external input
XTAL	5	O	76.8 kHz or 160 kHz clock output
OSCPD	2	I	Internal oscillator power down. Connected to <b>VSS</b> when using internal oscillator. Connected to <b>VDD</b> when using an external source.
<b>Receiver Control Lines</b>			
S1 - S7	22,21,20,19, 18,16,15	O	Seven three-state receiver control output
S0 / IFIN	23	O / I	S0 : Receiver control output when using external demodulator IFIN : Limited IF input when using internal demodulator
<b>Test pins</b>			
TEST2, TEST3	4,8	I	IC manufacturing test mode pin. Normally connected to <b>VSS</b> .
NC	1,9,17,25	O	IC manufacturing test mode pin. Normally connected to <b>VSS</b> . (Can be left unconnected.)

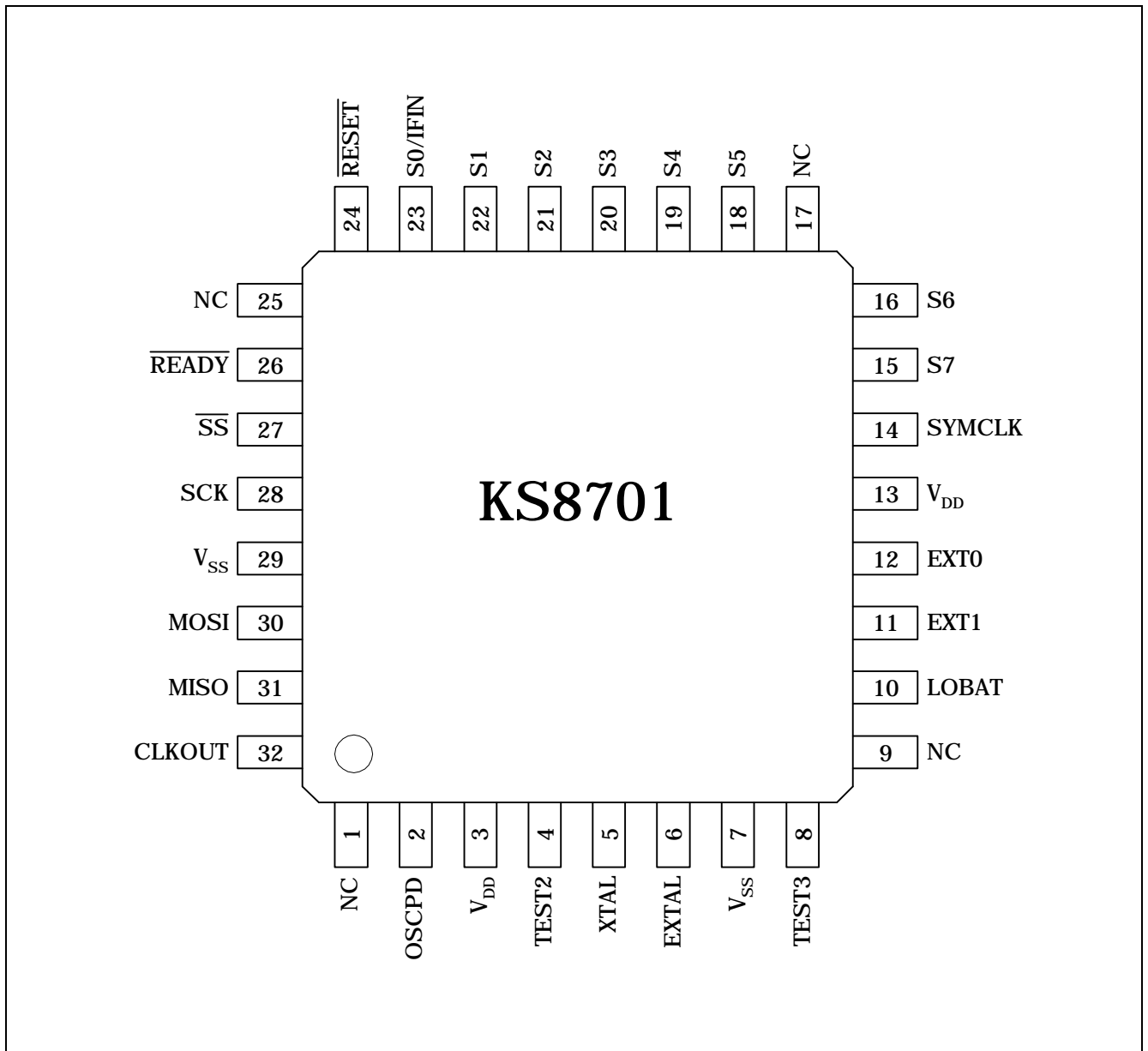


Figure 4 : KS8701 32-LQFP Top View

MECHANICAL SPECIFICATION

PACKAGE DIMENSION

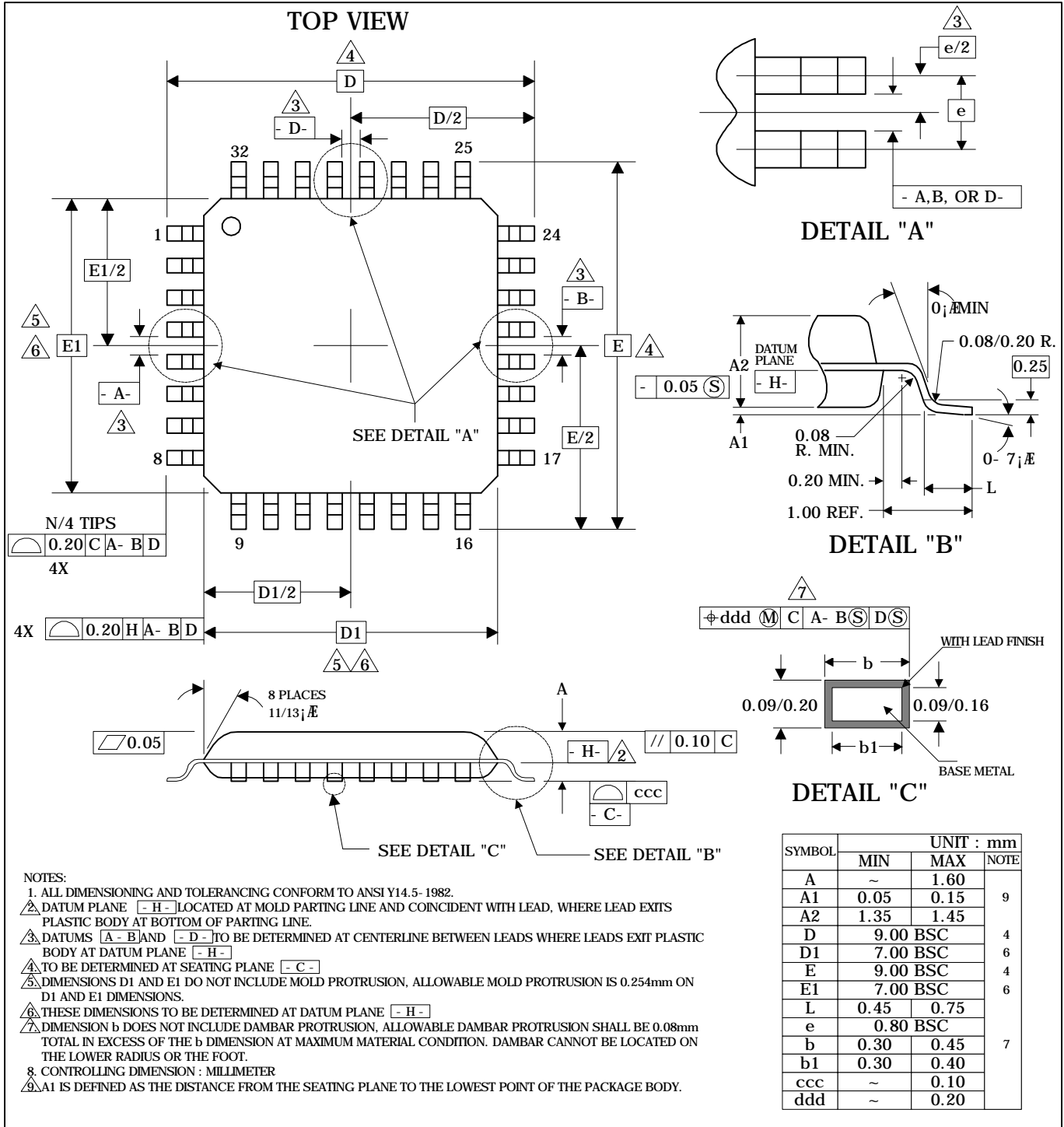


Figure 5 : 32-LQFP-0707 Package Dimension

## SPI PACKETS

All data communicated between the KS8701 and the host MCU is transmitted on the SPI in 32-bit packets. Each packet consists of an 8-bit ID followed by 24 bits of information. The KS8701 uses the SPI bus in full duplex mode. In other words, whenever a packet communication occurs, the data in both directions is valid packet data.

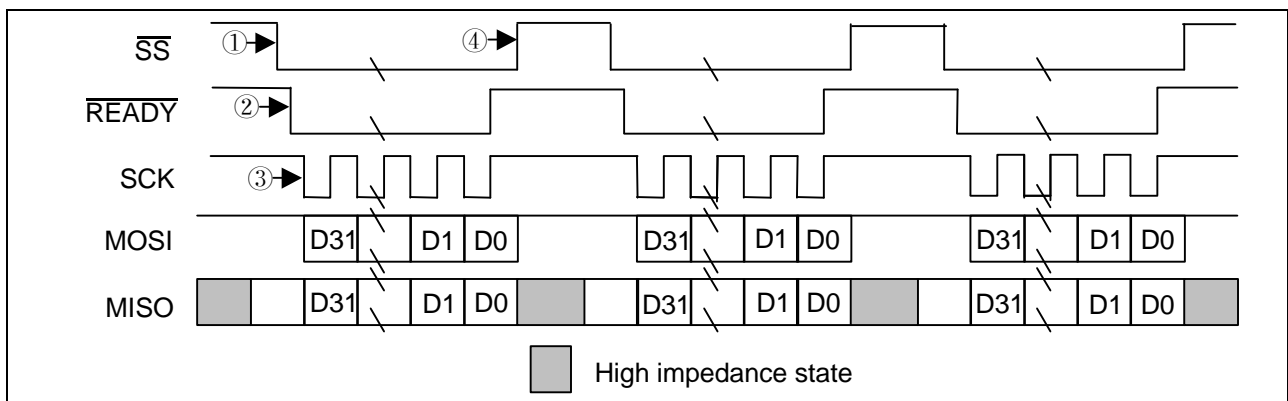
The SPI interface consists of a  $\overline{\text{READY}}$  pin and four SPI pins ( $\overline{\text{SS}}$ , **SCK**, **MOSI**, and **MISO**). The  $\overline{\text{SS}}$  is used as a chip select for the KS8701. The **SCK** is a clock supplied by the host MCU. The data from the host is transmitted on the **MOSI**(Master-Out-Slave-In) line. The data from the KS8701 is transmitted on the **MISO**(Master-In-Slave-Out) line.

Timing requirements for SPI communication are specified in “[SPI Timing](#)” on page 69.

### PACKET COMMUNICATION INITIATED BY THE HOST

Refer to [figure 6 on page 11](#). When the host sends a packet to the KS8701, it performs the following steps:

1. Select the KS8701 by driving the  $\overline{\text{SS}}$  pin low.
2. Wait for the KS8701 to drive the  $\overline{\text{READY}}$  pin low.
3. Send the 32-bit packet.
4. De-select the KS8701 by driving the  $\overline{\text{SS}}$  pin high.
5. Repeat steps 1 through 4 for each additional packet.



**Figure 6: Typical Multiple Packet Communications Initiated by the Host**

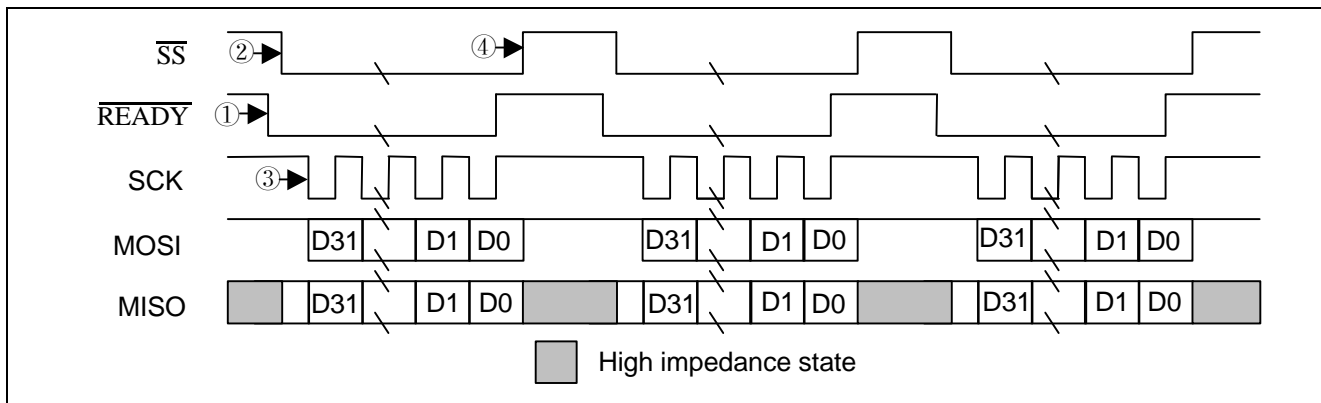
When the host sends a packet, it will also receive a valid packet from the KS8701. If the KS8701 is enabled (see “[Checksum Packet](#)” on page 16 for a definition of enabled) and has no other packets waiting to be sent, the KS8701 will send a status packet.

The host must transition the  $\overline{\text{SS}}$  pin from high to low to begin each 32-bit packet. The KS8701 must see a negative transition on the  $\overline{\text{SS}}$  pin in order for the host to initiate each packet communication.

**PACKET COMMUNICATION INITIATED BY THE FLEX DECODER IC**

Refer to [figure 7 on page 12](#). When the KS8701 has a packet for the host to read, the following occurs:

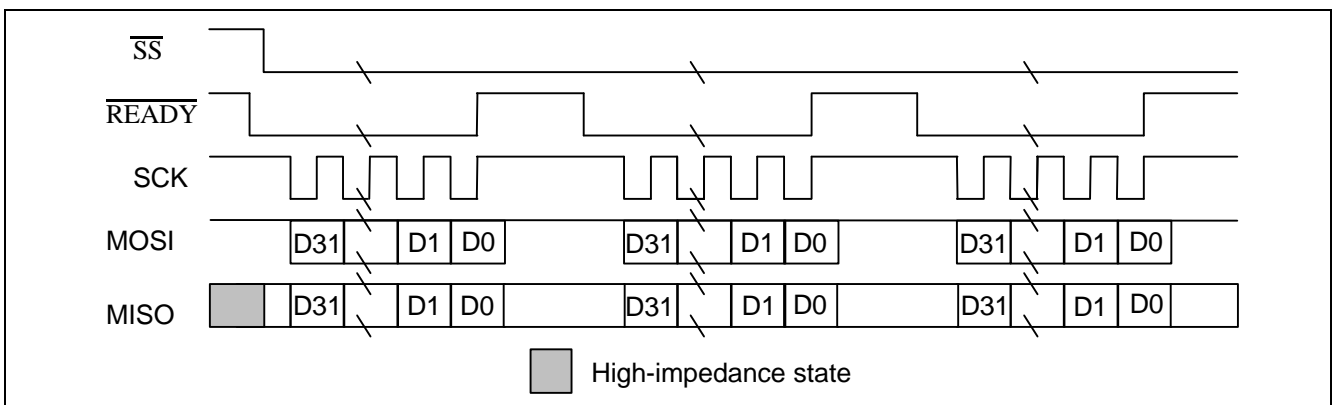
1. The KS8701 drives the **READY** pin low.
2. If the KS8701 is not already selected, the host selects the KS8701 by driving the **SS** pin low.
3. The host receives (and sends) a 32-bit packet.
4. The host de-selects the KS8701 by driving the **SS** pin high (optional).



**Figure 7: Typical Multiple Packet Communications Initiated by the FLEX decoder IC**

When the host is reading a packet from the KS8701, it must send a valid packet to the KS8701. If the host has no data to send, it is suggested that the host send a Checksum Packet with all of the data bits set to 0 in order to avoid disabling the KS8701. See [“Checksum Packet” on page 16](#) for more details on enabling and disabling the KS8701.

The following figure illustrates that it is not necessary to de-select the KS8701 between packets then the packets are initiated by the KS8701.



**Figure 8: Multiple Packet Communications Initiated by the FLEX decoder IC with No De-select**

## HOST-TO-DECODER PACKET MAP

The upper 8 bits of a packet comprise the packet ID. The following table describes the packet id's for all of the packets that can be sent to the KS8701 from the host.

Table 1: Host-to-Decoder Packet ID Map

Packet ID (Hexadecimal)	Packet Type	Page
00	Checksum	16
01	Configuration	18
02	Control	21
03	All Frame Mode	23
04	Operator Message Address Enables	24
05	Roaming Control Packet	25
06	Timing Control Packet	28
07 - 0E	Reserved (Host should never send)	
0F	Receiver Line Control	29
10	Receiver Control Configuration (Off setting)	30
11	Receiver Control Configuration (Warm Up 1 Setting)	31
12	Receiver Control Configuration (Warm Up 2 Setting)	31
13	Receiver Control Configuration (Warm Up 3 Setting)	31
14	Receiver Control Configuration (Warm Up 4 Setting)	31
15	Receiver Control Configuration (Warm Up 5 Setting)	31
16	Receiver Control Configuration (3200sps Sync Setting)	32
17	Receiver Control Configuration (1600sps Sync Setting)	33
18	Receiver Control Configuration (3200sps Data Setting)	33
19	Receiver Control Configuration (1600sps Data Setting)	33
1A	Receiver Control Configuration (Shut Down 1 Setting)	34
1B	Receiver Control Configuration (Shut Down 2 Setting)	34
1C - 1F	Special (Ignored by KS8701)	
20	Frame-Assignment (Frames 112 through 127)	35
21	Frame Assignment (Frames 96 through 111)	35
22	Frame Assignment (Frames 80 through 95)	35
23	Frame Assignment (Frames 64 through 79)	35

Table 1: Host-to-Decoder Packet ID Map (Continued)

Packet ID (Hexadecimal)	Packet type	Page
24	Frame Assignment (Frames 48 through 63)	35
25	Frame Assignment (Frames 32 through 47)	35
26	Frame Assignment (Frames 16 through 31)	35
27	Frame Assignment (Frames 0 through 15)	35
28 – 77	Reserved (Host should never send)	
78	User Address Enable	36
79 - 7F	Reserved (Host should never send)	
80	User Address Assignment (User address 0)	37
81	User Address Assignment (User address 1)	37
82	User Address Assignment (User address 2)	37
83	User Address Assignment (User address 3)	37
84	User Address Assignment (User address 4)	37
85	User Address Assignment (User address 5)	37
86	User Address Assignment (User address 6)	37
87	User Address Assignment (User address 7)	37
88	User Address Assignment (User address 8)	37
89	User Address Assignment (User address 9).	37
8A	User Address Assignment (User address 10)	37
8B	User Address Assignment (User address 11)	37
8C	User Address Assignment (User address 12)	37
8D	User Address Assignment (User address 13)	37
8E	User Address Assignment (User address 14)	37
8F	User Address Assignment (User address 15)	37
90 - FF	Reserved (Host should never send)	

## DECODER-TO-HOST PACKET MAP

The following table describes the packet ID's for all of the packets that can be sent to the host from the KS8701.

Table 2: Decoder-to-Host Packet ID Map

Packet ID (Hexadecimal)	Packet Type	Page
00	Block Information Word	39
01	Address	41
02 - 57	Vector or Message (ID is word number in frame)	42
58 - 5F	Reserved	
60	Roaming Status Packet	48
61 - 7D	Reserved	
7E	Receiver Shutdown	50
7F	Status	51
80 - FE	Reserved	
FF	Part ID	53



## HOST-TO-DECODER PACKET DESCRIPTIONS

The following sections describe the packets of information sent from the host to the KS8701. In all cases the packets should be sent MSB first (bit 7 of byte 3 = bit 31 of the packet = MSB).

### CHECKSUM PACKET

The Checksum Packet is used to insure proper communication between the host and the KS8701. The KS8701 exclusive-or's the 24 data bits of every packet it receives (except the Checksum Packet and the special packet ID's 1C through 1F hexadecimal) with an internal checksum register. Upon reset and whenever the host writes a packet to the KS8701, the KS8701 is disabled from sending any information to the host processor until the host processor sends a Checksum Packet with the proper checksum value (**CV**) to the KS8701. When the KS8701 is disabled in this way, it prompts the host to read the Part ID Packet. Note that all other operation continues normally when the KS8701 is "disabled". Disabled only implies that data cannot be read, all other internal operations continue to function.

When the KS8701 is reset, it is disabled and the internal checksum register is initialized to the 24 bit part ID defined in the Part ID Packet. See "Part ID Packet" on page 53 for a description of the Part ID. Every time a packet other than the Checksum Packet and the special packets 1C through 1F is sent to the KS8701, the value sent in the 24 information bits is exclusive-or'ed with the internal checksum register, the result is stored back to the checksum register, and the KS8701 is disabled. If a Checksum Packet is sent and the **CV** bits match the bits in the checksum register, the KS8701 is enabled. If a Checksum Packet is sent when the KS8701 is already enabled, the packet is ignored by the KS8701 in which case a null packet having the ID and data bits set to 0 is suggested. If a packet other than the Checksum Packet is sent when the KS8701 is enabled, the KS8701 will be disabled until a Checksum Packet is sent with the correct **CV** bits.

When the host reads a packet out of the KS8701 but has no data to send, the Checksum Packet should be sent so the KS8701 will not be disabled. The data in the Checksum Packet could be a null packet (32 bit stream of all zeros) since a Checksum Packet will not disable the KS8701. When the host re-configures the KS8701, the KS8701 will be disabled from sending any packets other than the Part ID Packet until the KS8701 is enabled with a Checksum Packet having the proper data. The ID of the Checksum Packet is 0.

Table 3: Checksum Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	0	0
Byte 2	CV <sub>23</sub>	CV <sub>22</sub>	CV <sub>21</sub>	CV <sub>20</sub>	CV <sub>19</sub>	CV <sub>18</sub>	CV <sub>17</sub>	CV <sub>16</sub>
Byte 1	CV <sub>15</sub>	CV <sub>14</sub>	CV <sub>13</sub>	CV <sub>12</sub>	CV <sub>11</sub>	CV <sub>10</sub>	CV <sub>9</sub>	CV <sub>8</sub>
Byte 0	CV <sub>7</sub>	CV <sub>6</sub>	CV <sub>5</sub>	CV <sub>4</sub>	CV <sub>3</sub>	CV <sub>2</sub>	CV <sub>1</sub>	CV <sub>0</sub>

**CV:** Checksum Value.

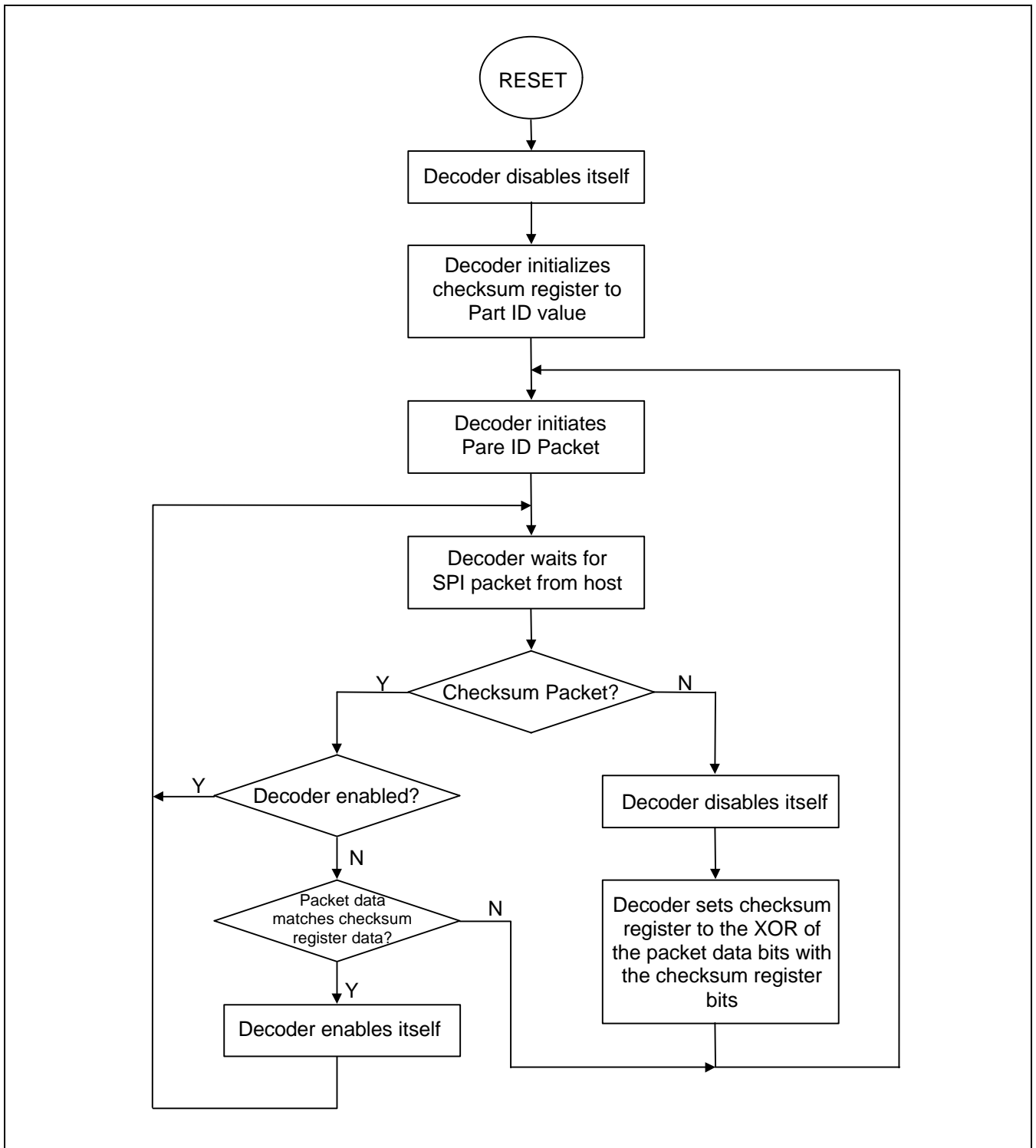


Figure 9: FLEX Decoder IC Checksum Flow Chart

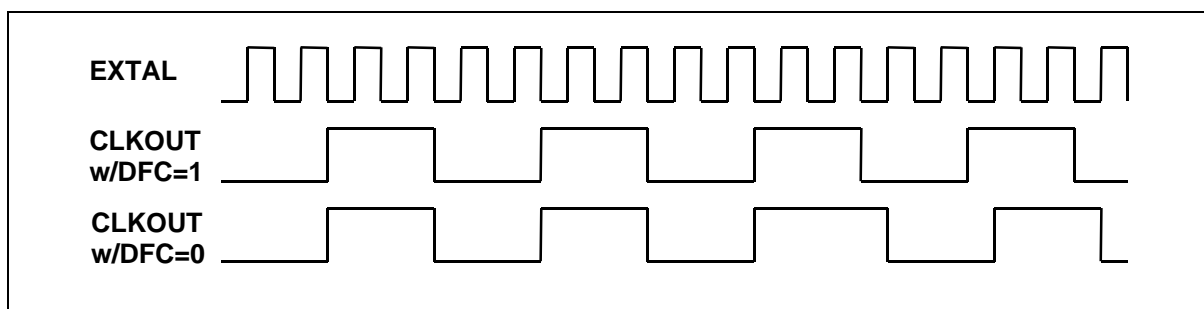
## CONFIGURATION PACKET

The Configuration Packet defines a number of different configuration options for the KS8701. Proper operation is not guaranteed if these settings are changed when decoding is enabled (i.e. the **ON** bit in the Control Packet is set). The ID of the Configuration Packet is 1.

Table 4: Configuration Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	0	1
Byte 2	0	DFC	0	0	0	IDE	OFD <sub>1</sub>	OFD <sub>0</sub>
Byte 1	0	0	0	0	0	PCE	SP <sub>1</sub>	SP <sub>0</sub>
Byte 0	SME	MOT	COD	MTE	LBP	ICO	0	0

**DFC:** Disable Fractional Clock. When this bit is set and **IDE** is set, the **CLKOUT** signal will generate a 40 kHz signal (**EXTAL** divided by 4). When this bit is cleared and **IDE** is set, the **CLKOUT** signal will generate 38.4 kHz signal (**EXTAL** fractionally divided by 25/6 see diagram below). This bit has no effect when **IDE** is cleared. (value after reset=0)



**IDE:** Internal Demodulator Enable. When this bit is set, the internal demodulator is enabled and clock frequency at **EXTAL** is expected to be 160 kHz. When this bit is cleared, the internal demodulator is disabled and the clock frequency at **EXTAL** is expected to be 76.8 kHz.(value after reset=0)

**OFD:** Oscillator Frequency Difference. These bits describe the maximum difference in the frequency of the 76.8 kHz oscillator crystal with respect to the frequency of the transmitter. These limits should be the worst case difference in frequency due to all conditions including but not limited to aging, temperature, and manufacturing tolerance. Using a smaller frequency difference in this packet will result in lower power consumption due to higher receiver battery save ratios. Note that this value is not the absolute error of the oscillator frequency provided to the KS8701. The absolute error of the clock used by the FLEX transmitter must be taken into account. (e.g. If the transmitter tolerance is +/- 25 ppm and the 76.8 kHz oscillator tolerance is +/-140 ppm, the oscillator frequency difference is +/- 165 ppm and **OFD** should be set to 0.)(value after reset=0)

OFD <sub>1</sub>	OFD <sub>0</sub>	Frequency Difference
0	0	+/- 300 ppm
0	1	+/-150 ppm
1	0	+/- 75 ppm
1	1	+/- 0 ppm

**PCE:** Partial Correlation Enable. When this bit is set, partial correlation of addresses is enabled. When partial correlation is enabled, the KS8701 will shutdown the receiver before the end of the last FLEX block which contains addresses if it can determine that none of the addresses in that FLEX block will match any enabled address in the KS8701. When this bit is cleared, the receiver will be controlled as it was in previous versions of the IC.(value after reset=0)

**SP:** Signal Polarity. These bits set the polarity of **EXTS1** and **EXTS0** input signals. (value after reset=0)  
The polarity of the **EXTS0** and **EXTS1** bits will be determined by the receiver design.

SP <sub>1</sub>	SP <sub>0</sub>	Signal Polarity	
		EXTS1	EXTS0
0	0	Normal	Normal
0	1	Normal	Inverted
1	0	Inverted	Normal
1	1	Inverted	Inverted

FSK Modulation @ SP = 0, 0	EXTS1	EXTS0
+4800 Hz	1	0
+1600 Hz	1	1
-1600 Hz	0	1
-4800 Hz	0	0

**SME:** Synchronous Mode Enable. When this bit is set, a Status Packet will be automatically sent whenever the **SMU** (synchronous mode update) bit in the Status Packet is set. The host can use the **SM** (synchronous mode) bit in the Status Packet as an in-range/out-of-range indication. (value after reset=0)

**MOT:** Maximum Off Time. This bit has no effect if **AST** in the Timing Control Packet is non-zero. When **AST=0** and **MOT=0**, asynchronous A-word searches will time-out in 4 minutes. When **AST=0** and **MOT=1**, asynchronous A-word searches will time-out in 1 minute. (value after reset=0)

- COD:** Clock Output Disable. When this bit is clear, a 38.4 kHz or 40kHz (depending on **IDE** and **DFC**) signal will be output on the **CLKOUT** pin. When this bit is set, the **CLKOUT** pin will be driven low. Note that setting and clearing this bit can cause pulses on the **CLKOUT** pin that are less than one half the clock period. Also note that when the clock output is enabled and not set for clock intermittent operation (see **ICO** in this packet), the **CLKOUT** pin will always output the clock signal even when the KS8701 is in reset (as long as the KS8701 oscillator is seeing clocks). Further note that when the KS8701 is used in internal demodulator mode (i.e. uses a 160 kHz oscillator), the **CLKOUT** pin will be 80 kHz from reset until the time the **IDE** bit is set. This is because the KS8701 defaults to external demodulator mode at reset. (value after reset=0)
- MTE:** Minute Timer Enable. When this bit is set, a Status Packet will be sent at one minute intervals with the **MT** (minute time-out) bit in the Status Packet set. When this bit is clear, the internal one-minute timer stops counting. The internal one-minute timer is reset when this bit is changed from 0 to 1 or when the **MTC** (minute timer clear) bit in the Control Packet is set. Note that the minute timer will not be accurate using a 160 kHz oscillator until the **IDE** bit is set. (value after reset=0)
- LBP:** Low Battery Polarity. This bit defines the polarity of the KS8701's **LOBAT** pin. The **LB** bit in the Status Packet is initialized to the inverse value of this bit when the KS8701 is turned on (by setting the **ON** bit in the Control Packet). When the KS8701 is turned on, the first low battery update in the Status Packet will be sent to the host when a low battery condition is detected on the **LOBAT** pin. Setting this bit means that a high on the **LOBAT** pin indicates a low voltage condition. (value after reset=0)
- ICO:** Intermittent Clock Out. When this bit is clear and **COD** is clear, a 38.4 kHz or 40 kHz (depending on the values of **IDE** and **DFC**) signal will be output on the **CLKOUT** pin. When this bit is set and **COD** is clear, the clock will only be output on the **CLKOUT** pin while the receiver is not in the Off state. The clock will be output for a few cycles before the receiver transitions from the off state and for a few cycles after the receiver transitions to the off state (this is to insure that the receiver receives enough clocks to detect and process the changes to and from the Off state). The **CLKOUT** pin will be driven low when it is not driving a clock. Note that when the clock is automatically enabled and disabled (i.e. when **ICO** is set), the **CLKOUT** signal transitions will be clean (i.e. no pulses less than half the clock period) when it transitions between no clock and clocked output. This bit has no effect when **COD** is set. (value after reset=0)

## CONTROL PACKET

The Control Packet defines a number of different control bits for the KS8701. The ID of the Control Packet is 2.

Table 5: Control Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	1	0
Byte 2	FF <sub>7</sub>	FF <sub>6</sub>	FF <sub>5</sub>	FF <sub>4</sub>	FF <sub>3</sub>	FF <sub>2</sub>	FF <sub>1</sub>	FF <sub>0</sub>
Byte 1	0	SPM	PS <sub>1</sub>	PS <sub>0</sub>	0	0	0	0
Byte 0	0	SBI	0	MTC	0	0	EAE	ON

- FF:** Force Frame 0-7. These bits enable and disable forcing the KS8701 to look in frames 0 through 7. When an **FF** bit is set, the KS8701 will decode the corresponding frame. Unlike the **AF** bits in the Frame Assignment Packets, the system collapse of a FLEX system will not affect frames assigned using the **FF** bits (e.g. Where as setting **AF**<sub>0</sub> to 1 when the system collapse is 5 will cause the KS8701 to decode frames 0, 32, 64, and 96, setting **FF**<sub>0</sub> to 1 when the system collapse is 5 will only cause the KS8701 to decode frame 0.). This may be useful for acquiring transmitted time information or channel attributes (e.g. Local ID). (value after reset =0)
- SPM:** Single Phase Mode. When this bit is set, the KS8701 will decode only one phase of the transmitted data. When this bit is clear, the KS8701 will decode all of the phases it receives. A change to this bit while the KS8701 is on, will not take affect until the next block 0 of the next decoded frame. (value after reset =0)
- PS:** Phase Select. When the **SPM** bit is set, these bits define what phase the KS8701 should decode according to the following table. This value is determined by the service provider. A change to these bits while the KS8701 is on, will not take affect until the next block 0 of a frame. (value after reset =0)

PS Value		Phase Decoded (based on FLEX Data Rate)		
PS <sub>1</sub>	PS <sub>0</sub>	1600bps	3200bps	6400bps
0	0	a	a	a
0	1	a	a	b
1	0	a	c	c
1	1	a	c	d

- SBI:** Send Block Information words 2-4. When this bit is set, any errored or time related block information words 2-4 will be sent to the host. See “[Block Information Word Packet](#)” on page 39 for a description of the words sent. (value after reset=0)
- MTC:** Minute Timer Clear. Setting this bit will cause the one minute timer to restart from 0.

- EAE:** End of Addresses Enable. When this bit is set, the **EA** bit in the Status Packet will be set immediately after the KS8701 decodes the last address word in the frame if there was any address detected in the frame. When this bit is cleared, the **EA** bit will never be set.
- ON:** Turn On Decoder. Set if the KS8701 should be decoding FLEX signals. Clear if signal processing should be off (very low power mode). If the **ON** bit is changed twice and the control packets making the changes are received within 2ms of each other, the KS8701 may ignore the double change and stay in its original state (e.g. if it is turned off then on again within 2ms it may stay on and ignore the off pulse). Therefore it is recommended that the host insures a minimum of 2ms between changes in the **ON** bit. (value after reset=0)

**NOTES:** Turning off the KS8701 must be done using the following sequence. This sequence is performed automatically by the FLEX stack software version 1.2 and greater.

1. Turn off the KS8701 by sending a Control Packet with the **ON** bit cleared.
2. Turn on the KS8701 by sending a Control Packet with the **ON** bit set.
3. Turn off the KS8701 by sending a Control Packet with the **ON** bit cleared.

Timing between these steps is specified below and is measured from the positive edge of the last clock of one packet to the positive edge of the last clock of the next packet:

- The minimum time between steps 1 and 2 is 2ms or the programmed shut down time, whichever is greater. The programmed shut down time is the sum of all the of the times . programmed in the used Receiver Shut Down Settings Packets.
- There is no maximum time between steps 1 and 2.
- The minimum time between steps 2 and 3 is 2ms.
- The maximum time between steps 2 and 3 is the programmed warm up time minus 2ms. The programmed warm up time is the sum of all the of the times programmed in the used Receiver Warm Up Settings Packets.

## ALL FRAME MODE PACKET

The All Frame Mode Packet is used to decrement temporary address enable counters by one, decrement the all frame mode counter by one, and/or enable or disable forcing all frame mode. All frame mode is enabled if any temporary address enable counter is non-zero, the all frame mode counter is non-zero, or the force all frame mode bit is set. If all frame mode is enabled, the KS8701 will attempt to decode every frame and send a Status Packet with the **EOF** (end-of-frame) bit set at the end of every frame. Both the all frame mode counter and the temporary address enable counters can only be incremented internally by the KS8701 and can only be decremented by the host. The KS8701 will increment a temporary address enable counter whenever a short instruction vector is received assigning the corresponding temporary address. See [“Operation of a Temporary Address” on page 64](#) for details. The KS8701 will increment the all frame mode counter whenever an alphanumeric, HEX / binary, or secure vector is received. When the host determines that a message associated with a temporary address, or a fragmented message has ended, then the appropriate temporary address counter or all frame mode counter should be decremented by writing an All Frame Mode Packet to the KS8701 in order to exit the all frame mode, thereby improving battery life. See [“Building a Fragmented Message” on page 61](#) for details. Neither the temporary address enable counters nor the all frame mode counter can be incremented past the value 127 (i.e. it will not roll-over) or decremented past the value 0. The temporary address enable counters and the all frame mode counter are initialized to 0 at reset and when the decoder is turned off. The ID of the All Frame Mode Packet is 3.

Table 6: All Frame Mode Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	1	1
Byte 2	DAF	FAF	0	0	0	0	0	0
Byte 1	DTA15	DTA14	DTA13	DTA12	DTA11	DTA10	DTA9	DTA8
Byte 0	DTA7	DTA6	DTA5	DTA4	DTA3	DTA2	DTA1	DTA0

- DAF:** Decrement All Frame counter. Setting this bit decrements the all frame mode counter by one. If a packet is sent with this bit clear, the all frame mode counter is not affected. (value after reset=0)
- FAF:** Force All Frame mode. Setting this bit forces the KS8701 to enter all frame mode. If this bit is clear, the KS8701 may or may not be in all frame mode depending on the status of the all frame mode counter and the temporary address enable counters. This may be useful in acquiring transmitted time information.(value after reset=0)
- DTA:** Decrement Temporary Address enable counter. When a bit in this word is set, the corresponding temporary address enable counter is decremented by one. When a bit is cleared, the corresponding temporary address enable counter is not affected. When a temporary address enable counter reaches zero, the temporary address is disabled.(value after reset=0)



## OPERATOR MESSAGING ADDRESS ENABLE PACKET

The operator messaging address enable packet is used to enable and disable the built-in FLEX operator messaging addresses. Enabling and disabling operator messaging addresses does not affect what frames the decoder IC decodes. To decode the proper frames, the host must modify the **FF** bits in the Control Packet or the **AF** bits in the Frame Assignment Packets. The ID of the operator messaging address enable packet is 4.

Table 7: System Address Enable Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	1	0	0
Byte 2	0	0	0	0	0	0	0	0
Byte 1	OAE <sub>15</sub>	OAE <sub>14</sub>	OAE <sub>13</sub>	OAE <sub>12</sub>	OAE <sub>11</sub>	OAE <sub>10</sub>	OAE <sub>9</sub>	OAE <sub>8</sub>
Byte 0	OAE <sub>7</sub>	OAE <sub>6</sub>	OAE <sub>5</sub>	OAE <sub>4</sub>	OAE <sub>3</sub>	OAE <sub>2</sub>	OAE <sub>1</sub>	OAE <sub>0</sub>

**OAE:** Operator messaging Address Enable. When a bit is set, the corresponding operator messaging address is enabled. When it is cleared, the corresponding operator messaging address is disabled. **OAE<sub>0</sub>** through **OAE<sub>15</sub>** corresponds to the hexadecimal operator messaging address values of 1F7810 through 1F781F respectively. (value after reset=0)

## ROAMING CONTROL PACKET

The roaming control packet controls the features of the KS8701 that allow implementation of a roaming device. The ID of the roaming control packet is 5.

Table 8: Roaming Control Packet Bit Assignments

	Bit	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	1	0	1
Byte 2	IRS	NBC	MCM	IS1	SDF	RSP	SND	CND
Byte 1	RND	ABI	SAS	DAS	0	0	0	0
Byte 0	0	0	MFC <sub>1</sub>	MFC <sub>0</sub>	0	0	MCO <sub>1</sub>	MCO <sub>0</sub>

- IRS:** Ignore Re-synchronization Signal. When this bit is set, KS8701 will not go asynchronous when detecting an Ar or  $\overline{Ar}$  signal during searches for A-words. It will merely report that the re-synchronization signal was received by setting **RSR** to 1 in the Roaming Status packet. This allows the host to decide what to do when the paging device is synchronous to more than one channel and only one channel is sending the re-synchronization signal. It also prevents the KS8701 from losing synchronization when it detects the re-synchronization signal while the paging device is checking an unknown channel. This bit is set and cleared by the host. (value after reset=0)
- NBC:** Network Bit Check. Setting this bit will enable reporting of the received network bit value (**NBU** and **n**) in the Roaming Status Packet. Setting this bit also makes the KS8701 abandon a frame after the Frame Info word without synchronizing to the frame if the frame information word is uncorrectable or if the **n** bit in the frame information word is not set. If the KS8701 was in synchronous mode when this occurred (probably due to synchronizing to a second channel), it will maintain synchronization to the original channel. If the KS8701 was in asynchronous mode when this occurred, it will stay in asynchronous mode and end the A-word search. This is done to avoid synchronizing to a non-roaming channel when searching for roaming channels. This bit is set and cleared by the host. (value after reset=0)
- MCM:** Manual Collapse Mode. When this bit is set, the KS8701 behaves as if the system collapse was 7. The KS8701 will not apply the received system collapse to the **AF** bits. When this bit is set, the received system collapse is reported to the host via **SCU** and **RSC** in the Roaming Status Packet. This is so the host can modify the **AF** bits based on the system collapse of the channel. This bit is set and cleared by the host. (value after reset=0)
- IS1:** Invert **EXTS1**. Setting this bit inverts the expected polarity of the **EXTS1** pin from the way it is configured by **SP1** in the Configuration Packet (e.g. if both **IS1** and **SP1** are set, the polarity of the **EXTS1** pin is untouched). This bit is intended to be changed when a change in a channel changes the polarity of the received signal. This bit is set and cleared by the host. This bit has the equivalent effect when using the internal demodulator. (value after reset=0)
- SDF:** Stop Decoding Frame. Setting this bit causes the KS8701 to stop decoding a frame without losing frame synchronization. This bit is set by the host, and cleared by the KS8701 once it has been processed. The packet with the **SDF** bit set must be sent after receiving the status packet with **EA** bit set. It must be sent within 40ms of the end of block in which the KS8701 set the **EA** bit. (value after reset=0)

- RSP:** Receiver Shutdown Packet enable. When this bit is set, a Receiver Shutdown Packet will be sent whenever the receiver is shut down. The receiver shutdown packet informs the host that the receiver shutdown, and how long it will be before the KS8701 will automatically warm the receiver back up. (value after reset=0)
- SND:** Start Noise Detect. Setting this bit while the KS8701 is battery saving will cause it to warm-up the receiver, run a noise detect, and report the result of the noise detect via **NDR** in the Roaming Status Packet. This bit is set by the host, and cleared by the KS8701 once it has been processed. If the time comes for the KS8701 to warm up for automatically or the **SAS** bit is set while an **SND** is being processed, the noise detect will be abandoned and the abandoned noise detect result (**NDR=01**) will be sent in the Roaming Status Packet. (value after reset=0)
- CND:** Continuous Noise Detect. Setting this bit will cause the KS8701 to do continuous noise detects during the decoded block data of a frame. The results of the noise detect will only be reported if noise is detected (**NDR=11**). Only one noise detected result (**NDR=11**) will be sent per block. If the KS8701 has not completed a noise detect when it shuts down for the frame, that noise detect will be abandoned, but no abandon result (**NDR=01**) will be sent. This bit is set and cleared by the host. (value after reset=0)
- RND:** Report Noise Detects. Setting this bit will cause the KS8701 to report the results of the noise detects it does under normal asynchronous operation (when first turned on and when asynchronous). The results of the noise detect will be reported via **NDR** in the Roaming Status Packet. This bit is set and cleared by the host. (value after reset=0)
- ABI:** All Block Information words. When this bit is set, the KS8701 will send all received Block Information words 2-4 to the host. Note: Setting the **SBI** bit in the Control Packet only enables errored and real time clock related block info words. (value after reset=0)
- SAS:** Start A-word Search. Setting this bit while in asynchronous battery save mode will cause the KS8701 to warm-up the receiver and run an A-word search. If, during the A-word search, the KS8701 finds sufficient FLEX signal, it will enter synchronous mode and start decoding the frame. If the A-word search times-out without finding sufficient FLEX signal, it will battery save and continue doing periodic noise detects. The time-out for the A-word searches is controlled by the **AST** bits in the Timing Control Packet and the **MOT** bit in the Configuration Packet. The A-word search takes priority over noise detects. Therefore, if the KS8701 is performing an A-word search and the time comes to do automatic noise detect, the noise detect will not be performed. This bit is set by the host, and cleared by the KS8701 once it has been acted on. (value after reset=0)
- DAS:** Disable A-word Search. When this bit is set, an A-word search will not automatically occur after a noise detect in asynchronous mode finds FLEX signal. This includes automatic noise detects and noise detects initiated by the host by setting **SND**. The KS8701 will shut down the receiver after the noise detect completes regardless of the result. When this bit is cleared, A-word searches will occur after a noise detect finds signal in asynchronous mode. (value after reset=0)

**MFC:** Missed Frame Control. These bits control the frames for which missing frame data (**MS1**, **MFI**, **MS2**, **MBI**, and **MAW**) is reported in the Roaming Status Packet. (value after reset=0)

<b>MFC<sub>1</sub></b>	<b>MFC<sub>0</sub></b>	<b>Missing Frame Data Reported</b>
0	0	Never
0	1	Only during frames 0 through 3
1	0	Only during frames 0 through 7
1	1	Always

**MCO:** Maximum Carry On. The value of these bits sets the maximum carry on that the KS8701 will follow. For example, if the KS8701 receives a carry on of 3 over the air and **MCO** is set to 1, the KS8701 will only carry on for one frame. (value after reset=3)

## TIMING CONTROL PACKET

The timing control packet gives the host control of the timing used when the KS8701 is in asynchronous mode. The packet ID for the timing control packet is 6.

Table 9: Timing Control Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	1	1	0
Byte 2	0	0	0	0	0	0	0	0
Byte 1	AST <sub>7</sub>	AST <sub>6</sub>	AST <sub>5</sub>	AST <sub>4</sub>	AST <sub>3</sub>	AST <sub>2</sub>	AST <sub>1</sub>	AST <sub>0</sub>
Byte 0	ABT <sub>7</sub>	ABT <sub>6</sub>	ABT <sub>5</sub>	ABT <sub>4</sub>	ABT <sub>3</sub>	ABT <sub>2</sub>	ABT <sub>1</sub>	ABT <sub>0</sub>

**AST:** A-word Search Time. The value of these bits sets the A-word search time for all asynchronous A-word searches in units of 80ms (e.g. value of 1 is 80ms. value of 2 is 160ms, etc.) If the value is 0, the KS8701 defaults to the 1-minute (**MOT**=1) or 4-minute (**MOT**=0) A-word search time controlled by the **MOT** bit in the configuration packet. (Value after reset=0)

**ABT:** Asynchronous Battery-save Time. The value of these bits sets the battery save time (time from the beginning of one automatic noise detect to the beginning of the next automatic noise detect) in asynchronous mode in units of 80ms (e.g. value of 1 is 80ms, value of 2 is 160ms, etc.) If the value is 0, the battery save time is set to the default value of 1.5 seconds. The minimum allowed **ABT** is 320ms, therefore values of 1, 2, 3, and 4 are invalid. (Value after reset=0)

## RECEIVER LINE CONTROL PACKET

This packet gives the host control over the settings on the receiver control lines (**S0-S7**) in all modes except reset. In reset, the receiver control lines are in high impedance settings. The ID for the Receiver Line Control Packet is 15 (decimal).

Table 10: Receiver Line Control Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	1	1	1	1
Byte 2	0	0	0	0	0	0	0	0
Byte 1	FRS <sub>7</sub>	FRS <sub>6</sub>	FRS <sub>5</sub>	FRS <sub>4</sub>	FRS <sub>3</sub>	FRS <sub>2</sub>	FRS <sub>1</sub>	FRS <sub>0</sub>
Byte 0	CLS <sub>7</sub>	CLS <sub>6</sub>	CLS <sub>5</sub>	CLS <sub>4</sub>	CLS <sub>3</sub>	CLS <sub>2</sub>	CLS <sub>1</sub>	CLS <sub>0</sub>

- FRS:** Force Receiver Setting. Setting a bit to one will cause the corresponding **CLS** bit in this packet to override the internal receiver control settings on the corresponding receiver control line (**S0 - S7**). Clearing a bit gives control of the corresponding receiver control lines (**S0 - S7**) back to the KS8701. (value after reset=0)
- CLS:** Control Line Setting. If the corresponding **FRS** bit was set in this packet, these bits define what setting should be applied to the corresponding receiver control lines.(value after reset=0)

## RECEIVER CONTROL CONFIGURATION PACKETS

These packets allow the host to configure what setting is applied to the receiver control lines **S0-S7**, how long to apply the setting, and when to read the value of the **LOBAT** input pin. For a more detailed description of how the KS8701 uses these settings see “Receiver Control” on page 55. The KS8701 defines 12 different receiver control settings. Proper operation is not guaranteed if these settings are changed when decoding is enabled (i.e. the **ON** bit in the Control Packet is set). The IDs for these packets range from 16 to 27 (decimal).

### RECEIVER OFF SETTING PACKET

Table 11: Receiver Off setting Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit1	Bit 0
Byte 3	0	0	0	1	0	0	0	0
Byte 2	0	0	0	0	LBC	0	0	0
Byte 1	CLS <sub>7</sub>	CLS <sub>6</sub>	CLS <sub>5</sub>	CLS <sub>4</sub>	CLS <sub>3</sub>	CLS <sub>2</sub>	CLS <sub>1</sub>	CLS <sub>0</sub>
Byte 0	ST <sub>7</sub>	ST <sub>6</sub>	ST <sub>5</sub>	ST <sub>4</sub>	ST <sub>3</sub>	ST <sub>2</sub>	ST <sub>1</sub>	ST <sub>0</sub>

**LBC:** Low Battery Check. If this bit is set, the KS8701 will check the status of the **LOBAT** port just before leaving this receiver state. (value after reset=0)

**CLS:** Control Line Setting. This is the value to be output on the receiver control lines (**S0 - S7**) for this receiver state. (value after reset=0)

**ST:** Step Time. This is the time the KS8701 is to keep the receiver off before applying the first warm up state's receiver control value to the receiver control lines. The setting is in steps of 625us. Valid values are 625us (**ST=01**) to 159.375ms (**ST=FF** in hexadecimal). (value after reset=625us)

**RECEIVER WARM UP SETTING PACKETS**

Table 12: Receiver Warm Up Setting Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	1	0	s <sub>2</sub>	s <sub>1</sub>	s <sub>0</sub>
Byte 2	SE	0	0	0	LBC	0	0	0
Byte 1	CLS <sub>7</sub>	CLS <sub>6</sub>	CLS <sub>5</sub>	CLS <sub>4</sub>	CLS <sub>3</sub>	CLS <sub>2</sub>	CLS <sub>1</sub>	CLS <sub>0</sub>
Byte 0	0	ST <sub>6</sub>	ST <sub>5</sub>	ST <sub>4</sub>	ST <sub>3</sub>	ST <sub>2</sub>	ST <sub>1</sub>	ST <sub>0</sub>

**s:** Setting Number. Receiver control setting for which this packet’s values are to be applied. The following truth table shows the names of each of the values for s that apply to this packet.

s <sub>2</sub> s <sub>1</sub> s <sub>0</sub>	Setting Name
001	Warm Up 1
010	Warm Up 2
011	Warm Up 3
100	Warm Up 4
101	Warm Up 5

**SE:** Step Enable. The receiver setting is enabled when the bit is set. If a step in the warm up sequence is disabled, the disabled step and all remaining steps will be skipped. (value after reset=0)

**LBC:** Low Battery Check. If this bit is set, the KS8701 will check the status of the **LOBAT** port just before leaving this receiver state. (value after reset=0)

**CLS:** Control Line Setting. This is the value to be output on the receiver control lines (**S0 - S7**) for this receiver state. (value after reset=0)

**ST:** Step Time. This is the time the KS8701 is to wait before applying the next state’s receiver control value to the receiver control lines. The setting is in steps of 625us. Valid values are 625us (**ST=01**) to 79.375ms (**ST=7F** in hexadecimal), (value after reset=625us)



## 3200SPS SYNC SETTING PACKETS

Table 13: 3200sps Sync Setting Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	1	0	1	1	0
Byte 2	0	0	0	0	LBC	0	0	0
Byte 1	CLS <sub>7</sub>	CLS <sub>6</sub>	CLS <sub>5</sub>	CLS <sub>4</sub>	CLS <sub>3</sub>	CLS <sub>2</sub>	CLS <sub>1</sub>	CLS <sub>0</sub>
Byte 0	0	ST <sub>6</sub>	ST <sub>5</sub>	ST <sub>4</sub>	ST <sub>3</sub>	ST <sub>2</sub>	ST <sub>1</sub>	ST <sub>0</sub>

**LBC:** Low Battery Check. If this bit is set, the KS8701 will check the status of the **LOBAT** port just before leaving this receiver state. (value after reset=0)

**CLS:** Control Line Setting. This is the value to be output on the receiver control lines (**SO** - **S7**) for this receiver state. (value after reset=0)

**ST:** Step Time. This is the time the KS8701 is to wait before expecting good signals on the **EXTS1** and **EXTS0** signals after warming up. The setting is in steps of 625us. Valid values are 625us (**ST=01**) to 79.375ms (**ST=7F** in hexadecimal). (value after reset=625us)

## RECEIVER ON SETTING PACKETS

Table 14: Receiver On Setting Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	1	$s_3$	$s_2$	$s_1$	$s_0$
Byte 2	0	0	0	0	LBC	0	0	0
Byte 1	$CLS_7$	$CLS_6$	$CLS_5$	$CLS_4$	$CLS_3$	$CLS_2$	$CLS_1$	$CLS_0$
Byte 0	0	0	0	0	0	0	0	0

- s:** Setting Number. Receiver control setting for which this packet's values are to be applied. The following truth table shows the names of each of the values for s that apply to this packet.

$s_3s_2s_1s_0$	Setting Name
0111	1600sps Sync
1000	3200sps Data
1001	1600sps Data

**LBC:** Low Battery Check. If this bit is set, the KS8701 will check the status of the **LOBAT** port just before leaving this receiver state. (value after reset=0)

**CLS:** Control Line Setting. This is the value to be output on the receiver control lines (**S0 - S7**) for this receiver state. (value after reset=0)

## RECEIVER SHUT DOWN SETTING PACKETS

Table 15: Receiver Shut Down Setting Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	1	1	0	1	s
Byte 2	SE	0	0	0	LBC	0	0	0
Byte 1	CLS <sub>7</sub>	CLS <sub>6</sub>	CLS <sub>5</sub>	CLS <sub>4</sub>	CLS <sub>3</sub>	CLS <sub>2</sub>	CLS <sub>1</sub>	CLS <sub>0</sub>
Byte 0	0	0	ST <sub>5</sub>	ST <sub>4</sub>	ST <sub>3</sub>	ST <sub>2</sub>	ST <sub>1</sub>	ST <sub>0</sub>

**s:** Setting Number. Receiver control setting for which this packet's values are to be applied. The following truth table shows the names of each of the values for s that apply to this packet.

s	Setting Name
0	Shut Down 1
1	Shut Down 2

**SE:** Step Enable. The receiver setting is enabled when the bit is set. If a step in the shut down sequence is disabled, all steps following the disabled step will be ignored. (value after reset=0)

**LBC:** Low Battery Check. If this bit is set, the KS8701 will check the status of the **LOBAT** port just before leaving this receiver state. (value after reset=0)

**CLS:** Control Line Setting. This is the value to be output on the receiver control lines (**S0 - S7**) for this receiver state. (value after reset=0)

**ST:** Step Time. This is the time the KS8701 is to wait before applying the next state's receiver control value to the receiver control lines. The setting is in steps of 625us. Valid values are 625us (**ST=01**) to 39.375ms (**ST=3F** in hexadecimal).(value after reset=625us)

## FRAME ASSIGNMENT PACKETS

The FLEX protocol defines that each address of a FLEX pager is assigned a home frame and a battery cycle. The KS8701 must be configured so that a frame that is assigned by one or more of the addresses' home frames and battery cycles has its corresponding configuration bit set. For example, if the KS8701 has one enabled address and it is assigned to frame 3 with a battery cycle of 4, the **AF** bits for frames 3, 19, 35, 51, 67, 83, 99, and 115 should be set and the **AF** bits for all other frames should be cleared.

When the KS8701 is configured for manual collapse mode by setting the **MCM** bit in the Roaming Control Packet, the KS8701 will not apply the received system collapse to the **AF** bits. The host should set the **AF** bits for all frames that should be decoded on all channels. For example, if frames 0 and 64 should be decoded on one channel and frames 4, 36, 68, and 100 should be decoded on another channel, all six of the corresponding **AF** bits should be set. The host can then change the receiver's carrier frequency after the KS8701 decodes frames 0, 36, 64, and 100.

There are 8 Frame Assignment Packets. The Packet IDs for these packets range from 32 to 39 (decimal).

Table 16: Frame Assignment Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	1	0	0	$f_2$	$f_1$	$f_0$
Byte 2	0	0	0	0	0	0	0	0
Byte 1	$AF_{15}$	$AF_{14}$	$AF_{13}$	$AF_{12}$	$AF_{11}$	$AF_{10}$	$AF_9$	$AF_8$
Byte 0	$AF_7$	$AF_6$	$AF_5$	$AF_4$	$AF_3$	$AF_2$	$AF_1$	$AF_0$

- f:** Frame range. This value determines which 16 frames correspond to the 16 **AF** bits in the packet according to the following table. At least one of these bits must be set when the KS8701 is turned on by setting the **ON** bit in the control packet. (value after reset=0)

$f_2f_1f_0$	$AF_{15}$	$AF_0$
000	Frame 127	Frame 112
001	Frame 111	Frame 96
010	Frame 95	Frame 80
011	Frame 79	Frame 64
100	Frame 63	Frame 48
101	Frame 47	Frame 32
110	Frame 31	Frame 16
111	Frame 15	Frame 0

- AF:** Assigned Frame. If a bit is set, the KS8701 will consider the corresponding frame to be assigned via an address's home frame and pager collapse. (value after reset=0)

## USER ADDRESS ENABLE PACKET

The User Address Enable Packet is used to enable and disable the 16 user address words. Although the host is allowed to change the user address words while the KS8701 is decoding FLEX signals, the host must disable a user address word before changing it. The ID of the User Address Enable Packet is 120 (decimal).

Table 17: User Address Enable Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	1	1	1	1	0	0	0
Byte 2	0	0	0	0	0	0	0	0
'Byte 1	UAE <sub>15</sub>	UAE <sub>14</sub>	UAE <sub>13</sub>	UAE <sub>12</sub>	UAE <sub>11</sub>	UAE <sub>10</sub>	UAE <sub>9</sub>	UAE <sub>8</sub>
Byte 0	UAE <sub>7</sub>	UAE <sub>6</sub>	UAE <sub>5</sub>	UAE <sub>4</sub>	UAE <sub>3</sub>	UAE <sub>2</sub>	UAE <sub>1</sub>	UAE <sub>0</sub>

**UAE:** User Address Enable. When a bit is set, the corresponding user address word is enabled. When it is cleared, the corresponding user address word is disabled. **UAE<sub>0</sub>** corresponds to the user address word configured using a packet ID of 128, and **UAE<sub>15</sub>** corresponds to the user address word configured using a packet ID of 143. (value after reset=0)

## USER ADDRESS ASSIGNMENT PACKETS

The KS8701 has 16 user address words. Each word can be programmed to be a short address, part of a long address, or the first part of a network ID. The addresses are configured using the Address Assignment Packets. Each user address can be configured as long or short and tone-only or regular (network ID's are short and regular). Although the host is allowed to send these packets while the KS8701 is on, the host must disable the user address word by clearing the corresponding **UAE** bit in the User Address Enable Packet before changing any of the bits in the corresponding User Address Assignment Packet. This method allows for easy reprogramming of user addresses without disrupting normal operation. The IDs for these packets range from 128 to 143 (decimal).

Table 18: User Address Assignment Packet Bit Assignments

	Bit7	Bit 6	Bit 5	Bit4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	1	0	0	0	$a_3$	$a_2$	$a_1$	$a_0$
Byte 2	0	LA	TOA	$A_{20}$	$A_{19}$	$A_{18}$	$A_{17}$	$A_{16}$
Byte 1	$A_{15}$	$A_{14}$	$A_{13}$	$A_{12}$	$A_{11}$	$A_{10}$	$A_9$	$A_8$
Byte 0	$A_7$	$A_6$	$A_5$	$A_4$	$A_3$	$A_2$	$A_1$	$A_0$

- a:** User Address Word Number. This specifies which address word is being configured. A zero in this field corresponds to address index zero ( $AI=0$ ) in the Address Packet received from the KS8701 when an address is detected. See "Address Packet" on page 41 for a description of the address index field.
- LA:** Long address. When this bit is set, the address is considered a long address. Both words of a long address must have this bit set. The first word of a long address must have an even address index and the second word must be in the address index immediately following the first word.
- TOA:** Tone-Only Address. When this bit is set, the KS8701 will consider this address a tone-only address and will not decode a vector word when the address is received. If the **TOA** bit of a long address word is set, the **TOA** bit of the other word of the long address must also be set.
- A:** Address word. This is the 21 bit value of the address word. Valid FLEX messaging addresses or Network ID's may be used.

## DECODER-TO-HOST PACKET DESCRIPTIONS

The following sections describe the packets of information that will be sent from the KS8701 to the host. In all cases the packets are sent MSB first (bit 7 of byte 3 = bit 31 of the packet = MSB). The KS8701 decides what data should be sent to the host. If the KS8701 is disabled through the checksum feature (see “Checksum Packet” on page 16 for a description of the checksum feature) the Part ID Packet will be sent. Data Packets relating to data received over the air are buffered in the 32 packet transmit buffer. The Data packets include Block Information Word Packets, Address Packets, Vector Packets, and Message Packets.

If the KS8701 is enabled and a receiver shutdown packet is pending, the receiver shutdown packet will be sent. If there is no receiver shutdown packet pending, but there is a roaming status packet pending, the roaming status packet will be sent. If neither the receiver shutdown packet nor the roaming status packet is pending and there is data in the transmit buffer, a packet from the transmit buffer will be sent. Otherwise, the KS8701 will send the Status Packet (which is not buffered). In the event of a buffer overflow, the KS8701 will automatically stop decoding and clear the buffer.

It is recommended that the Host be designed to empty the FIFO buffer every block with enough time left over to read a status packet. This would ensure that any applicable Status Packet would be received within 1 block of the new status being available.

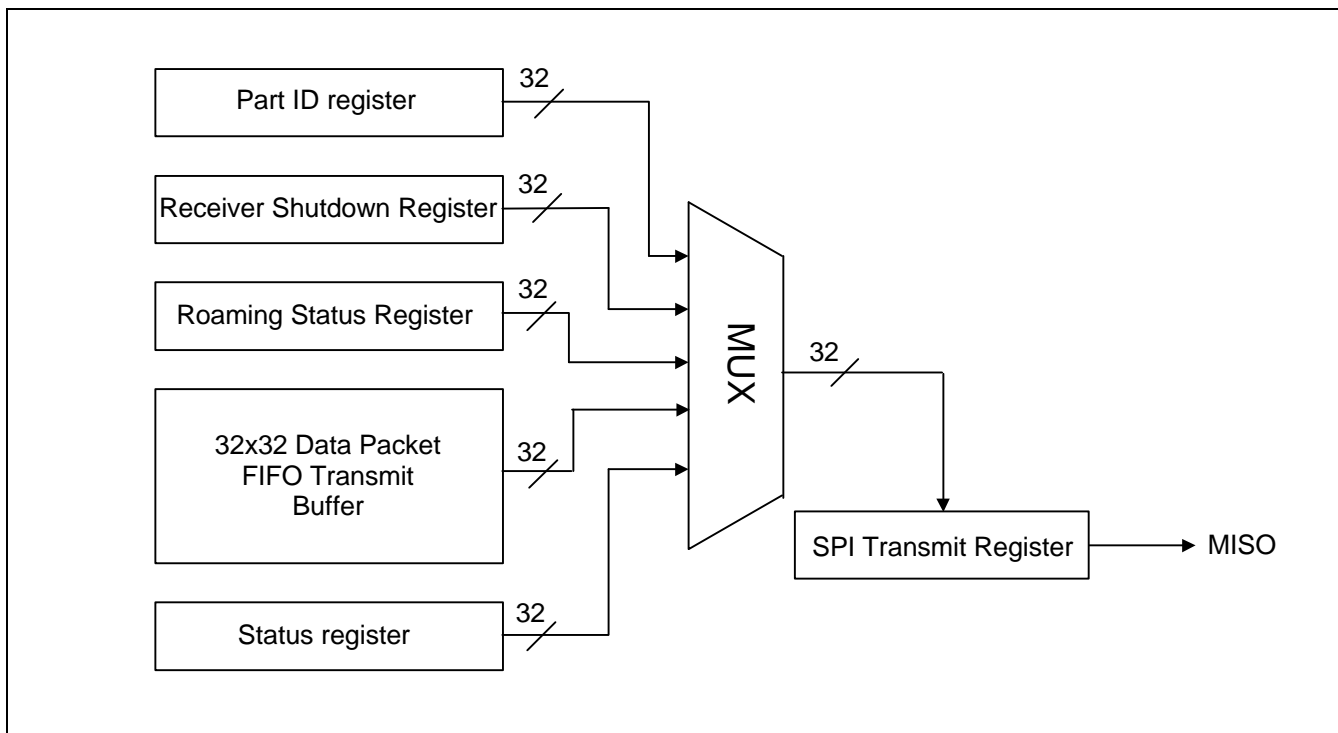


Figure 10: FLEX decoder IC SPI Transmit Functional Block Diagram

## BLOCK INFORMATION WORD PACKET

The Block Information Field is the first field following the synchronization codes of the FLEX protocol. This field contains information about the frame such as number of addresses and messages, information about current time, the channel ID, channel attributes, etc. The first block information word of each phase is used internally to the KS8701 and is never transmitted to the host with the exception of the system collapse which is sent to the host when the KS8701 is in manual collapse mode.

Time block information words 2-4 can be optionally sent to the host by setting the **SBI** bit in the control packet (see “Control Packet” on page 21). All block information words 2-4 can be optionally sent to the host by setting the **ABI** bit in the roaming control packet. When the **SBI** or **ABI** bit is set and any block information word 2-4 is received with an uncorrectable number of bit errors, the KS8701 will send the block information word to the host with the e bit set regardless of the value of the f field in the block information word. The KS8701 does not support decoding of the vector and message words associated with the Data/System Message block info word (f=101). The ID of a Block Information Word Packet is 0 (decimal).

Table 19: Block Information Word Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	0	0
Byte 2	e	p <sub>1</sub>	p <sub>0</sub>	x	x	f <sub>2</sub>	f <sub>1</sub>	f <sub>0</sub>
Byte 1	x	x	s <sub>13</sub>	s <sub>12</sub>	s <sub>11</sub>	s <sub>10</sub>	s <sub>9</sub>	s <sub>8</sub>
Byte 0	s <sub>7</sub>	s <sub>6</sub>	s <sub>5</sub>	s <sub>4</sub>	s <sub>3</sub>	s <sub>2</sub>	s <sub>1</sub>	s <sub>0</sub>

- e:** Set if more than 2 bit errors are detected in the word or if the check character calculation fails after error correction has been performed.
- p:** Phase on which the block information word was found (0=a, 1=b, 2=c, 3=d)
- x:** Unused bits. The value of these bits is not guaranteed.
- f:** Word Format Type. The value of these bits modify the meaning of the s bits in this packet as described in the BIW word descriptions in the s bit definition below.



- s: These are the information bits of the block information word. The definition of these bits depend on the f bits in this packet. The following table describes the block information words.

$f_2 f_1 f_0$	$S_{13} S_{12} S_{11} S_{10} S_9 S_8 S_7 S_6 S_5 S_4 S_3 S_2 S_1 S_0$	Description
000 <sup>a</sup>	$i_8 i_7 i_6 i_5 i_4 i_3 i_2 i_1 i_0 C_4 C_3 C_2 C_1 C_0$	Local ID, Coverage Zone
001 <sup>b</sup>	$m_3 m_2 m_1 m_0 d_4 d_3 d_2 d_1 d_0 Y_4 Y_3 Y_2 Y_1 Y_0$	Month, Day, Year
010 <sup>b</sup>	$S_2 S_1 S_0 M_5 M_4 M_3 M_2 M_1 M_0 H_4 H_3 H_2 H_1 H_0$	Second, Minute, Hour
011 <sup>a</sup>	Reserved by FLEX protocol for future use	
100 <sup>a</sup>	Reserved by FLEX protocol for future use	
101 <sup>b</sup>	$Z_9 Z_8 Z_7 Z_6 Z_5 Z_4 Z_3 Z_2 Z_1 Z_0 A_3 A_2 A_1 A_0$	System Message
110 <sup>a</sup>	Reserved by FLEX protocol for future use	
111 <sup>a</sup>	$C_9 C_8 C_7 C_6 C_5 C_4 C_3 C_2 C_1 C_0 T_3 T_2 T_1 T_0$	Country Code, Traffic Management Flags

- a. Will be decoded only if the **ABI** bit is set  
 b. Will be decoded only if the **SBI** or **ABI** bit is set

## ADDRESS PACKET

The Address Field follows the Block Information Field in the FLEX protocol. It contains all of the address in the frame.

If less than three bit errors are detected in a received address word and it matches an enabled address assigned to the KS8701, an Address Packet will be sent to the host processor. The Address Packet contains assorted data about the address and its associated vector and message. The ID of an Address Packet is 1 (decimal).

Table 20: Address Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	0	0	0	0	0	0	1
Byte 2	PA	p <sub>1</sub>	p <sub>0</sub>	LA	x	x	x	x
Byte 1	AI <sub>7</sub>	AI <sub>6</sub>	AI <sub>5</sub>	AI <sub>4</sub>	AI <sub>3</sub>	AI <sub>2</sub>	AI <sub>1</sub>	AI <sub>0</sub>
Byte 0	TOA	WN <sub>6</sub>	WN <sub>5</sub>	WN <sub>4</sub>	WN <sub>3</sub>	WN <sub>2</sub>	WN <sub>1</sub>	WN <sub>0</sub>

- PA:** Priority Address. Set if the address was received as a priority address.
- p:** Phase on which the address was detected (0=a, 1=b, 2=c, 3=d)
- LA:** Long Address type. Set if the address was programmed in the KS8701 as a long address.
- AI:** Address Index (valid values are 0 through 15 and 128 through 159). The index identifies which of the addresses was detected. Values 0 through 15 correspond to the 16 programmable address words. Values 128 through 143 correspond to the 16 temporary addresses. Values 144 through 159 correspond to the 16 operator messaging addresses. For long addresses, the address detect packet will only be sent once and the index will refer to the second word of the address.
- TOA:** Tone Only Address. Set if the address was programmed in the KS8701 as a tone-only address. This bit will never be set for temporary or operator messaging addresses. No vector word will be sent for tone-only addresses.
- WN:** Word number of vector (2 - 87). Describes the location in the frame of the vector word for the detected address. This value is invalid for this packet if the **TOA** bit is set.
- x:** Unused bits. The value of these bits is not guaranteed.

## VECTOR PACKET

The Vector Field follows the Address Field in the FLEX protocol. Each Vector Packet must be matched to its corresponding Address Packet. The ID of the vector packet is the word number where the vector word was received in the frame. This value corresponds to the **WN** bits sent in the associated address packet. The phase information in both the Address Packet and the Vector Packet must also match. It is important to note for long addresses, the first message word will be transmitted in the word location immediately following the associated vector. See [“Message Building” on page 59](#) for a message building example. In this case, the word number (identified by **b<sub>6</sub>** to **b<sub>0</sub>**) in the Vector Packet will indicate the message start of the second message word if the message is longer than 1 word.

There are several types of vectors - 3 types of Numeric Vectors, a Short Message / Tone Only Vector, a Hex / Binary Vector, an Alphanumeric Vector, a Secure Message Vector, and a Short Instruction Vector. Each is described in the following pages. One of the modes of the Short Instruction Vector is used for assigning temporary addresses that may be associated with a group call.

The Numeric, Hex / Binary, Alphanumeric, and Secure Message Vector Packets have associated Message Word Packets in the message field. The host must use the **n** and **b** bits of the vector word to calculate what message word locations are associated with the vector. Both the message word locations and the phase must match.

Four of the vectors (Hex / Binary, Alphanumeric, Secure Message, and Short Instruction) enable the KS8701 to begin the all frame mode. This mode is required to allow for the decoding of temporary addresses and / or fragmented messages. The host disables the All Frame Mode after the proper time by writing to the decoder via the All Frame Mode Packet. See [“Building a Fragmented Message” on page 61](#) and [“Operation of a Temporary Address” on page 64](#) for more information. For any Address Packet sent to the host (except tone-only addresses), a corresponding Vector Packet will always be sent. If more than two bit errors are detected (via BCH calculations, parity calculations, check character calculations, or value validation) in the vector word the **e** bit will be set and the message words will not be sent.

## NUMERIC VECTOR PACKET

Table 21: Numeric Vector Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	$WN_6$	$WN_5$	$WN_4$	$WN_3$	$WN_2$	$WN_1$	$WN_0$
Byte 2	e	$p_1$	$p_0$	x	x	$V_2$	$V_1$	$V_0$
Byte 1	x	x	$K_3$	$K_2$	$K_1$	$K_0$	$n_2$	$n_1$
Byte 0	$n_0$	$b_6$	$b_5$	$b_4$	$b_3$	$b_2$	$b_1$	$b_0$

**V:** Vector type identifier.

$V_2 V_1 V_0$	Name	Description
011	Standard Numeric Vector	No special formatting of characters is specified
100	Special Format Numeric Vector	Formatting of the received characters is predetermined by special rules in the host.
111	Numbered Numeric Vector	The received information has been numbered by the service provider to indicate all messages have been properly received

**WN:** Word number of vector (2 - 87 decimal). Describes the location of the vector word in the frame.

**e:** Set if more than 2 bit errors are detected in the word, if the check character calculation fails after error correction has been performed, or if the vector value is determined to be invalid.

**p:** Phase on which the vector was found (0=a, 1=b, 2=c, 3=d)

**K:** Beginning check bits of the message.

**n:** Number of message words in the message including the second vector word for long addresses (000=1 word message, 001=2 word message, etc.). For long addresses, the first message word is located in the word location that immediately follows the associated vector.

**b:** Word number of message start in the message field (3 - 87 decimal). For long addresses, the word number indicates the location of the second message word.

**x:** Unused bits. The value of these bits is not guaranteed.

## SHORT MESSAGE / TONE ONLY VECTOR

Table 22: Short Message / Tone Only Vector Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	WN <sub>6</sub>	WN <sub>5</sub>	WN <sub>4</sub>	WN <sub>3</sub>	WN <sub>2</sub>	WN <sub>1</sub>	WN <sub>0</sub>
Byte 2	e	p <sub>1</sub>	p <sub>0</sub>	x	x	V <sub>2</sub>	V <sub>1</sub>	V <sub>0</sub>
Byte 1	x	x	d <sub>11</sub>	d <sub>10</sub>	d <sub>9</sub>	d <sub>8</sub>	d <sub>7</sub>	d <sub>6</sub>
Byte 0	d <sub>5</sub>	d <sub>4</sub>	d <sub>3</sub>	d <sub>2</sub>	d <sub>1</sub>	d <sub>0</sub>	t <sub>1</sub>	t <sub>0</sub>

**V:** 010 for a Short Message / Tone Only Vector

**WN:** Word number of vector (2 - 87 decimal). Describes the location of the vector word in the frame.

**e:** Set if more than 2 bit errors are detected in the word or, if after error correction, the check character calculation fails.

**p:** Phase on which the vector was found (0=a, 1=b, 2=c, 3=d)

**d:** Data bits whose definition depend on the value of **t** in this packet according to the following table. Note that if this vector is received on a long address and the **e** bit in this packet is not set, the decoder will send a Message Packet from the word location immediately following the Vector Packet. Except for the short message on a non-network address (**t**=0), all message bits in the Message Packet are unused and should be ignored.

t <sub>1</sub> t <sub>0</sub>	d <sub>11</sub>	d <sub>10</sub>	d <sub>9</sub>	d <sub>8</sub>	d <sub>7</sub>	d <sub>6</sub>	d <sub>5</sub>	d <sub>4</sub>	d <sub>3</sub>	d <sub>2</sub>	d <sub>1</sub>	d <sub>0</sub>	Description
00	c <sub>3</sub>	c <sub>2</sub>	c <sub>1</sub>	c <sub>0</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>	a <sub>3</sub>	a <sub>2</sub>	a <sub>1</sub>	a <sub>0</sub>	Short Numeric: 3 numeric chars <sup>a</sup> when on a messaging address
00	T <sub>3</sub>	T <sub>2</sub>	T <sub>1</sub>	T <sub>0</sub>	M <sub>2</sub>	M <sub>1</sub>	M <sub>0</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	Part of NID when on a Network Address
01	s <sub>8</sub>	s <sub>7</sub>	s <sub>6</sub>	s <sub>5</sub>	s <sub>4</sub>	s <sub>3</sub>	s <sub>2</sub>	s <sub>1</sub>	s <sub>0</sub>	S <sub>2</sub>	S <sub>1</sub>	S <sub>0</sub>	Tone Only: 8 source (S) and 9 unused bits(s)
10	s <sub>1</sub>	s <sub>0</sub>	R <sub>0</sub>	N <sub>5</sub>	N <sub>4</sub>	N <sub>3</sub>	N <sub>2</sub>	N <sub>1</sub>	N <sub>0</sub>	S <sub>2</sub>	S <sub>1</sub>	S <sub>0</sub>	Tone only: 8 source (s), message number(N), message retrieval flag (R), and 2 unused bits(s)
11													spare message type

a. For long addresses, an extra 5 characters are sent in the Message Packet immediately following the Vector Packet.

**t:** Message type. These bits define the meaning of the **d** bits in this packet.

**x:** Unused bits. The value of these bits is not guaranteed.

## HEX / BINARY, ALPHANUMERIC, AND SECURE MESSAGE VECTOR

Table 23: HEX / Binary, Alphanumeric, and Secure Message Vector Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	WN <sub>6</sub>	WN <sub>5</sub>	WN <sub>4</sub>	WN <sub>3</sub>	WN <sub>2</sub>	WN <sub>1</sub>	WN <sub>0</sub>
Byte 2	e	p <sub>1</sub>	p <sub>0</sub>	x	x	V <sub>2</sub>	V <sub>1</sub>	V <sub>0</sub>
Byte 1	x	x	n <sub>6</sub>	n <sub>5</sub>	n <sub>4</sub>	n <sub>3</sub>	n <sub>2</sub>	n <sub>1</sub>
Byte 0	n <sub>0</sub>	b <sub>6</sub>	b <sub>5</sub>	b <sub>4</sub>	b <sub>3</sub>	b <sub>2</sub>	b <sub>1</sub>	b <sub>0</sub>

**V:** Vector type identifier.

V <sub>2</sub> V <sub>1</sub> V <sub>0</sub>	Type
000	Secure
101	Alphanumeric
110	Hex / Binary

**WN:** Word number of vector (2 - 87 decimal). Describes the location of the vector word in the frame.

**e:** Set if more than 2 bit errors are detected in the word, if the check character calculation fails after error correction has been performed, or if the vector value is determined to be invalid.

**p:** Phase on which the vector was found (0=a, 1=b, 2=c, 3=d)

**n:** Number of message words in this frame including the first Message word that immediately follows a long address vector. Valid values are 1 through 85 decimal

**b:** Word number of message start in the message field. Valid values are 3 through 87 decimal.

**x:** Unused bits. The value of these bits is not guaranteed.

**Note:** For long addresses, the first Message Packet is sent from the word location immediately following the word location of the Vector Packet. The **b** bits indicate the second message word in the message field if one exists.

**SHORT INSTRUCTION VECTOR**

Table 24: Short Instruction Vector Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	WN <sub>6</sub>	WN <sub>5</sub>	WN <sub>4</sub>	WN <sub>3</sub>	WN <sub>2</sub>	WN <sub>1</sub>	WN <sub>0</sub>
Byte 2	e	p <sub>1</sub>	p <sub>0</sub>	x	x	V <sub>2</sub>	V <sub>1</sub>	V <sub>0</sub>
Byte 1	x	x	d <sub>10</sub>	d <sub>9</sub>	d <sub>8</sub>	d <sub>7</sub>	d <sub>6</sub>	d <sub>5</sub>
Byte 0	d <sub>4</sub>	d <sub>3</sub>	d <sub>2</sub>	d <sub>1</sub>	d <sub>0</sub>	i <sub>2</sub>	i <sub>1</sub>	i <sub>0</sub>

- V:** 001 for a Short Instruction Vector.
- WN:** Word number of vector (2 - 87 decimal). Describes the location of the vector word in the frame.
- e:** Set if more than 2 bit errors are detected in the word or, if after error correction the check character calculation fails.
- p:** Phase on which the vector was found (0=a, 1=b, 2=c, 3=d)
- d:** Data bits whose definition depend on the **i** bits in this packet according to the following table. Note that if this vector is received on a long address and the **e** bit in this packet is not set, the decoder will send a Message Packet immediately following the Vector Packet. All message bits in the message packet are unused and should be ignored for all modes except the Temporary address assignment with MSN (**i<sub>2</sub>i<sub>1</sub>i<sub>0</sub>**=010).

<b>i<sub>2</sub>i<sub>1</sub>i<sub>0</sub></b>	<b>d<sub>10</sub> d<sub>9</sub> d<sub>8</sub> d<sub>7</sub> d<sub>6</sub> d<sub>5</sub> d<sub>4</sub> d<sub>3</sub> d<sub>2</sub> d<sub>1</sub> d<sub>0</sub></b>	<b>Description</b>
000	a <sub>3</sub> a <sub>2</sub> a <sub>1</sub> a <sub>0</sub> f <sub>6</sub> f <sub>5</sub> f <sub>4</sub> f <sub>3</sub> f <sub>2</sub> f <sub>1</sub> f <sub>0</sub>	Temporary address assignment <sup>a</sup>
001	d <sub>10</sub> d <sub>9</sub> d <sub>8</sub> d <sub>7</sub> d <sub>6</sub> d <sub>5</sub> d <sub>4</sub> d <sub>3</sub> d <sub>2</sub> d <sub>1</sub> d <sub>0</sub>	11 Event Flags for System Event
010	a <sub>3</sub> a <sub>2</sub> a <sub>1</sub> a <sub>0</sub> f <sub>6</sub> N <sub>5</sub> N <sub>4</sub> N <sub>3</sub> N <sub>2</sub> N <sub>1</sub> N <sub>0</sub>	Temporary address assignment with MSN <sup>b</sup>
011		Reserved
100		Reserved
101		Reserved
110		Reserved
111		Reserved for test

- a. Assigned temporary address (a) and assigned frame (f). See “[Operation of a Temporary Address](#)” on page 64 for a description of the use of these fields
- b. Assigned temporary address (a), MSb of assigned frame (f<sub>6</sub>), and message sequence number (N). The message packet sent with this instruction on long addresses contains extra frame information, see “[Operation of a Temporary Address](#)” on page 64 for a description and for details on the use of the other fields.

- i:** Instruction type. These bits define the meaning of the **d** bits in this packet.
- x:** Unused bits. The value of these bits is not guaranteed.

## MESSAGE PACKET

The Message Field follows the Vector Field in the FLEX protocol. It contains the message data, checksum information, and may contain fragment numbers and message numbers. If the error bit of a vector word is not set and the vector word indicates that there are message words associated with the page, the message words are sent in Message Packets.

The ID of the Message Packet is the word number where the message word was received in the frame.

Table 25: Message Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 5	0	$WN_6$	$WN_5$	$WN_4$	$WN_3$	$WN_2$	$WN_1$	$WN_0$
Byte 2	e	$p_1$	$p_0$	$i_{20}$	$i_{19}$	$i_{18}$	$i_{17}$	$i_{16}$
Byte 1	$i_{15}$	$i_{14}$	$i_{13}$	$i_{12}$	$i_{11}$	$i_{10}$	$i_9$	$i_8$
Byte 0	$i_7$	$i_6$	$i_5$	$i_4$	$i_3$	$i_2$	$i_1$	$i_0$

**WN:** Word number of message word (3 - 87 decimal). Describes the location of the message word in the frame.

**e:** Set if more than 2 bit errors are detected in the word.

**p:** Phase on which the message word was found (0=a, 1=b, 2=c, 3=d)

**i:** These are the information bits of the message word. The definitions of these bits depend on the vector type and which word of the message is being received.



## ROAMING STATUS PACKET

The KS8701 will prompt the host to read a Roaming Status Packet if **RSR**, **MS1**, **MFI**, **MS2**, **MBI**, **MAW**, **NBU**, **NDR<sub>1</sub>**, **NDR<sub>0</sub>**, or **SCU** is set.

Table 26: Roaming Status Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	1	1	0	0	0	0	0
Byte 2	RSR	MS1	MFI	MS2	MBI	MAW	NBU	n
Byte 1	x	x	x	x	x	x	NDR <sub>1</sub>	NDR <sub>0</sub>
Byte 0	x	x	x	x	SCU	RSC <sub>2</sub>	RSC <sub>1</sub>	RSC <sub>0</sub>

- RSR:** Re-synchronization Signal Received. Set when the KS8701 detected a re-synchronization signal and the host configured the KS8701 to ignore it via the **IRS** bit in the roaming control packet. This bit is cleared when read.
- MS1:** Missed Synchronization 1. Set when the KS8701 failed to detect the first synchronization pattern ( $A / \bar{A}$ ) of a FLEX frame and the KS8701 was configured to report missed frame information via the **MFC** bit in the roaming control packet. This bit is cleared when read.
- MFI:** Missed Frame Information word. Set when the frame information word is received with an uncorrectable number of errors and the KS8701 was configured to report missed frame information via the **MFC** bit in the roaming control packet. This bit is cleared when read.
- MS2:** Missed Synchronization 2. Set when the KS8701 failed to detect the second synchronization pattern ( $C / \bar{C}$ ) of a frame and the KS8701 was configured to report missed frame information via the **MFC** bit in the roaming control packet. This bit is cleared when read.
- MBI:** Missed Block Information word 1. Set when at least one of the block information word ones is received with an uncorrectable number of errors and the KS8701 was configured to report missed frame information via the **MFC** bit in the roaming control packet. This bit is set no more than once per frame regardless of the number of missed block information word 1's in the frame. This bit is cleared when read.
- MAW:** Missed Address Word. Set when any address words in the address field is received with an uncorrectable number of errors and the KS8701 was configured to report missed frame information via the **MFC** bit in the roaming control packet. This bit is set no more than once per frame regardless of the number of missed address words in the frame. This bit is cleared when read.
- NBU:** Network Bit Update. Set when the **NBC** bit in the roaming control packet is set and a frame information word is received with a correctable number of errors. This bit will not be set when the frame information word is not received due to missing the first synchronization pattern ( $A / \bar{A}$ ). This bit is cleared when read.
- n:** Network bit value. When **NBU** is set, this is the value of the **n** bit in the last received frame information word.

**NDR:** Noise Detect Result. These bits indicate the result of a noise detect. The results of noise detects initiated by setting the **SND** bit in the roaming control packet will always be reported. The results of the automatic noise detects performed in asynchronous mode will only be reported if the **RND** bit is set in the roaming control packet. When continuous noise detects during block data are enabled by setting the **CND** bit in the roaming control packet, only the “No FLEX signal detected” result will be reported. These bits are cleared when read.

<b>NDR</b>	<b>Noise Detect Result</b>
00	No Information
01	Noise Detect was abandoned
10	FLEX signal detected
11	FLEX signal not detected

**SCU:** System Collapse Update. Set when the KS8701 is configured for manual collapse mode by setting the **MCM** bit in the roaming control packet and the system collapse of a frame is received. This bit is set no more than once per frame regardless of the number of phases in the frame. This bit will not be set in frames in which no block information word ones is received properly. This bit is cleared when read.

**RSC:** Received System Collapse. When **SCU** is set, this value represents the system collapse value that was received in the frame

## RECEIVER SHUTDOWN PACKET

The Shutdown Packet is sent in both synchronous and asynchronous mode. It is designed to indicate to the host that the receiver is turned off and how much time there is until the KS8701 will automatically turn it back on.

Table 27: Receiver Shut Down Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	1	1	1	1	1	1	0
Byte 2	FNV	CF <sub>6</sub>	CF <sub>5</sub>	CF <sub>4</sub>	CF <sub>3</sub>	CF <sub>2</sub>	CF <sub>1</sub>	CF <sub>0</sub>
Byte 1	TNF <sub>7</sub>	TNF <sub>6</sub>	TNF <sub>5</sub>	TNF <sub>4</sub>	TNF <sub>3</sub>	TNF <sub>2</sub>	TNF <sub>1</sub>	TNF <sub>0</sub>
Byte 0	FCO	NAF <sub>6</sub>	NAF <sub>5</sub>	NAF <sub>4</sub>	NAF <sub>3</sub>	NAF <sub>2</sub>	NAF <sub>1</sub>	NAF <sub>0</sub>

- FNV:** Frame Number Valid. This bit is set if the last decoded frame info word was correctable and the frame number was the expected value. When in asynchronous mode, this value will be 0.
- CF:** Current Frame. When in synchronous mode, this is the current frame number. This value is latched on the negative edge of the **READY** line when this packet is sent to the host. The value of this field is valid only if the KS8701 is in synchronous mode and the **FIV** bit in the status packet is set. When in asynchronous mode, this value will be 0.
- TNF:** Time to Next Frame. When in synchronous mode **TNF** indicates the time to the start of the A-word check if the KS8701 were to warm up for the next frame. When in asynchronous mode **TNF** indicates the time to the start of the next automatic noise detect. See “[Using the Receiver Shutdown Packet](#)” on [page 66](#) for an explanation on how to use this value. This value is latched on the negative edge of the **READY** line when this packet is sent to the host.
- FCO:** Frame Carried On. Set if the KS8701 is decoding the next frame due to the reception of a non-zero carry-on value in a previous frame. When in synchronous mode, this value will be 0.
- NAF:** Next Assigned Frame. This is the frame number of the next frame the KS8701 was scheduled to decode when the receiver shut down. The value of this field is valid only if the KS8701 is in synchronous mode and the **FIV** bit in the status packet is set. When in asynchronous mode this value will be 0.

## STATUS PACKET

The Status Packet contains various types of information that the host may require. The Status Packet will be sent to the host whenever the KS8701 is polled and has no other data to send. The KS8701 can also prompt the host to read the Status Packet due to events for which the KS8701 was configured to send it (see “[Configuration Packet](#)” on page 18 and “[Control Packet](#)” on page 21 for a detailed description of the bits). The KS8701 will prompt the host to read a Status Packet if the...

1. ... **SMU** bit in the Status Packet and the **SME** bit in the Configuration Packet are set.
2. ... **MT** bit in the Status Packet and the **MTE** bit in the Configuration Packet are set.
3. ... **EOF** bit in the Status Packet is set.
4. ... **LBU** bit in the Status Packet is set.
5. ... **EA** bit in the Status Packet is set.
6. ... **BOE** bit in the Status Packet is set.

The ID of the Status Packet is 127 (decimal).

Table 28: Status Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	0	1	1	1	1	1	1	1
Byte 2	FIV	f <sub>6</sub>	f <sub>5</sub>	f <sub>4</sub>	f <sub>3</sub>	f <sub>2</sub>	f <sub>1</sub>	f <sub>0</sub>
Byte 1	SM	LB	x	x	c <sub>3</sub>	c <sub>2</sub>	c <sub>1</sub>	c <sub>0</sub>
Byte 0	SMU	LBU	x	MT	x	EOF	EA	BOE

**FIV:** Frame Info Valid. Set when a valid frame info word has been received since becoming synchronous to the system and the **f** and **c** fields contain valid values. If this bit is clear, no valid frame info words have been received since the KS8701 became synchronous to the system. This value will change from 0 to 1 at the end of block 0 of the frame in which the 1st frame info word was properly received. It will be cleared when the KS8701 goes into asynchronous mode. This bit is initialized to 0 when the KS8701 is reset and when the KS8701 is turned off by clearing the **ON** bit in the Control Packet.

**f:** Current frame number. This value is updated every frame regardless of whether the KS8701 needs to decode the frame. This value will change to its proper value for a frame at the end of block 0 of the frame. The value of these bits is not guaranteed when **FIV** is 0.

**SM:** Synchronous Mode. This bit is set when the KS8701 is synchronous to the system. The KS8701 will set this bit when the first synchronization words are received. It will clear this bit when the KS8701 has not received both synchronization words in any frame for 8, 16, or 32 minutes (depending on the number of assigned frames and the system collapse). This bit is initialized to 0 when the KS8701 is reset and when it is turned off by clearing the **ON** bit in the Control Packet

**LB:** Low Battery. Set to the value last read from the **LOBAT** pin. The host controls when the **LOBAT** pin is read via the Receiver Control Packets. This bit is initialized to 0 at reset. It is also initialized to the inverse of the **LBP** bit in the Configuration Packet when the KS8701 is turned on by setting the **ON** bit in the Control Packet.

- c:** Current system cycle number. This value is updated every frame regardless of whether the KS8701 needs to decode the frame. This value will change to its proper value for a frame at the end of block 0 of the frame. The value of these bits is not guaranteed when **FIV** is 0.
- SMU:** Synchronous Mode Update. Set if the **SM** bit has been updated in this packet. When the KS8701 is turned on, this bit will be set when the first synchronization words are found (**SM** changes to 1) or when the first synchronization search window after the KS8701 is turned on expires (**SM** stays 0). The latter condition gives the host the option of assuming the paging device is in range when it is turned on, and displaying out-of-range only after the initial A search window expires. After the initial synchronous mode update, the **SMU** bit will be set whenever the KS8701 transitions from/to synchronous mode. Cleared when read. Changes in the **SM** bit due to turning off the KS8701 will not cause the **SMU** bit to be set. This bit is initialized to 0 when the KS8701 is reset.
- LBU:** Low Battery Update. Set if the value on two consecutive reads of the **LOBAT** pin yielded different results. Cleared when read. The host controls when the **LOBAT** pin is read via the Receiver Control Packets. Changes in the **LB** bit due to turning on the KS8701 will not cause the **LBU** bit to be set. This bit is initialized to 0 when the KS8701 is reset.
- MT:** Minute Time-out. Set if one minute has elapsed. Cleared when read. This bit is initialized to 0 when the KS8701 is reset.
- EOF:** End Of Frame. Set when the KS8701 is in all frames mode and the end of frame has been reached. The KS8701 is in all frames mode if the all frames mode enable counter is non-zero, if any temporary address enabled counter is non-zero, or if the **FAF** bit in the All Frame Mode Packet is set. Cleared when read. This bit is initialized to 0 when the KS8701 is reset.
- EA:** End of Addresses. If **EAE** of the control packet is set and an address is detected in a frame, **EA** will be set after the KS8701 processes the last address in the frame. Since data packets take priority over the status packet, the status packet with the **EA** bit set is guaranteed to come after all address packets for the frame. Cleared when read. This bit is initialized to 0 when the KS8701 is reset.
- BOE:** Buffer Overflow Error. Set when information has been lost due to slow host response time. When the data packet FIFO transmit buffer on the KS8701 overflows, the KS8701 clears the transmit buffer, turns off decoding by clearing the **ON** bit in the Control Packet, and sets this bit. Cleared when read. This bit is initialized to 0 when the KS8701 is reset.
- x:** Unused bits. The value of these bits is not guaranteed.

## PART ID PACKET

The Part ID Packet is sent by the KS8701 whenever the KS8701 is disabled due to the checksum feature. See “Checksum Packet” on page 16 for a description of the checksum feature. Since the KS8701 is disabled after reset, this is the first packet that will be received by the host after reset. The ID of the Part ID Packet is 255 (decimal).

Table 29: Part ID Packet Bit Assignments

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 3	1	1	1	1	1	1	1	1
Byte 2	MDL <sub>1</sub>	MDL <sub>0</sub>	CID <sub>13</sub>	CID <sub>12</sub>	CID <sub>11</sub>	CID <sub>10</sub>	CID <sub>9</sub>	CID <sub>8</sub>
Byte 1	CID <sub>7</sub>	CID <sub>6</sub>	CID <sub>5</sub>	CID <sub>4</sub>	CID <sub>3</sub>	CID <sub>2</sub>	CID <sub>1</sub>	CID <sub>0</sub>
Byte 0	REV <sub>7</sub>	REV <sub>6</sub>	REV <sub>5</sub>	REV <sub>4</sub>	REV <sub>3</sub>	REV <sub>2</sub>	REV <sub>1</sub>	REV <sub>0</sub>

**MDL:** Model. This identifies the FLEX decoder model. Current value is 0.

**CID:** Compatibility ID. This value describes the FLEX decoder ICs to which this part is backwards compatible. See table below for meaning and current value.

Bit	Indicates this IC can be used in place of	Value for FLEX™ Roaming Decoder II
CID <sub>0</sub>	FLEX Alphanumeric Decoder I <sup>a</sup>	1 (TRUE)
CID <sub>1</sub>	FLEX Roaming Decoder I <sup>b</sup>	1 (TRUE)
CID <sub>2</sub>	FLEX Numeric Decoder	0 (FALSE)

- Compatibility to FLEX Alphanumeric Decoder II is indicated by **MDL** set to 0, **CID<sub>0</sub>** set to 1, and **REV** greater than or equal to 7.
- Compatibility to FLEX Roaming Decoder II is indicated by **MDL** set to 0, **CID<sub>1</sub>** set to 1, and **REV** greater than or equal to 8.

**REV:** Revision. This identifies the revision and manufacturer of the FLEX decoder IC. The following table lists the currently available part ID's of the FLEX Decoder IC family.

Part ID Packet (Hex)	Revision	Manufacturer
00 01 03	FLEX Alphanumeric Decoder I	Texas Instruments
00 01 04	FLEX Alphanumeric Decoder I	Motorola Semiconductor Products Sector
00 01 06	FLEX Alphanumeric Decoder I	Philips
00 01 07	FLEX Alphanumeric Decoder II	Motorola Semiconductor Products Sector
00 03 03	FLEX Roaming Decoder I	Motorola Semiconductor Products Sector
00 03 05	FLEX Roaming Decoder I	Texas Instruments
00 03 09	FLEX Roaming Decoder II	Motorola Semiconductor Products Sector
00 03 14	FLEX Roaming Decoder II	Samsung Electronics
00 04 01	FLEX Numeric Decoder	Texas Instruments

## APPENDIX A : APPLICATION NOTES

### RECEIVER CONTROL

#### INTRODUCTION

The KS8701 has 8 programmable receiver control lines (**S0 - S7**). The host has control of the receiver warm up and shut down timing as well as all of the various settings on the control lines through configuration registers on the KS8701. The configuration registers for most settings allow the host to configure what setting is applied to the control lines, how long to apply the setting, and if the **LOBAT** input pin is polled before changing from the setting. With this programmability, the KS8701 should be able to interface with many off-the-shelf receiver ICs. When using the internal demodulator (i.e. when the **IDE** bit of the configuration packet is set), the **S0** pin becomes the input for the demodulator and the **S0** register setting in the receiver control configuration packets controls the tracking mode of the peak and valley detectors for the internal data slicer. When the **S0** bit is set in a receiver setting, the internal data slicer will be in fast track mode. When **S0** bit is cleared in a receiver setting, the internal data slicer will be in slow track mode. For details on the configuration of the receiver control settings, see [“Receiver Control Configuration Packets” on page 30](#).

#### RECEIVER SETTINGS AT RESET

The receiver control ports are three-state outputs which are set to the high-impedance state when the KS8701 is reset and until the corresponding **FRS** bit in the Receiver Line Control Packet is set or until the KS8701 is turned on by setting the **ON** bit in the Control Packet. This allows the designer to force the receiver control lines to the receiver off setting with external pull-up or pull-down resistors before the host can configure these settings in the KS8701. When the KS8701 is turned on, the receiver control ports are driven to the settings configured by the [“Receiver Control Configuration Packets” on page 30](#) until the KS8701 is reset again.

#### AUTOMATIC RECEIVER WARM UP SEQUENCE

The KS8701 allows for up to 6 steps associated with warming up the receiver. When the KS8701 automatically turns on the receiver, it starts the warm up sequence 160ms before it requires valid signals at the **EXTS0** and **EXTS1** input pins. (or the equivalent internal signals when using the internal demodulator/data slicer). The first step of the warm up sequence involves leaving the receiver control lines in the “Off” state for the amount of time programmed for “Warm Up Off Time”. At the end of the “Warm Up Off Time”, the first warm up setting, if enabled, is applied to the receiver control lines for the amount of time programmed for that setting. Each subsequent warm up setting is applied to the receiver control lines for their corresponding time until a disabled warm up setting is found. At the end of the last used warm up setting, the “1600sps Sync Setting” or the “3200sps Sync Setting” is applied to the receiver control lines depending on the current state of the KS8701. The sum total of all of the used warm up times and the “Warm Up Off Time” must not exceed 160ms. If it exceeds 160ms, the KS8701 will execute the receiver shut down sequence at the end of the 160ms warm up period. The receiver warm up sequence while decoding when all warm up settings are enabled is shown in [figure 11 on page 56](#).



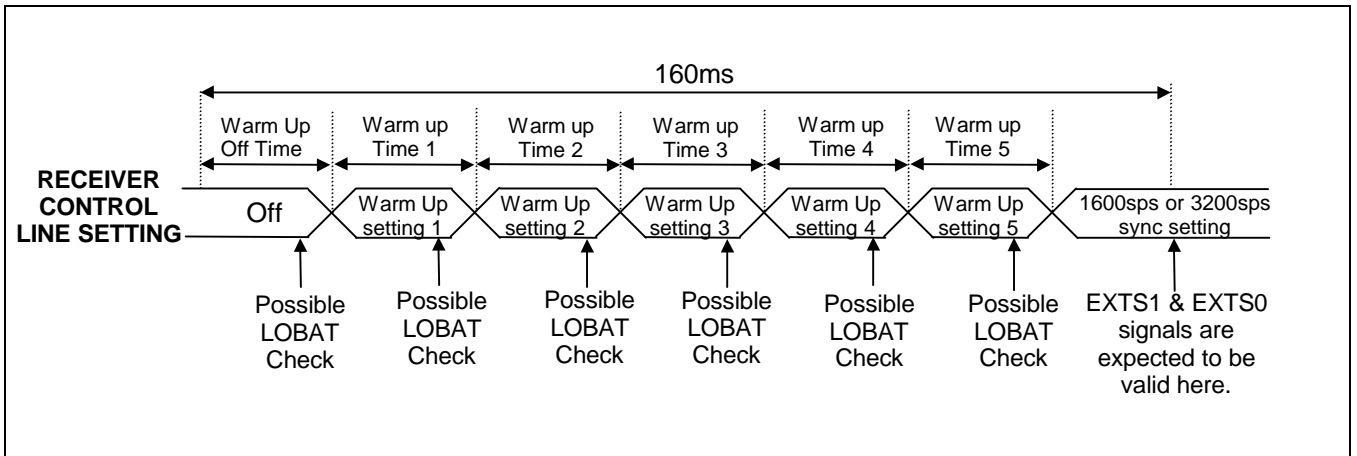


Figure 11: Automatic Receiver Warm Up Sequence

**HOST INITIATED RECEIVER WARM UP SEQUENCE**

The host can cause the KS8701 to warm-up the receiver in three ways: (1) by turning on KS8701 by setting the **ON** bit in the control packet; (2) by requesting a noise detect by setting the **SND** bit in the roaming control packet; or (3) by requesting an A-word search by setting the **SAS** bit in the roaming control packet. When the KS8701 warms up the receiver in response to a host request, the first warm up setting, if enabled, is applied to the receiver control lines for the amount of time programmed for that setting. Each subsequent warm up setting is applied to the receiver control lines for their corresponding time until a disabled warm up setting is found. Once a disabled warm up setting is found, the “3200sps Sync Setting” (for **ON** and **SND** warm ups) or the “1600sps Sync Setting” (for **SAS** warm ups) is applied to the receiver control lines and the decoder does not expect valid signal until after the “3200sps Sync Warm Up Time” (for **ON**, **SND**, and **SAS** warm ups) has expired. In [figure 12 on page 56](#) the receiver warm up sequence when the host initiates a warm-up sequence and when all warm up settings are enabled is shown.

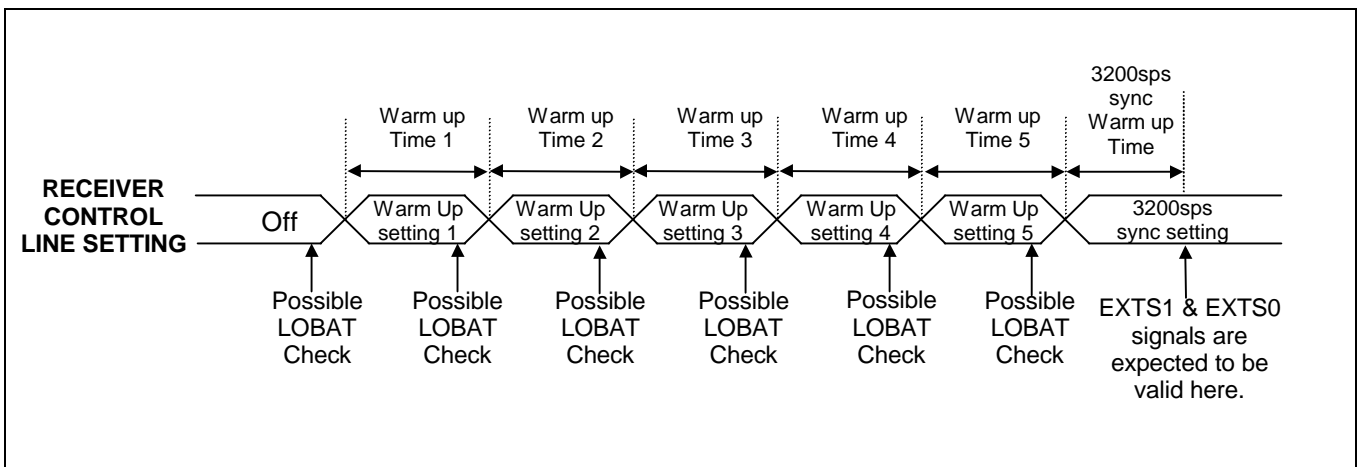
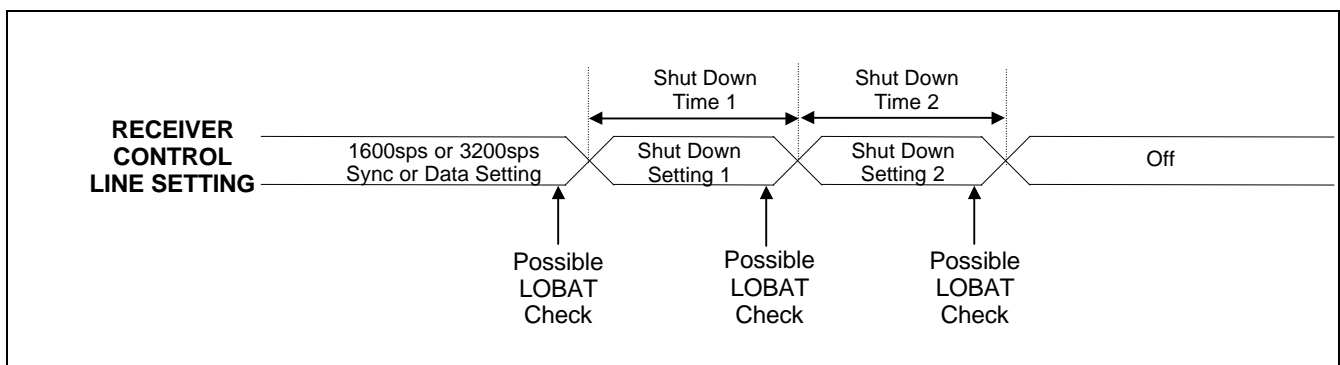


Figure 12: Host Initiated Receiver Warm Up Sequence

**RECEIVER SHUT DOWN SEQUENCE**

The KS8701 allows for up to 3 steps associated with shutting down the receiver. When the KS8701 decides to turn off the receiver, the first shut down setting, if enabled, is applied to the receiver control lines for the corresponding shut down time. At the end of the last used shut down time, the “Off” setting is applied to the receiver control lines. If the first shut down setting is not enabled, the KS8701 will transition directly from the current on setting to the “Off” setting. The receiver turn off sequence when all shut down settings are enabled is shown in [figure 13 on page 57](#)

If the receiver is on or being warmed up when the decoder is turned off (by clearing the **ON** bit in the Control Packet), the KS8701 will execute the receiver shutdown sequence. If the KS8701 is executing the shut down sequence when the KS8701 is turned on (by setting the **ON** bit in the Control Packet), the KS8701 will complete the shut down sequence before starting the warm up sequence.



**Figure 13: Receiver Shut Down Sequence**

## MISCELLANEOUS RECEIVER STATES

In addition to the warm up and shut down states, the KS8701 has four other receiver states. When these settings are applied to the receiver control lines, the KS8701 will be decoding the **EXTS1** and **EXTS0** input signals. The timing of these signals and their duration depends on the data the KS8701 decodes. The four settings are as follows:

**1600sps Sync Setting:** This setting is applied when the KS8701 is searching for a 1600 symbols per second signal.

**3200sps Sync Setting:** This setting is applied when the KS8701 is searching for a 3200 symbols per second signal.

**1600sps Data Setting:** This setting is applied after the KS8701 has found the C or  $\bar{C}$  sync word in a 1600 symbols per second frame.

**3200sps Data Setting:** This setting is applied after the KS8701 has found the C or  $\bar{C}$  sync word in a 3200 symbols per second frame.

Some examples of how these settings will be used in the KS8701 are shown in [figure 14 on page 58](#).

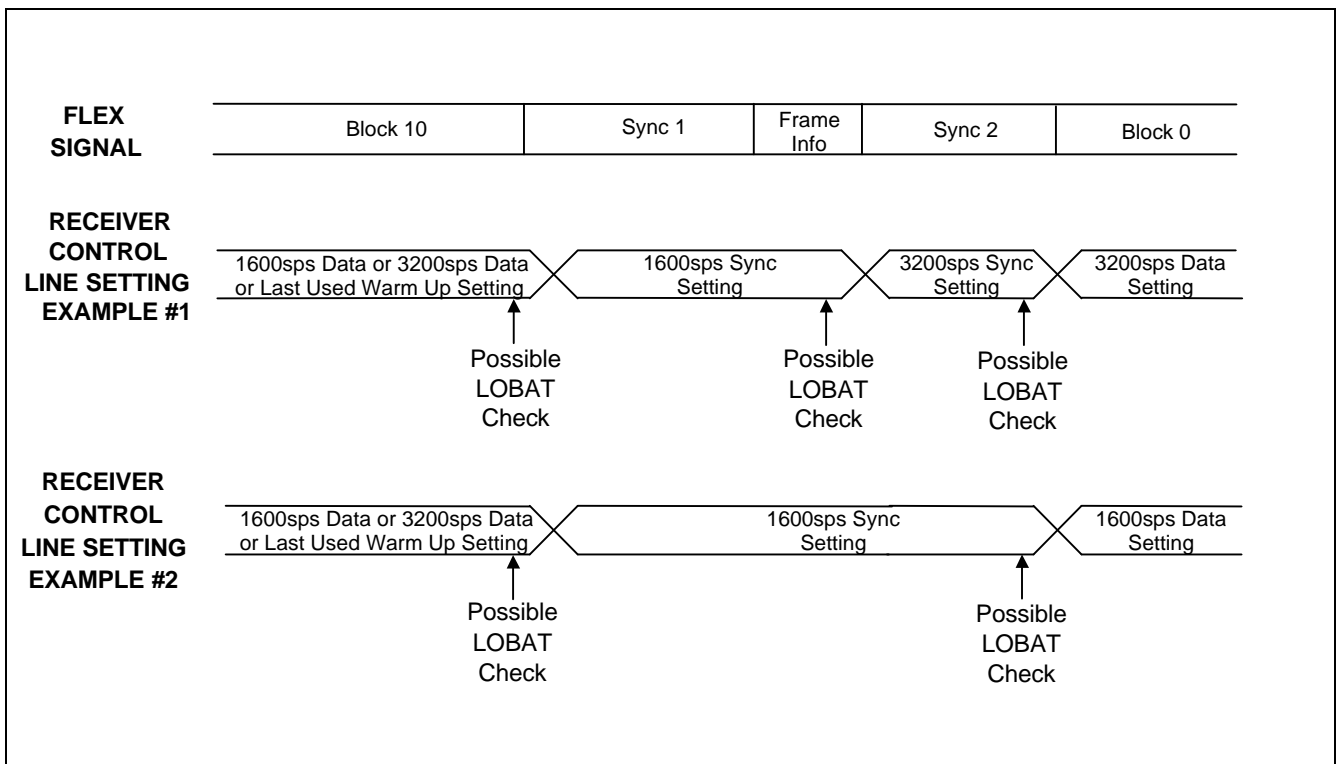


Figure 14: Examples of Receiver Control Transitions

## LOW BATTERY DETECTION

The KS8701 can be configured to poll the **LOBAT** input pin at the end of every receiver control setting. This check can be enabled or disabled for each receiver control setting. If the poll is enabled for a setting, the pin will be read just before the KS8701 changes the receiver control lines from that setting to another setting. The KS8701 will send a Status Packet whenever the value on two consecutive reads of the **LOBAT** pin yields different results.

## MESSAGE BUILDING

A simple message consists of an Address Packet followed by a Vector Packet indicating the word numbers of associated Message Packets. The tables below show a more complex example of receiving three Messages and two Block Information Word Packets in the first two blocks of a 2 phase 3200 bps, FLEX frame. Note that the messages shown may be portions of fragmented or group messages. Note further that in the case of a 6400 bps FLEX signal, there would be four phases: A, B, C and D, and in the case of a 1600 bps signal there would be only a single phase A.

Table 30 on page 59 shows the block number, word number (WN) and word content of both phases A and C. Note contents of words not meant to be received by the host are left blank. Each phase begins with a block information word (WN 0), this is not sent to the host. The first message is in phase A and has an address (WN 3), vector (WN 7) and three message words (WN 9- 11). The second message is also in phase A and has an address (WN 4), a vector (WN 8) and four message words (WN 12 - 15). The third message is in phase C and has a 2 word long address (WN 5 - 6) followed by a vector (WN 10) and three message words. Since the third message is sent on a long address, the first message word (WN 11) begins immediately after the vector. The vector indicates the location of the second and third message words (WN 14 - 15).

Table 30: FLEX SIGNAL

BLOCK	Word Number	PHASE A	PHASE C
0	0	BIW 1	BIW 1
	1		BIW
	3	ADDRESS 1	BIW
	4	ADDRESS 2	
	5		LONG ADDRESS 3 WORD 1
	6		LONG ADDRESS 3 WORD 2
	7	VECTOR 1	
1	8	VECTOR 2	
	9	MESSAGE 1,1	
	10	MESSAGE 1,2	VECTOR 3
	11	MESSAGE 1,3	MESSAGE 3,1
	12	MESSAGE 2,1	
	13	MESSAGE 2,2	
	14	MESSAGE 2,3	MESSAGE 3,2
	15	MESSAGE 2,4	MESSAGE 3,3

Table 31 on page 60 shows the sequence of packets received by the host. The KS8701 processes the FLEX signal one block at a time, and one phase at a time. Thus, the address and vector information in block 0 phase A is sent to the host in packets 1 - 3. Then information in block 0 phase C, two block information words and one long address, is sent to the host in packets 4-6. Packets 7 - 18 correspond to information in block 1, processed in phase A first and phase C second.

Table 31: FLEX DECODER PACKET SEQUENCE

PACKET	PACKET TYPE	PHASE	WORD NUMBER	COMMENT
1st	ADDRESS	A	N.A. (7)	Address 1 has a vector located at WN 7
2nd	ADDRESS	A	N.A. (8)	Address 2 has a vector located at WN 8
3rd	VECTOR	A	7	Vector for Address 1: Message Words located at WN =9 to 11, phase A
4th	BIW	C	N.A.	If BIWs enabled, then BIW packet sent
5th	BIW	C	N.A.	If BIWs enabled, then BIW packet sent
6th	LONG ADDRESS	C	N.A. (10)	Long Address 3 has a vector beginning in word 10 of phase C
7th	VECTOR	A	8	Vector for Address 2: Message Words located at WN = 12 to 15, phase A
8th	MESSAGE	A	9	Message information for Address 1
9th	MESSAGE	A	10	Message information for Address 1
10th	MESSAGE	A	11	Message information for Address 1
11th	MESSAGE	A	12	Message information for Address 2
12th	MESSAGE	A	13	Message information for Address 2
13th	MESSAGE	A	14	Message information for Address 2
14th	MESSAGE	A	15	Message information for Address 2
15th	VECTOR	C	10	Vector for Long Address 3: Message Words located at WN = 14 - 15, phase C
16th	MESSAGE	C	11	Second word of Long Vector is first message information word of Address 3
17th	MESSAGE	C	14	Message information for Address 3
18th	MESSAGE	C	15	Message information for Address 3

The first message is built by relating packets 1, 3, and 8 - 10. The second message is built by relating packets 2, 7 and 11 - 14. The third message is built by relating packets 6 and 15 - 18. Additionally, the host may process block information in packets 4 and 5 for time setting information.

## BUILDING A FRAGMENTED MESSAGE

The longest message which will fit into a frame is 84 code words total of message data. Three alpha characters per word yields a maximum message of 252 characters in a frame assuming no other traffic. Messages longer than this value must be sent as several fragments.

Additional fragments can be expected when the “continue bit” in the 1<sup>st</sup> Message Word is set. This causes the pager to examine every following frame for an additional fragment until the last fragment with the continue bit reset is found. The only requirement relating to the placement in time of the remaining fragments is that no more than 32 frames (1 minute) or 128 frames (4 minutes) as indicated by the service provider may pass between fragment receptions.

Each fragment contains a check sum character to detect errors in the fragment, a fragment number 0, 1, or 2 to detect missing fragments, a message number to identify which message the fragment is a part, and the continue bit which either indicates that more fragments are in queue or that the last fragment has been received.

The following describes the sequence of events between the Host and the KS8701 required to handle a fragmented message:

- The host will receive a vector indicating one of the following types:

$V_2V_1V_0$	Type
000	Secure
101	Alphanumeric
110	Hex / Binary

- The KS8701 will increment the all frame mode counter inside the KS8701 and begin to decode all of the following frames.
- The host will receive the Message Packet(s) contained within that frame followed by a Status Packet. The host must decide based on the Message Packet to return to normal decoding operation. If the message is indicated as fragmented by the Message Continued Flag “**C**” being set in the Message Packet then the host does not decrement the all frame mode counter at this time. The host decrements the counter if the Message Continued Flag “**C**” is clear by writing the All Frame Mode Packet to the KS8701 with the “**DAF**” bit = 1. If no other fragments, temporary addresses are pending and the **FAF** bit is clear in the All Frame Mode Register, then the KS8701 returns to normal operation.
- The KS8701 continues to decode all of the frames and passes any address information, vector information and message information to the host followed by a status packet indicating the end of the frame. If the message is indicated as fragmented by the Message Continued Flag “**C**” in the Message Packet then the host remains in the receive mode expecting more information from the KS8701.
- After the host receives the second and subsequent fragment with the Message Continued Flag “**C**” = 1, it should decrement the all frame mode counter by sending an All Frame Mode Packet to the KS8701 with the “**DAF**” bit = 1. Alternatively, the host may choose to decrement the counter at the end of the entire message by decrementing the counter once for each fragment received.

- When the host receives a Message Packet with the Message Continued Flag “**C**” = 0, it will send two All Frame Mode Packets to the KS8701 with the “**DAF**” bit = 1. The two packets decrement the count for the first fragment and the last fragment. This decrements the all frame counter to zero, if no other fragmented messages, temporary addresses are pending and the **FAF** bit is clear in the All Frame Mode Register, the KS8701 returns to normal operation.
- The above process must be repeated for each occurrence of a fragmented message. The host must keep track of the number of fragmented messages being decoded and insure the all frame mode counter decrements after each fragment or after each fragmented message.

Table 32: Alphanumeric Message without fragmentation

PACKET	PACKET TYPE	PHASE	All Frame Counter	COMMENT
1st	ADDRESS 1	A	0	Address 1 is received
2nd	VECTOR 1	A	1	Vector = Alphanumeric Type
3rd	MESSAGE	A	1	Message Word received “ <b>C</b> ” bit = 0, No more fragments are expected.
4th	Variable <sup>a</sup>		0	Host writes All Frame Mode Packet to the KS8701 with the “ <b>DAF</b> ” bit = 1

- a. Host Initiated Packet. The KS8701 returns a packet according to “Decoder-to-Host Packet Descriptions” on page 38.

Table 33: Alphanumeric Message with fragmentation

PACKET	PACKET TYPE	PHASE	All Frame Counter	COMMENT
1st	ADDRESS 1	A	0	Address 1 is received
2nd	VECTOR 1	A	1	Vector = Alphanumeric Type
3rd	MESSAGE	A	1	Message Word received “ <b>C</b> ” bit = 1, Message is fragmented, more expected
4th	STATUS		1	End of Frame Indication ( <b>EOF</b> = 1)
5th	ADDRESS 1	B	1	Address 1 is received
6th	VECTOR 1	B	2	Vector = Alphanumeric Type
7th	MESSAGE	B	2	Message Word received “ <b>C</b> ” bit = 1, Message is fragmented, more expected.
8th	Variable <sup>a</sup>		1	Host writes All Frame Mode Packet to the KS8701 with the “ <b>DAF</b> ” bit = 1
9th	STATUS		1	End of Frame Indication ( <b>EOF</b> = 1 )

Table 33: Alphanumeric Message with fragmentation (Continued)

PACKET	PACKET TYPE	PHASE	All Frame Counter	COMMENT
10th	ADDRESS 1	A	1	Address 1 is received
11th	VECTOR 1	A	2	Vector = Alphanumeric type
12th	MESSAGE	A	2	Message Word received “C” bit = 0, No more fragments are expected.
13th	Variable <sup>a</sup>		1	Host writes All Frame Mode Packet to the KS8701 with the “DAF” bit = 1
14th	Variable <sup>a</sup>		0	Host writes All Frame Mode Packet to the KS8701 with the “DAF” bit = 1

- a. Host Initiated Packet. The KS8701 returns a packet according to “[Decoder-to Host Packet Descriptions](#)” on page 38.



## OPERATION OF A TEMPORARY ADDRESS

### GROUP MESSAGING

The FLEX protocol allows for a dynamic group call for the purpose of sending a common message to a group of paging devices. The dynamic group call approach assigns a “Temporary Address” using the personal address and the short instruction vector.

The FLEX protocol specifies sixteen addresses for the dynamic group call which may be temporarily activated in a future frame (If the frame or one of the frames designated is equal to the present frame the host is to interpret this as the next occurrence of this frame 4 minutes in the future.) The temporary address is valid for one message starting in the specified frame(s) and remaining valid throughout the following frames to the completion of the message. If the message is not found in the specified frame(s) the host must disable the assigned temporary address.

The following describes the sequence of events between the Host and the KS8701 required to handle a temporary address:

- Following an Address Packet, the host will receive a Vector Packet with  $V_2V_1V_0 = 001$  and  $i_2i_1i_0 = 000$  or  $010$  (a Short Instruction Vector indicating a temporary address has been assigned to this pager). The system may send either  $i_2i_1i_0 = 000$  or  $i_2i_1i_0 = 010$  or both when assigning a temporary address. The vector packet with  $i_2i_1i_0 = 000$  will indicate which temporary address is assigned and the frame in which the temporary address is expected. The vector packet with  $i_2i_1i_0 = 010$  will indicate which temporary address is assigned, the MSb of the expected frame (essentially indicating 64 frames in which to look for the temporary address), and a message sequence number. When the vector packet with  $i_2i_1i_0 = 010$  is received on a long address, the specific assign frame is included in the message word sent after the vector
- The KS8701 will increment the corresponding temporary address counter for each temporary address assignment vector received and begin to decode all of the following frames. Note that this implies a single dynamic group assignment that is implemented by sending two short instructions (one for each temporary address assignment mode of the short instruction vector) will cause the corresponding temporary address counter to increment twice.
- The KS8701 continues to decode all of the frames and passes any address information, vector information and message information to the host followed by a status packet indicating the end of each frame and the current frame number.
- There are several scenarios which may occur with temporary addresses
  1. The temporary address is not found in the any of the assigned frames and therefore the host must terminate the temporary address mode by sending an All Frame Mode Packet to the KS8701 with the “DTA” bit of the particular temporary address set. (if both temporary address assignment packets were used to assign the temporary address, the “DTA” bit must be set twice to disable the temporary address)
  2. The temporary address is found in the frame it was assigned and was not a fragmented message. Again, the host must terminate the temporary address mode by sending an All Frame Mode Packet to the KS8701 with the “DTA” bit of the particular temporary address set.(if both temporary address assignment packets were used to assign the temporary address, the “DTA” bit must be set twice to disable the temporary address)

3. The temporary address is found in the assigned frame and it is a fragmented message. In this case, the host must follow the rules for Operation of a Fragmented Message and determine the proper time to stop the all frame mode operation. In this case, the host must write to the “**DAF**” bit with a “1” and the appropriate “**DTA**” bit with a “1” in the All Frame Mode Register in order to terminate both the fragmented message and the temporary address. (if both temporary address assignment packets were used to assign the temporary address, the “**DTA**” bit must be set twice to disable the temporary address)
- The above operation is repeated for every temporary address.

## USING THE RECEIVER SHUTDOWN PACKET

### CALCULATING TIME LEFT

The receiver shutdown packet gives timing information to the host. Two times are of particular interest when implementing a roaming algorithm.

- Time To Warm Up Start. Defined as the amount of time there is before the receiver will start to warm up (i.e. transition from the off state to the first warm up state).
- Time To Tasks Disabled. Defined as the amount of time the host has to complete any host initiated tasks (e.g. by setting **SND** or **SAS** in the roaming control packet).

The formula's for calculating these times depend on whether the KS8701 is in synchronous mode or asynchronous mode.

#### SYNCHRONOUS MODE:

$$\text{Time To Warm Up Start} \geq (\text{TNF} \cdot 80\text{ms}) + (\text{Skipped Frames} \cdot 1874.375\text{ms}) + \text{Receiver Off Time} - 167.5\text{ms}$$

$$\text{Time To Tasks Disabled} \geq (\text{TNF} \cdot 80\text{ms}) + (\text{Skipped Frames} \cdot 1874.375\text{ms}) - 247.5\text{ms}$$

#### ASYNCHRONOUS MODE:

$$\text{Time To Warm Up Start} \geq ((\text{TNF} - 2) \cdot 80\text{ms}) + \text{Receiver Off Time}$$

$$\text{Time To Tasks Disabled} \geq ((\text{TNF} - 3) \cdot 80\text{ms})$$

Where,

*TNF*: Time to Next Frame. Value from the receiver shutdown packet.

*Skipped Frames*: The number of frames that won't be decoded. This can be calculated from the Current Frame (**CF**) and Next Needed Frame (**NAF**) fields in the receiver shutdown packet (e.g. If **CF** is 10 and **NAF** is 12, then *Skipped Frames* is 1)

*Receiver Off Time*: The time programmed in the receiver off setting packet.

## CALCULATING HOW LONG TASKS TAKE

Since the Time To Task Disabled discussed in the previous section limits how much the host can do while the KS8701 is battery saving, it is necessary for the host to know how long it can take the KS8701 to perform a task.

The formulas below calculate how long the two types of host initiated tasks take to complete as measured from the last SPI clock of the packet that initiates the task to the time the receiver shutdown sequence starts. Note that the receiver shutdown sequence must start before tasks are disabled.

The following formula calculates how long it will take to complete a Noise Detect started by setting the **SND** bit in the roaming control packet. This formula assumes that (1) the noise detect was performed while in synchronous mode or (2) the noise detect was performed in asynchronous mode and did not find FLEX signal or (3) the noise detect found FLEX signal but the **DAS** bit of the roaming control packet was set.

$$\text{Time To Perform Noise Detect} \leq \text{Total Warm Up Time} + 82\text{ms}$$

Where,

**Total Warm Up Time:** The sum of the times programmed for the used warm up steps plus the time programmed for the 3200sps Sync Setting in the receiver control configuration packets.

The following formula calculates how long it will take to complete an A-word search initiated by setting the **SAS** bit in the roaming control packet. This formula assumes that the A-word search failed to find roaming FLEX channel.

$$\text{Time To Perform A word Search} \leq \text{Total Warm Up Time} + \text{AST} + 47\text{ms}$$

Where,

**Total Warm Up Time:** The sum of the times programmed for the used warm up steps plus the time programmed for the 3200sps Sync Setting in the receiver control configuration packets.

**AST:** The value configured using the timing control packet.

The following formula calculates how long it will take to complete a Noise Detect/A-word search combination. This can occur when the noise detect is performed while in asynchronous mode, the noise detect finds FLEX signal, and the **DAS** bit of the roaming control packet is not set.

$$\text{Time To Perform Both} \leq \text{Total Warm Up Time} + \text{AST} + 127\text{ms}$$

Where,

**Total Warm Up Time:** The sum of the times programmed for the used warm up steps plus the time programmed for the 3200sps Sync Setting in the receiver control configuration packets.

**AST:** The value configured using the timing control packet.

## APPENDIX B: SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS

Table 34: Absolute Maximum Ratings

Characteristic	Symbol	Min	Max	Unit
DC Supply Voltage	$V_{DD}$	-0.3	3.8	V
DC Input Voltage	$V_{IN}$	-0.3	$V_{DD} + 0.3$	V
DC Input Current	$I_{IN}$	-10	+10	mA
Storage Temperature	$T_{STG}$	-40	+125	°C
Operating Temperature	$T_A$	-25	+85	°C

- . Absolute Maximum Ratings may cause critical device failure by above table beyond limits.
- . All electrical characteristics are applied in digital cell library without analog core.

### DC CHARACTERISTICS

Table 35: DC Characteristics

Characteristic	Condition	Symbol	Min	Typ	Max	Unit
Supply Voltage		$V_{DD}$	1.8	3.0	3.6	V
High Level Input Voltage		$V_{IH}$	$0.8V_{DD}$			V
Low Level Input Voltage		$V_{IL}$			$0.2V_{DD}$	V
High Level Input Current		$I_{IH}$	-1		1	μA
Low Level Input Current		$I_{IL}$	-1		1	μA
High Level Output Voltage	$I_{OH}=-1mA$	$V_{OH}$	$V_{DD}-0.4$			V
Low Level Output Voltage	$I_{OL}=1mA$	$V_{OL}$			0.4	V
Tri-state Output Leakage Current		$I_{OZ}$	-5		5	μA
Standby Supply Current <sup>a</sup>	@3V, 76.8kHz, 25°C	$I_{DD}$		18		μA
Input Capacitance <sup>b</sup>		$C_{IN}$			4	pF
Output Capacitance <sup>b</sup>		$C_{OUT}$			4	pF

- This value depends on the customer application.
- This value excludes package parasitic capacitances.

## AC CHARACTERISTICS

### SPI TIMING

The following diagram and table describe the timing specifications of the SPI interface.

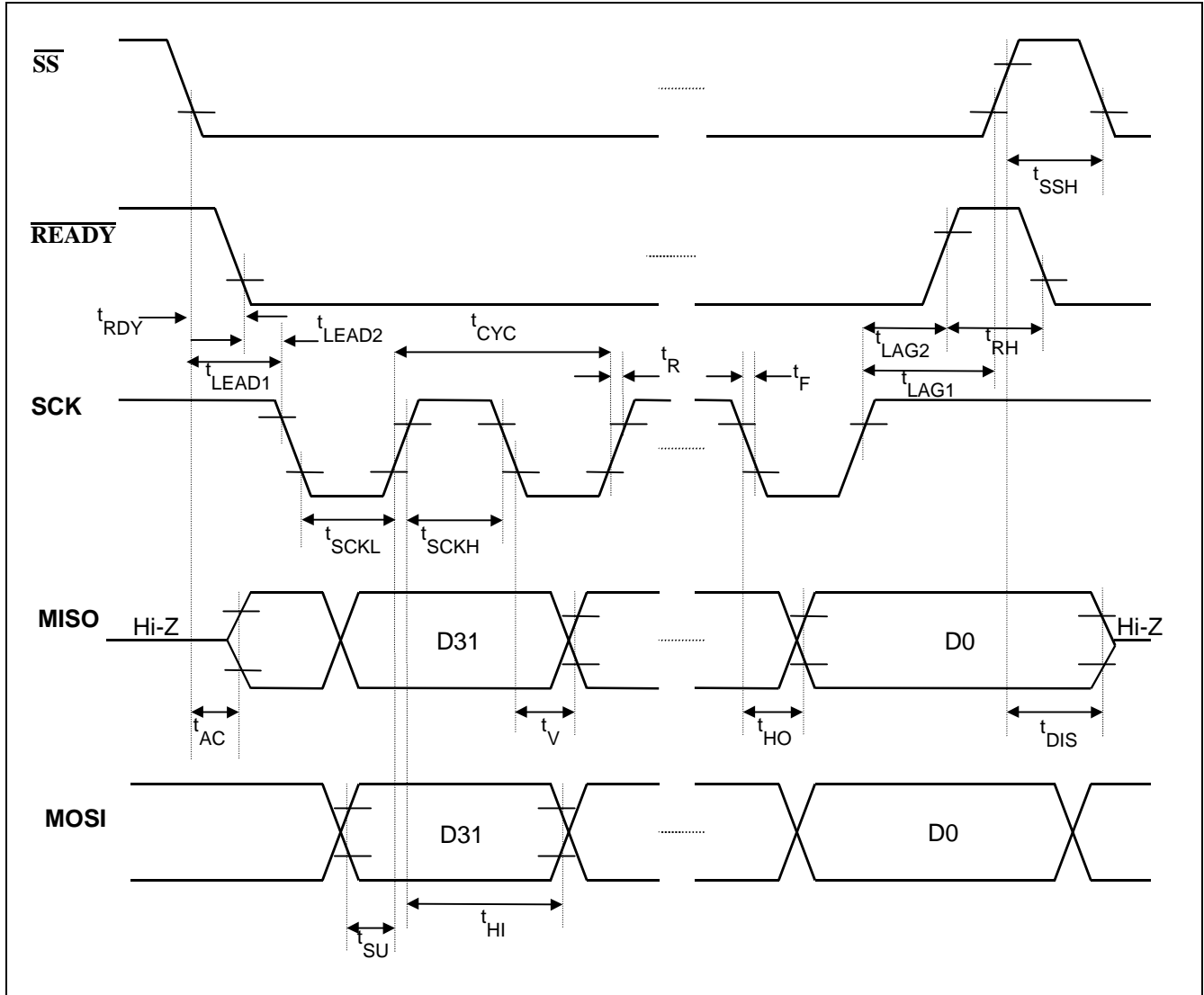


Figure 15: SPI Timing

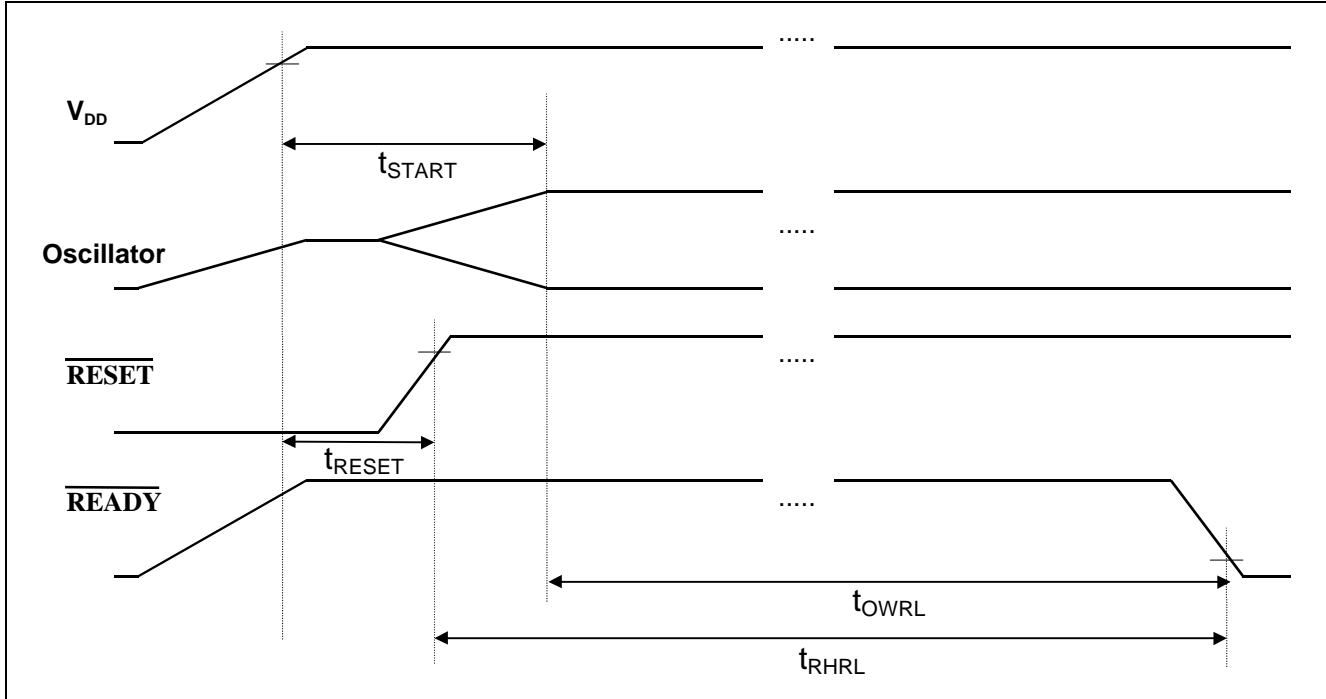
Table 36: SPI Timing ( $V_{DD} = 1.8V$  to  $3.6V$ ,  $T_A = -25^{\circ}C$  to  $+85^{\circ}C$ )

Characteristic	Conditions	Symbol	Min	Max	Unit
Operating Frequency		$f_{OP}$	0	1	MHz
Cycle Time		$t_{CYC}$	1000		ns
Select Lead Time		$t_{LEAD1}$	200		ns
De-select Lag Time		$t_{LAG1}$	200		ns
Select-to-Ready Time	previous packet did not program an address word <sup>a</sup> $C_L=50pf$	$t_{RDY}$		80	$\mu s$
Select-to-Ready Time	previous packet programmed an address word <sup>a</sup> $C_L=50pf$	$t_{RDY}$		420	$\mu s$
Ready High Time		$t_{RH}$	50		$\mu s$
Ready Lead Time		$t_{LEAD2}$	200		ns
Not Ready Lag Time	$C_L=50pf$	$t_{LAG2}$		200	ns
MOSI Data Setup Time		$t_{SU}$	200		ns
MOSI Data Hold Time		$t_{HI}$	200		ns
MISO Access Time	$C_L=50pf$	$t_{AC}$	0	200	ns
MISO Disable Time		$t_{DIS}$		300	ns
MISO Data Valid Time	$C_L=50pf$	$t_V$		200	ns
MISO Data Hold Time		$t_{HO}$	0		ns
$\overline{SS}$ High Time		$t_{SSH}$	200		ns
SCK High Time		$t_{SCKH}$	300		ns
SCK Low Time		$t_{SCKL}$	300		ns
SCK Rise Time	20% to 70% $V_{DD}$	$t_R$		1	$\mu s$
SCK Fall Time	20% to 70% $V_{DD}$	$t_F$		1	$\mu s$

- a. When the host re-programs an address word with a Host-to-FLEX decoder packet ID > 127(decimal), there may be an added delay before the KS8701 is ready for another packet.

**START-UP TIMING**

The following diagram and table describe the timing specifications of the KS8701 when power is applied.



**Figure 16: Start-up Timing**

Table 37: Start-up Timing ( $V_{DD} = 1.8V$  to  $3.6V$ ,  $T_A = -25^{\circ}C$  to  $+85^{\circ}C$ )

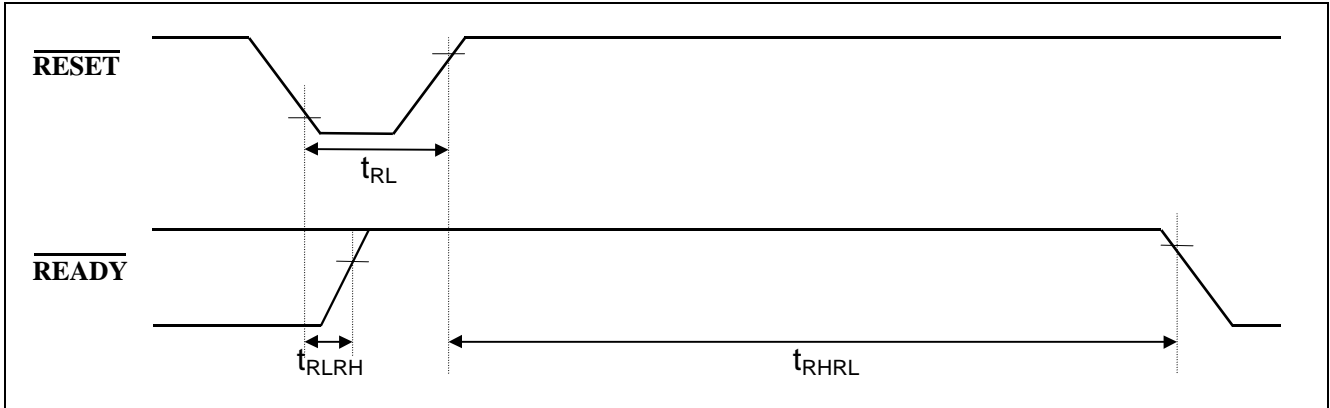
Characteristic	Conditions	Symbol	Min	Typ	Max	Unit
Oscillator Start-up Time		$t_{START}$			5	sec
$\overline{RESET}$ Hold Time		$t_{RESET}$	200			ns
$\overline{RESET}$ High to $\overline{READY}$ Low <sup>a</sup>		$t_{RHRL}$		1		sec
Oscillator Warmed up to $\overline{READY}$ Low <sup>a</sup>	$C_L=50pf$	$t_{OWRL}$		1		sec

a. Note that from power-up, the oscillator start-up time can impact the availability and period of clock strobes. This can affect the actual  $\overline{RESET}$  high to  $\overline{READY}$  low timing.



**RESET TIMING**

The following diagram and table describe the timing specifications of the KS8701 when it is reset.



**Figure 17: Reset Timing**

Table 38: Reset Timing ( $V_{DD} = 1.8V$  to  $3.6V$ ,  $T_A = -25^{\circ}C$  to  $85^{\circ}C$ )

Characteristic	Conditions	Symbol	Min	Typ	Max	Unit
$\overline{RESET}$ Pulse Width		$t_{RL}$	200		-	ns
$\overline{RESET}$ Low to $\overline{READY}$ High		$t_{RLRH}$	-		200	ns
$\overline{RESET}$ High to $\overline{READY}$ Low	Requires stable clock	$t_{RHRL}$		1		sec