



ERMES PAGING DECODER

GENERAL DESCRIPTION

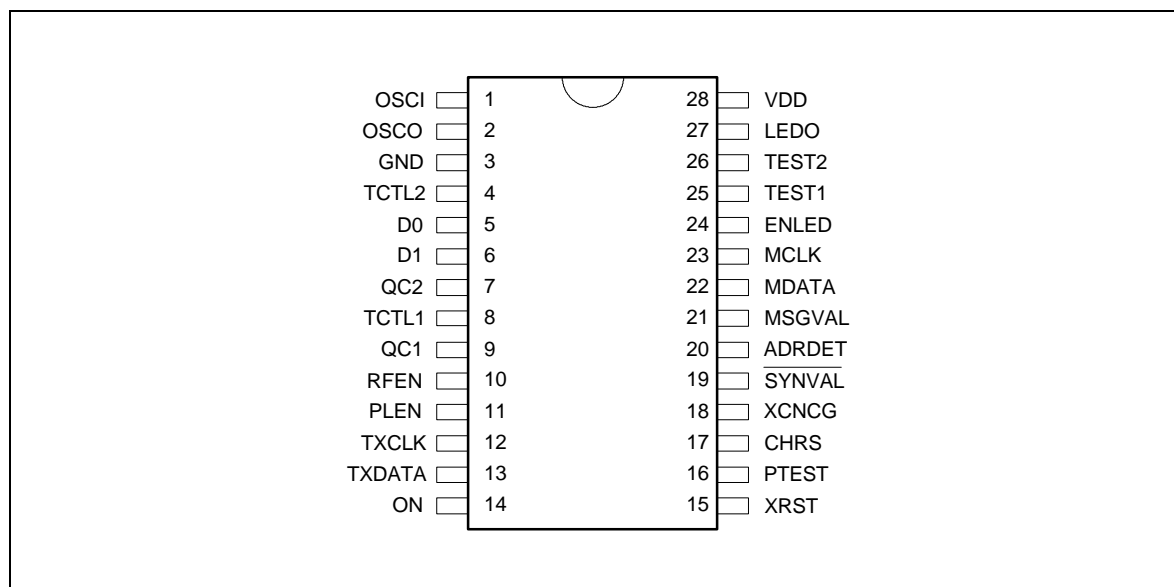
The W93910 is a low-power ERMES (Enhanced Radio MESSage System) paging protocol decoder using a single 100 kHz crystal. The W93910 supports individual call, group call, long message, changing character set and remote programming functions. To enhance the sensitivity of the pager system, a digital filter and DPLL are incorporated to remove noise and lock the signal. For convenient pager programming, the W93910 provides fully software-programmable options and also offers an independent LED frequency output.

With built-in flexible RF power saving control, frequency synthesizer enable control, quick charge controls, as well as automatic channel scan algorithm, the W93910 can combine with different RF receivers to construct a high performance, low power dissipation pager system.

FEATURES

- 100 kHz crystal
- Built-in digital filter and digital phase lock loop
- Built-in two addresses concurrently
- One remote programming address
- International roaming capability
- Automatic channel scan algorithm
- Built in de-interleaving circuit
- 2-bit random error correction
- Individual call, long message, changing character set and remote programming
- CTAP group call
- Serial interface with μ C
- 2-bit signal input from RF receiver
- RF and frequency synthesizer power saving control available
- Quick charge-discharge timing control
- Provides LED output
- 2.5 to 3.5 volts operating voltage range
- Packaged in 28-pin SSOP

PIN CONFIGURATION



PIN DESCRIPTION

SYMBOL	PIN	I/O	PIN DESCRIPTION
OSCI	1	I	100 kHz crystal input.
OSCO	2	O	100 kHz crystal output.
GND	3	I	Ground power.
TCTL2	4	O	RF control pin. Inversion output of QC2.
D0	5	I	Demodulated data input bit0(LSB).
D1	6	I	Demodulated data input bit1(MSB).
QC2	7	O	Receiver quick charge 2 signal enable. Active high/low is dependent on QC2L option bit.
TCTL1	8	O	RF control pin.
QC1	9	O	Receiver quick charge 1 signal enable. Active high/low is dependent on QC1L option bit.
RFEN	10	O	Receiver power control. Active high/low is dependent on RFENL option bit.
PLEN	11	O	PLL frequency synthesizer power control. Active high/low depends on PLENL option bit. μ C must program the freq. synthesizer counter while PLEN inactive. W93910 internal channel will be decided during PLEN active edge.

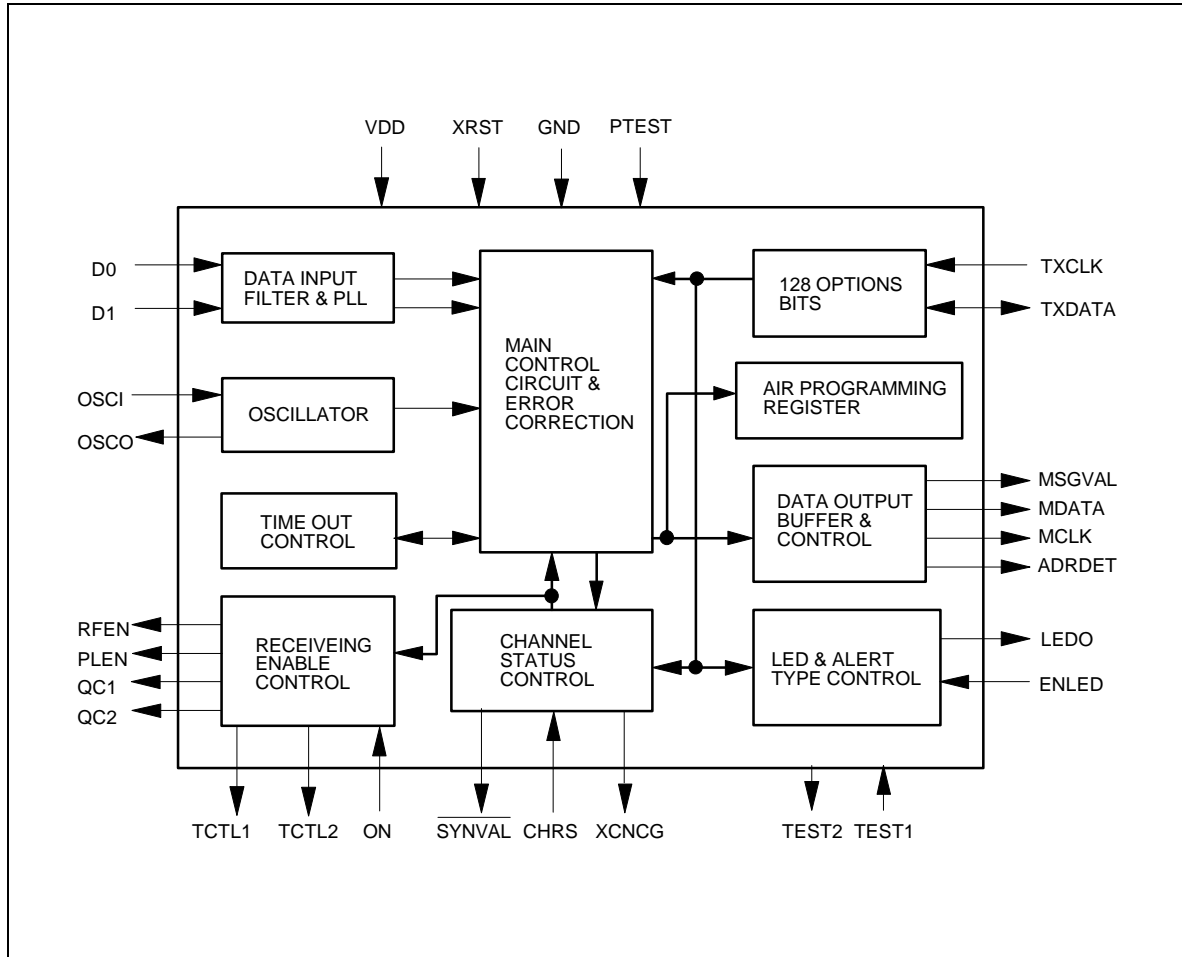


Pin Description, continued

SYMBOL	PIN	I/O	PIN DESCRIPTION
TXCLK	12	I	192 option bits clock input from μ C. TXDATA will be latched by W93910 during TXCLK rising edge.
TXDATA	13	I/O	192 option bits serial data input from μ C. Option bit address will be increased by one after each TXCLK period. After 192 option setting, the TXDATA pin will change to output pin for received OPID information access.
ON	14	I	Active high to enable W93910 chip operating. Oscillator starts oscillation after ON rising edge. OSCO will always stop while ON is low.
XRST	15	I	Internal pull low, Active high to reset decoder.
PTEST	16	I	Internal pull low, Test mode only.
CHRS	17	I	Force roaming control pin. Connect to GND for normal operation. Pull high is only for test purpose.
XCNCG	18	O	During PLEN pin high level, XCNCG (eXternal ChaNnel ChanGe) rising edge will inform μ C to change channel according to channel scanning rule.
$\overline{\text{SYNVAL}}$	19	O	Synchronization Indicator (out-of-range indicator output). Output low when synchronized with paging system.
ADRDET	20	O	Active high while the user IA detected in the address partition. (normally Low)
MSGVAL	21	O	MSGVAL will be active during MCLK, MDATA available period. Active high/low is dependent on MSGI option bit.
MDATA	22	O	Serial paging message output to μ C. Rising/falling edge is dependent on MCKEG option bit. UDI1-0 used to select interval per bytes MDATA.
MCLK	23	O	Serial clock output to μ C for available paging message. MCKI used to select initial state, and MCK1, MCK0 used to select clock rate.
ENLED	24	I	Internal pull low, Active high to enable LEDO output.
TEST1	25	I	Test only. No connection for normal operation
TEST2	26	O	Test only. No connection for normal operation
LEDO	27	O	10/4 kHz or 40/16 kHz CMOS clock output.
VDD	28	I	3 volts power supply.



BLOCK DIAGRAM





ADDRESS & OPTION LIST

BIT NO.	DATA	BIT NO.	DATA	BIT NO.	DATA	BIT NO.	DATA	BIT NO.	DATA	BIT NO.	DATA
b0	0	b32	FILT1	b64	1	b96	SIEN	b128	1	b160	1
b1	IA17	b33	GIA17	b65	ZC2	b97	QCON0	b129	RPIA17	b161	RPZC2
b2	IA16	b34	GIA16	b66	ZC1	b98	RFON	b130	RPIA16	b162	RPZC1
b3	IA15	b35	GIA15	b67	ZC0	b99	PL1	b131	RPIA15	b163	RPZC0
b4	IA14	b36	GIA14	b68	CC6	b100	PL0	b132	RPIA14	b164	RPCC6
b5	IA13	b37	GIA13	b69	CC5	b101	GIAEN	b133	RPIA13	b165	RPCC5
b6	IA12	b38	GIA12	b70	CC4	b102	PAEN	b134	RPIA12	b166	RPCC4
b7	IA11	b39	GIA11	b71	CC3	b103	GPAEN	b135	RPIA11	b167	RPCC3
b8	IA10	b40	GIA10	b72	CC2	b104	MCKI	b136	RPIA10	b168	RPCC2
b9	IA9	b41	GIA9	b73	CC1	b105	MDAI	b137	RPIA9	b169	RPCC1
b10	IA8	b42	GIA8	b74	CC0	b106	MCKEG	b138	RPIA8	b170	RPCC0
b11	IA7	b43	GIA7	b75	OP2	b107	RFENL	b139	RPIA7	b171	RPOP2
b12	IA6	b44	GIA6	b76	OP1	b108	PLENL	b140	RPIA6	b172	RPOP1
b13	IA5	b45	GIA5	b77	OP0	b109	QC1L	b141	RPIA5	b173	RPOP0
b14	IA4	b46	GIA4	b78	FSN3	b110	QC2L	b142	RPIA5	b174	RSVD
b15	IA3	b47	GIA3	b79	FSN2	b111	D0IV	b143	RPIA3	b175	RSVD
b16	IA2	b48	GIA2	b80	FSN1	b112	D1IV	b144	RPIA2	b176	RSVD
b17	IA1	b49	GIA1	b81	FSN0	b113	MCK1	b145	RPIA1	b177	RSVD
b18	IA0	b50	GIA0	b82	0	b114	MCK0	b146	RPIA0	b178	RSVD
b19	BN3	b51	CH3	b83	1	b115	LKR1	b147	RPI	b179	RSVD
b20	BN2	b52	CH2	b84	0	b116	LKR0	b148	RSVD	b180	RSVD
b21	BN1	b53	CH1	b85	1	b117	0	b149	RSVD	b181	RSVD
b22	BN0	b54	CH0	b86	1	b118	LEDF	b150	RSVD	b182	RSVD
b23	PA5	b55	GPA5	b87	0	b119	MSGI	b151	RPPA5	b183	RSVD
b24	PA4	b56	GPA4	b88	0	b120	UDI1	b152	RPPA4	b184	RSVD
b25	PA3	b57	GPA3	b89	0	b121	UDI0	b153	RPPA3	b185	RSVD
b26	PA2	b58	GPA2	b90	0	b122	QC1WTH	b154	RPPA2	b186	RSVD
b27	PA1	b59	GPA1	b91	0	b123	0	b155	RPPA1	b187	RSVD
b28	PA0	b60	GPA0	b92	0	b124	0	b156	RPPA0	b188	RSVD
b29	0	b61	LPWR	b93	0	b125	0	b157	RSVD	b189	RSVD
b30	0	b62	QCON1	b94	0	b126	0	b158	RSVD	b190	RSVD
b31	0	b63	0	b95	0	b127	0	b159	0	b191	0

Table 1



192 OPTION BITS

Detailed description given in Function Description section.

RIC format

IA17–IA0: Basic RIC initial address

BN3–BN0: Basic RIC batch number A(0000)–P(1111)

PA5–PA0: Basic RIC paging area code (000000–111111)

PAEN: Enable PA5–PA0 while PAEN active

GIA17–GIA0: Second RIC initial address

CH3–CH0: Home channel initial value from Channel 0 (0000)–Channel F (1111)

GPA5–GPA0: Second RIC paging area code (000000–111111)

GPAEN: Enable GPA5–GPA0 while GPAEN active

GIAEN: Enable GIA17–GIA0 initial address

ZC2–ZC0: Receiver zone code

CC6–CC0: Receiver country code

OP2–OP0: Receiver operator code

FSN3–FSN0: Frequency subset number (0000–1111)

RPIA17–RPIA0: Remote programming initial address

RPPA5–RPPA0: Remote programming paging area code (000000–111111)

RPZC2–RPZC0: Remote programming zone code

RPCC6–RPCC0: Remote programming country code

RPOP2–RPOP0: Remote programming operation code

RPI: Remote programming index

RF Interface:

RFENL: RFEN pin active level option bit

PLENL: PLEN pin active level option bit

QC1L: QC1 active level option bit

QC2L: QC2 active level option bit

D0IV: D0 input polarity option bit

D1IV: D1 input polarity option bit

PL1–0, RFON, QCON1–0, QC1WTH: RFEN, PLEN, QC1 and QC2 active timing control bits.

uC Interface:

MSGI, MCKI, MDA I: MSGVAL, MCLK, MDATA pin initial state option bit

MCKEG: MCLK active edge;

MCK1–MCK0: MCLK output clock option bits

UDI1–0: MCLK stop clock option

LEDF: LED freq. output selection(1:10/40 kHz; 0:4/16 kHz)

Others:

LKR1–LKR0: SYNC lost hold time option

SIEN: System information output enable option

LPWR: Power saving option

FILT1: Digital filter option



FUNCTION DESCRIPTION

The W93910 ERMES paging decoder can be used to easily construct an ERMES pager with RF receiver and μ C. To initialize the decoder, first, 192 option bits must be programmed through TXCLK, TXDATA pin by μ C. After the oscillator has been turned on and is stable, the decoder can then receive and decode the 2 bit digital QFSK signal from the RF receiver. With built-in PLEN, RFEN, QC1 and QC2 controls, the decoder can warm up and shut down the frequency synthesizer and IF demodulator for optimum reception in different stages.

While starting, the pager will begin to search the home channel. If system synchronization can't occur in the current channel, the pager will change to the next channel according to the channel scan algorithm until synchronization occurs. Once synchronized with the channel, the pager will lock to its own batch, ready to receive paging message. If an address-matched message is received, the de-interleaved data will be transferred to μ C through MDATA and MCLK pin. With the automatic channel scan algorithm, the decoder will inform μ C by PLEN and XCNCG to change channel during channel scan and normal mode.

RECEIVING OPERATION FLOW

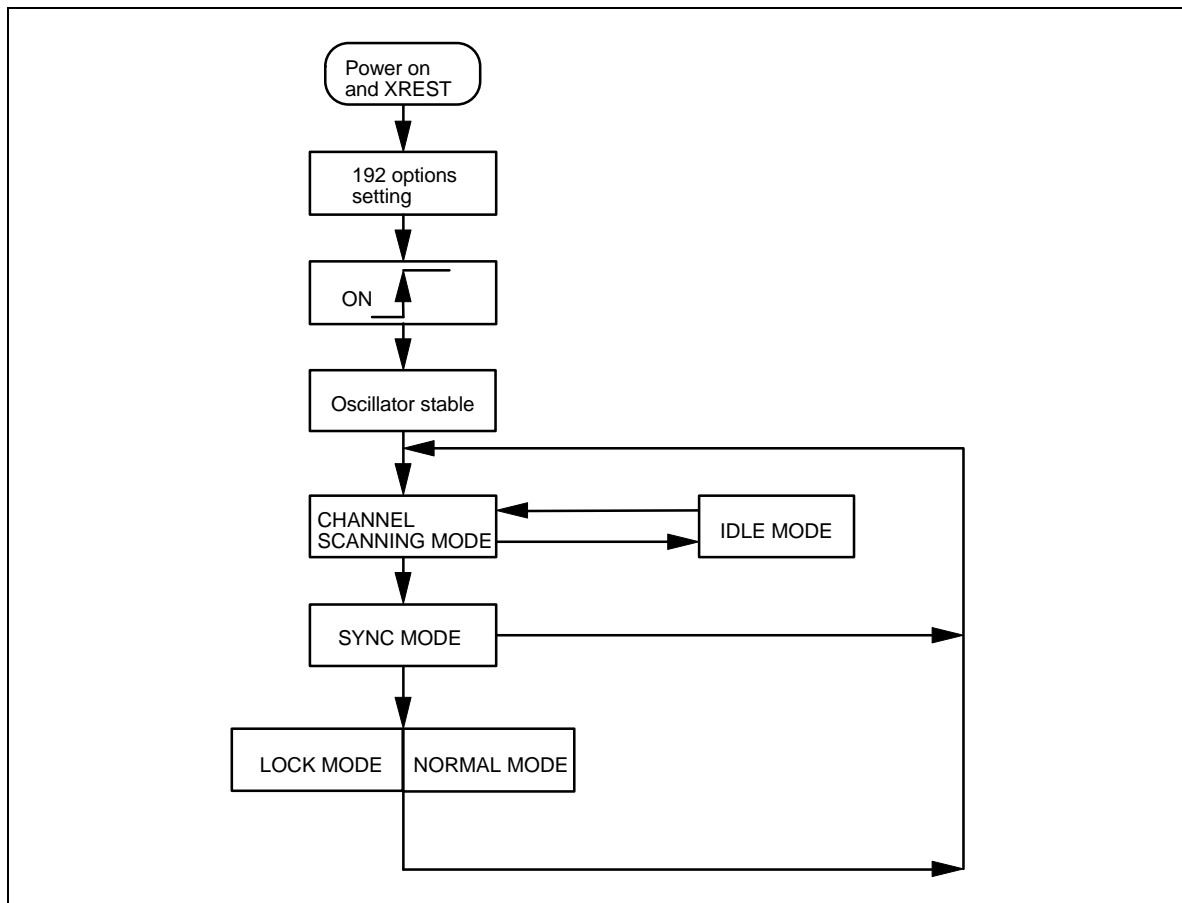


Figure 1. Operating Flow Chart



192 OPTION BITS PROGRAMMING

After power on and XRST pin active, the μ C should send 192 clock inputs to TXCLK pin and 192 options to TXDATA pin. Figure 2 shows the TXCLK and TXDATA programming timing. The data values in TXDATA are latched at TXCLK rising edge. The clock rate of TXCLK should be smaller than 1 MHz.

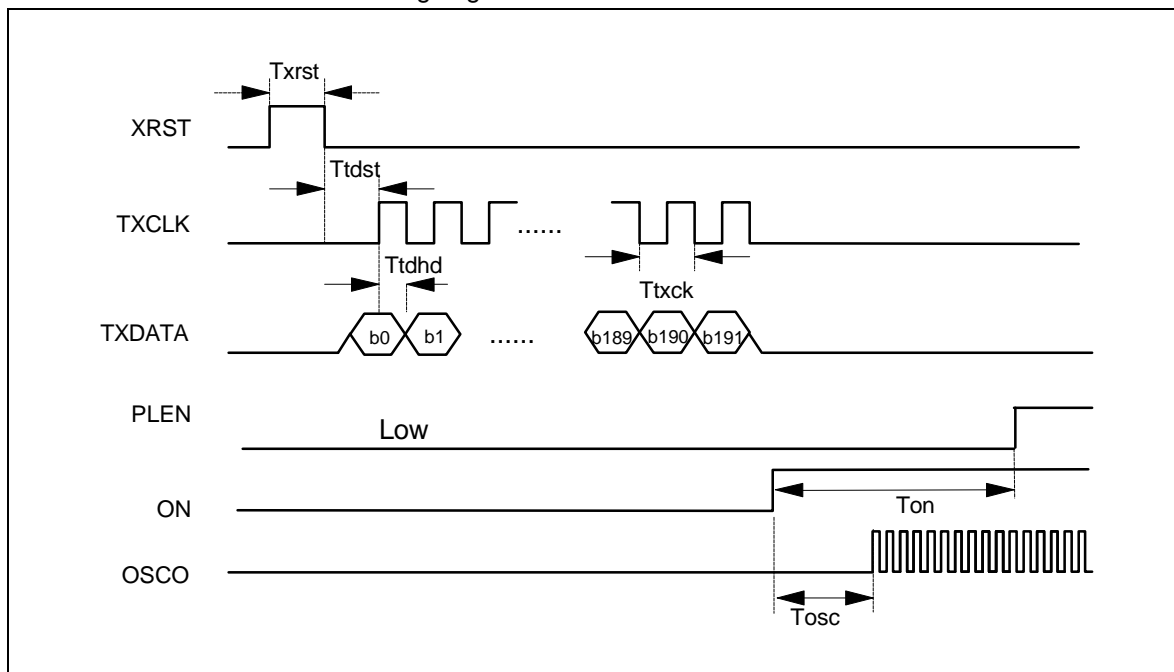


Figure 2. 192 option bits programming timing

RECEIVING ENABLE CONTROL

After the W93910 has received the 192 options, it will start the operation if the ON pin is high, or in stand-by mode if ON pin is low. The On pin can be pulled high at any time to activate the oscillator. After oscillator is stable, the decoder will activate the PLEN, RFEN, QC1, QC2, TCTL1, and TCTL2 to control the frequency synthesizer and IF demodulator, based on the option setting as shown in Figure 3. The frequency synthesizer need to be programmed to the right channel (normally home channel) before PLEN active. The PLEN is used to control the frequency synthesizer power, and inform μ C of the receiving status. The output levels of RFEN, PLEN, QC1 and QC2 are defined by the option bits RFENL, PLENL, QC1L and QC2L as shown in Table 2. TCTL2 is the inversion output of QC2. The TCTL1 active level is fixed. The TCTL1 and TCTL2 output will be activated only when the LEDF option bit is set to 1.

Option bit PL1-0, RFON, QCON1-0 and QC1WTH provides different set up time for PLEN, RFEN, QC1, QC2, TCTL1 and TCTL2, as shown in Table 3, to meet different RF receiver requirements.

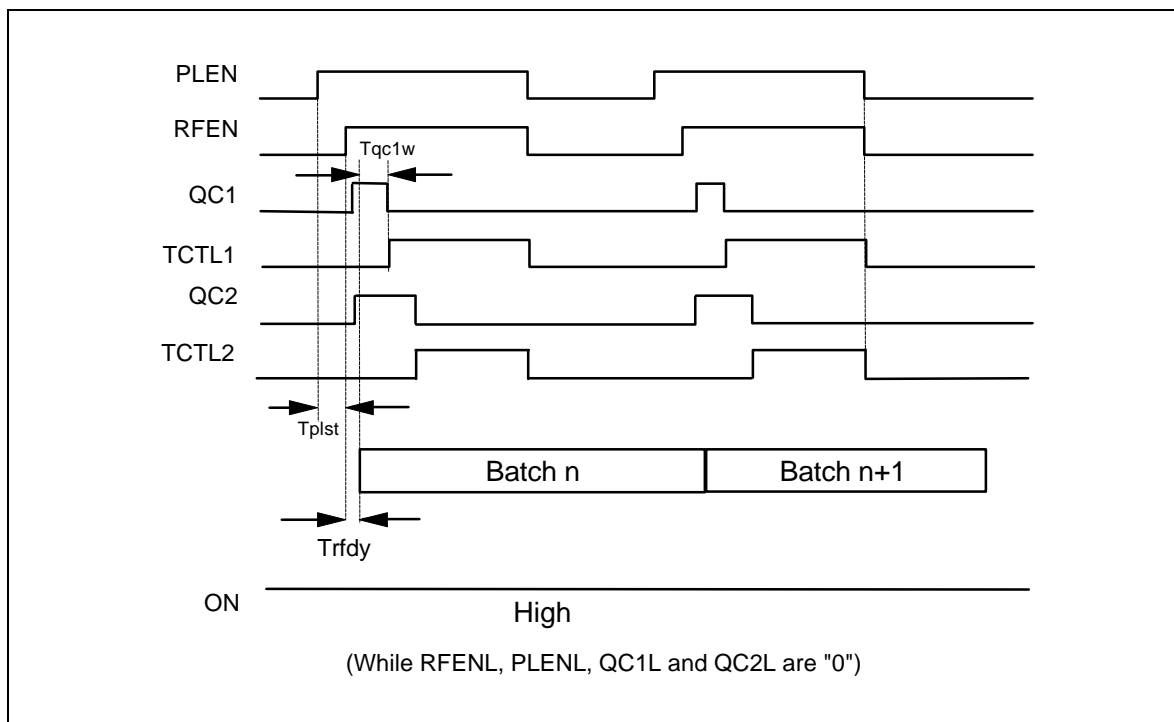


Figure 3. PLEN, RFEN, QC1, QC2, TCTL1 and TCTL2 timing

OPTION BIT	FUNCTION
RFENL, PLEN, QC1L, QC2L	RFEN, PLEN, QC1, and QC2 pin voltage level
0	Active high
1	Active low

Table 2. RF interface active option bits

OPTION BIT		FUNCTION
PL1	PL0	Tplst setting
0	0	9.6 mS
0	1	19.2 mS
1	0	28.8 mS
1	1	Reserved

Table 3. PLL enable timing



OPTION BIT	FUNCTION
RFON	Trfdy
0	4.8 mS
1	9.6 mS

Table 4. RF interface timing control option bit

OPTION BIT	FUNCTION
QC1WTH	Tqc1w
0	3.8 mS
1	2.5 mS

Table 5. Quick-charge duration option bit

OPTION BIT		FUNCTION	
QCON1	QCON0	QC1 duration	QC2 duration
1	0	$T_{plst} + T_{rfdy} + T_{qc1w}$	$T_{plst} + T_{rfdy} + 9.6ms$
0	0	$T_{rfdy} + T_{qc1w}$	$T_{rfdy} + 9.6ms$
0	1	T_{qc1w}	9.6 ms

Table 6. Quick-charge active timing control option bits

CHANNEL SCAN MODE

In this mode, decoder will enable the receiver to search the available channel in different frequency channels based on the channel scan control algorithm.

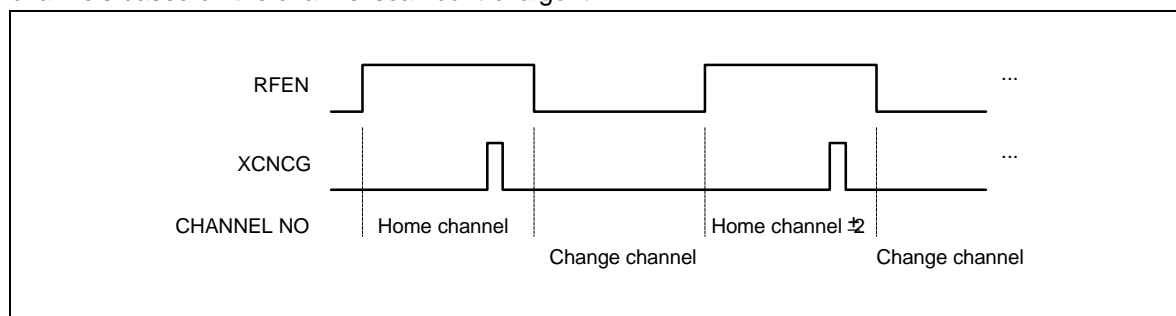


Figure 4. Channel Scan Mode



CHANNEL SCAN CONTROL

The channel scanning and switching are controlled by the decoder. Table 7 shows the channel number and frequency. In channel scan mode, the decoder will first search the home channel, defined by the CH3–CH0. Therefore, the synthesizer should be programmed to home channel before the channel scan mode. If the pager can not detect a valid signal in the home channel, the pager will change to the next channel to search until the decoder lock to the signal. The scanning sequence is shown in Figure 5, and needs to be followed to avoid losing signal.

OPTION BIT CH3–CH0	FUNCTION	
	Home channel number	RF center frequency
0000	0	169.425 MHz
0010	2	169.475 MHz
0100	4	169.525 MHz
0110	6	169.575 MHz
1000	8	169.625 MHz
1010	A	169.675 MHz
1100	C	169.725 MHz
1110	E	169.775 MHz
1111	F	169.800 MHz
1101	D	169.750 MHz
1011	B	169.700 MHz
1001	9	169.650 MHz
0111	7	169.600 MHz
0101	5	169.550 MHz
0011	3	169.500 MHz
0001	1	169.450 MHz

Table 7. Channel number and frequency

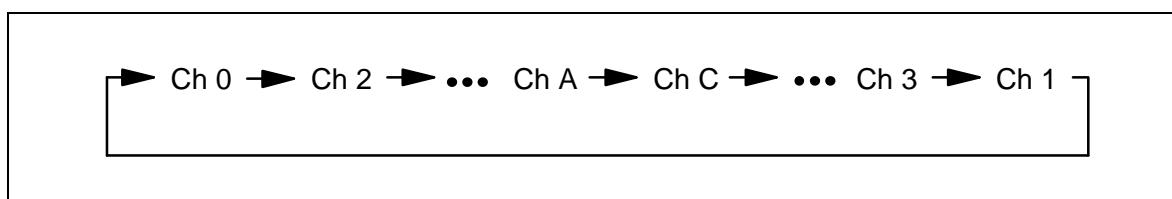


Figure 5. Channel scan sequence



The frequency channel adjustment is implemented by XCNCG, PLEN, and μ C. XCNCG is used to output a high pulse to inform μ C of the frequency channel increment request. μ C needs to count the XCNCG high pulse during the PLEN active period. Each XCNCG pulse indicates one frequency channel increment. During the PLEN inactive period, the μ C should program the synthesizer with suitable data based on the previous XCNCG counting result to ensure the receiver can catch the right channel. During the lock mode, the pager will fix at the same channel as shown in Figure 6 and 7. The normal mode operation is described in Figure 8 and 9. The batch number setting is shown in Table 8.

OPTION BIT	FUNCTION
bn3–bn0	Batch Number
0000	A
0001	B
0010	C
0011	D
0100	E
0101	F
0110	G
0111	H
1000	I
1001	J
1010	K
1011	L
1100	M
1101	N
1110	O
1111	P

Table 8. bn3–bn0 batch number format

IDLE MODE

If there is no meaningful signal after scanning the channel several times, the decoder will enter idle mode to save power, and will re-enter the channel scan mode after a period of time.

SYNC MODE

While synchronizing with the paging system, the decoder enters sync mode and the $\overline{\text{SYNVAL}}$ pin outputs LOW. The decoder will then change to lock mode or normal mode based on the receiving information.



LOCK MODE

In lock mode, the decoder will stay at the same channel. If matching addresses appear, all the available paging messages will be received until messages are finished or time out occurs.

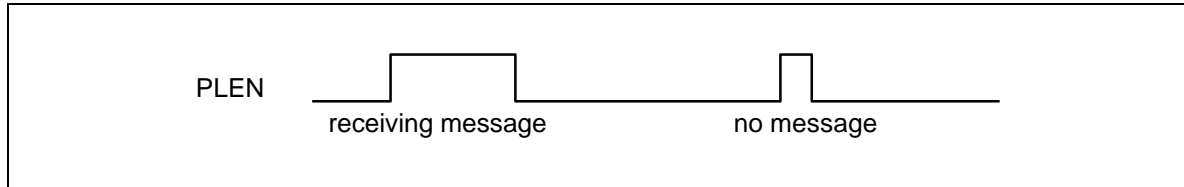


Figure 6. Lock Mode

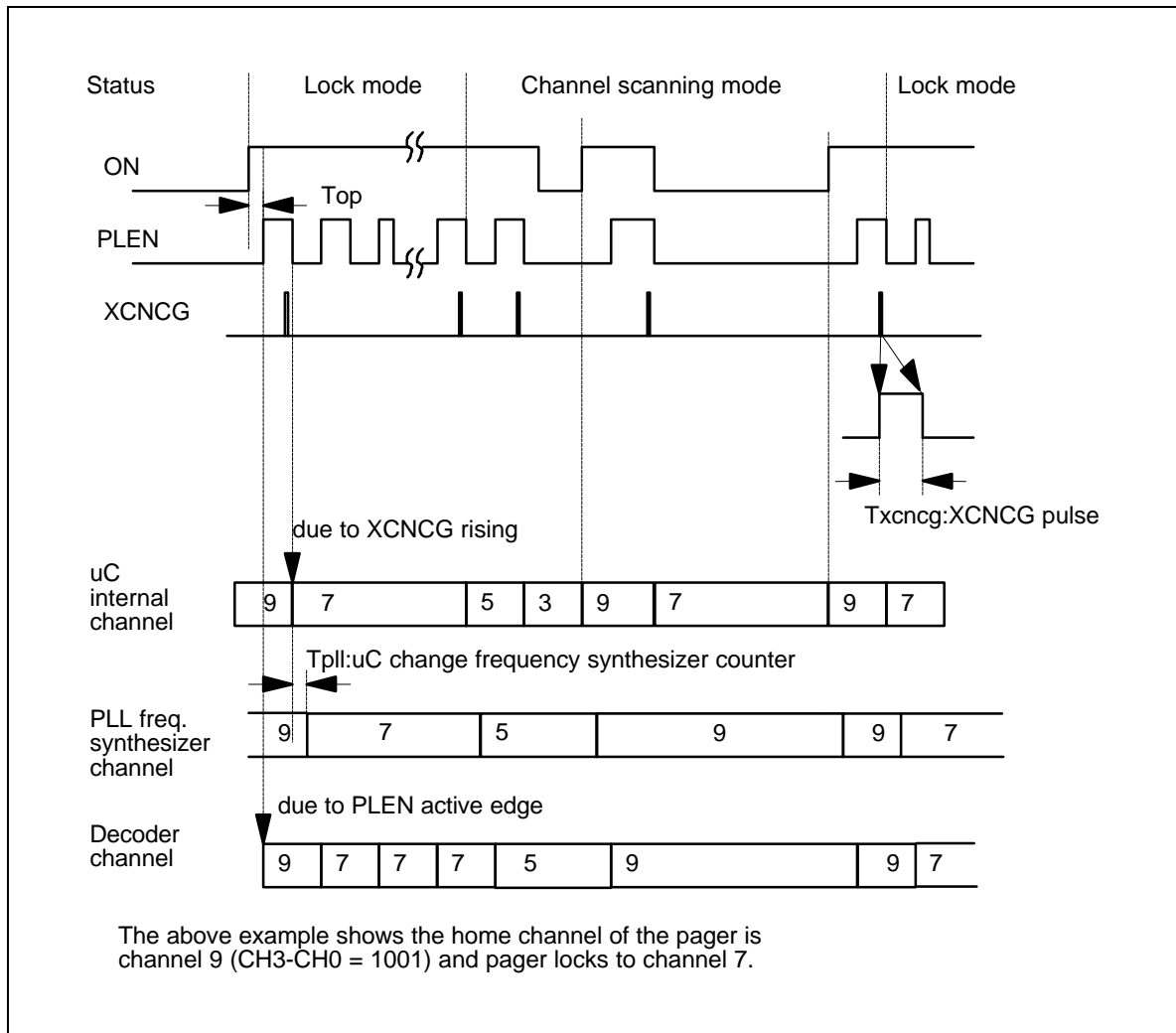


Figure 7. Channel Scan mode and lock mode



NORMAL MODE (NON-LOCK)

Decoder will enter normal mode while not in the home network or the border area indication condition. In this mode, the decoder will switch and listen to different frequency channel based on the channel scan control algorithm. The PLEN operating timing is shown in Figure 8.

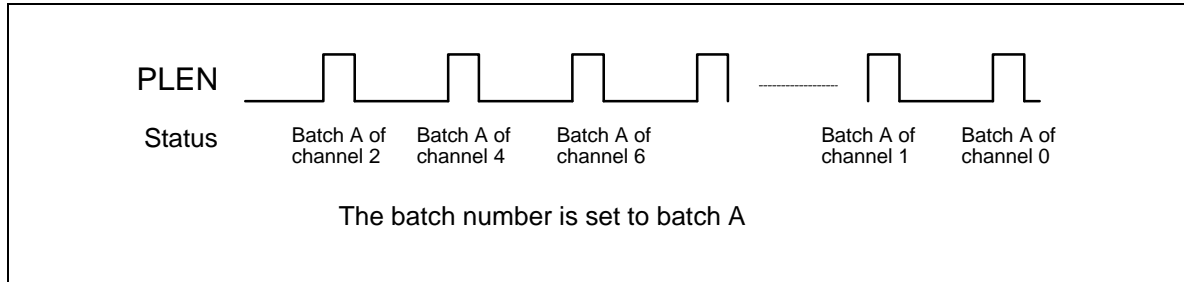


Figure 8. Normal Mode

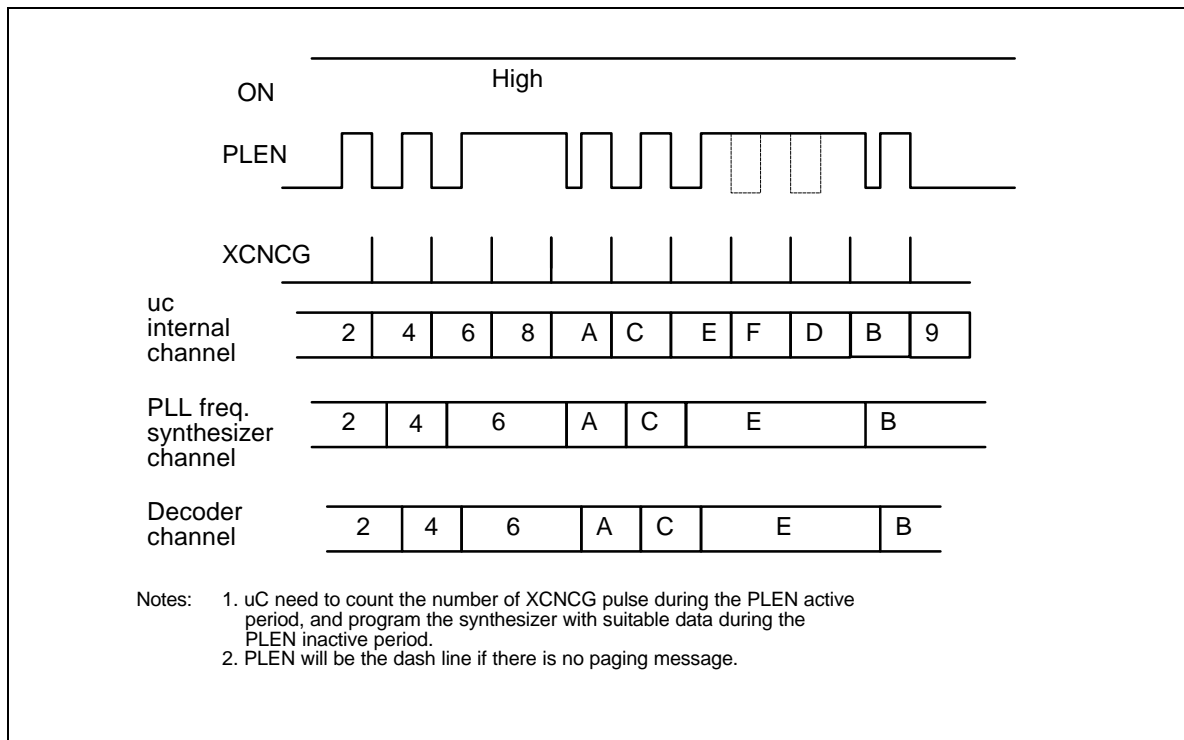


Figure 9. Channel scan in NORMAL MODE



LOST SYNCHONIZATION

If synchronization is lost for several minutes (pre-defined by option bit LKR1–LKR0), the pager will change to the channel scan mode. The $\overline{\text{SYNVAL}}$ pin will keep low during the lock mode and normal mode unless the synchronization lost duration exceeds the hold time condition, then the $\overline{\text{SYNVAL}}$ pin will change to high level and the decoder will go back to the channel scan mode.

OPTION BIT		FUNCTION
LKR1	LKR0	Synchronization lost hold time
0	0	1 min.
0	1	2 min.
1	0	3 min.
1	1	4 min.

Table 9. Lock re-try option bits

RIC (Radio Identify Code) FORMAT

For ERMES system, RIC has 35 bits and is defined by ZC2–ZC0, CC6–CC0, OP2–OP0, IA17–IA0, and BN3–BN0 option bits as shown in Table 10.

Function	Radio Identify Code					
	OPID			LOCAL ADDRESS		
	Zone Code	Country Code	Operator Code	Initial Address	Batch Number	Paging area
OPTION bit	ZC2–ZC0	CC6–CC0	OP2–OP0	IA17–IA0 GIA17–GIA0	BN3–BN0	PA5–PA0 GPA5–GPA0

Table 10. RIC format

The W93910 provides two initial addresses with corresponding paging area code, IA17–IA0 with PA5–PA0 and GIA17–GIA0 with GPA5–GPA0, for the same OPID. The first one is dedicated for the basic RIC. Each pager has one unique batch number, defined by BN3–BN0, and will only turn on and listen at that specific batch except where a message continues over one batch. If PAEN option bit is set to "1", the received message must match to the pre--defined paging area code, PA5–PA0. Other than in this situation, the received paging area code doesn't need to match the pre-defined PA5–PA0, but must be consistent throughout the whole message. The second IA, GIA17–GIA0, is enabled by setting the GIAEN option bit to 1. GPAEN has the same function as PAEN, but for GIA17–GIA0 address only.

OPTION BIT	FUNCTION
GIAEN	Second user address (GPA+GIA)
0	Disable
1	Enable

Table 11-1. Second initial address setting option bits



OPTION	FUNCTION
PAEN, GPAEN	PA5–PA0, GPA5–GPA0
0	Don't care
1	Enable

Table 11-2. Paging area setting

REMOTE PROGRAMMING

The W93910 provides remote programming addresses including initial address, paging area, zone code, and country code to support the remote programming function. These option bits are listed in Table 12. These temporary addresses can be programmed during the initial setting or modified by the air message. While receiving the remote programming address message, W93910 will automatic update the internal remote programming addresses and also pass the programming message to μ C through MDATA pin. The data should be stored for re-initialization purpose. Please refer to Summary of Data Output Format. If the remote programming data is less than 18 bits, the dummy "0" is filled in the other low bits of rd17–rd0. For the first time initialization, all the option bits should be "0" including the RPI. The RPI is the remote programming index, which can be read out from MDW while receiving the remote programming message.

OPTION BIT	FUNCTION
RPIA17–RPIA0	Initial Address
RPPA5–RPPA0	Paging Area
RPZC2–RPZC0	Zone Code
RPCC6–RPCC0	Country Code
RPOP2–RPOP0	Operator Code
RPI	Remote Programming Index

Table 12. Remote programming register

SYSTEM INFORMATION

By setting the SIEN option bit to 1, the system information can also be read out from TXDATA pin. After 192 option bits setting, if the μ C decides to read out the received system information, the μ C needs to send 31 clocks to TXCLK pin. The first clock pulse will switch TXDATA pin from input to output, and the last clock pulse will disable this function. At the falling edge of the each clock pulse except the first and last clock one, the system information (batch no, country code, operator code, cycle no., hour) can be read out from the TXDATA pin. The best timing to read out the system information is right after PLEN falling edge. The format and timing are shown in Figure 10. This function is disabled if SIEN is set to 0.

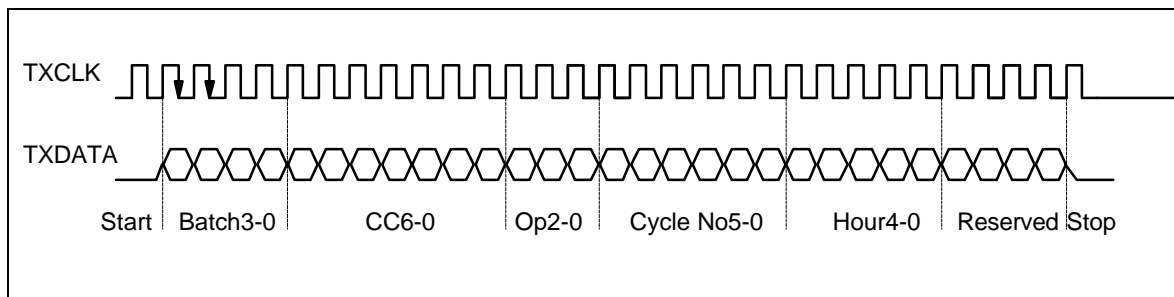


Figure 10. System information read out format

DATA INPUT

The 4 level FSK signal is converted to 2 bit digital signal by IF demodulator, as shown in Figure 11, where f_n is the carrier frequency from 169.425 MHz to 169.8 MHz. The 2 bit digital signal should be connected to the D1(MSB), D0(LSB) inputs of W93910. The D1 and D0 inputs could be inverted by setting the D1IV, and D0IV option bits to provide some flexibility.

OPTION BIT	FUNCTION
D1IV, D0IV	D1 input, D0 input
0	Non-inversion
1	Inversion

Table 13. D1, D0 relative option bits

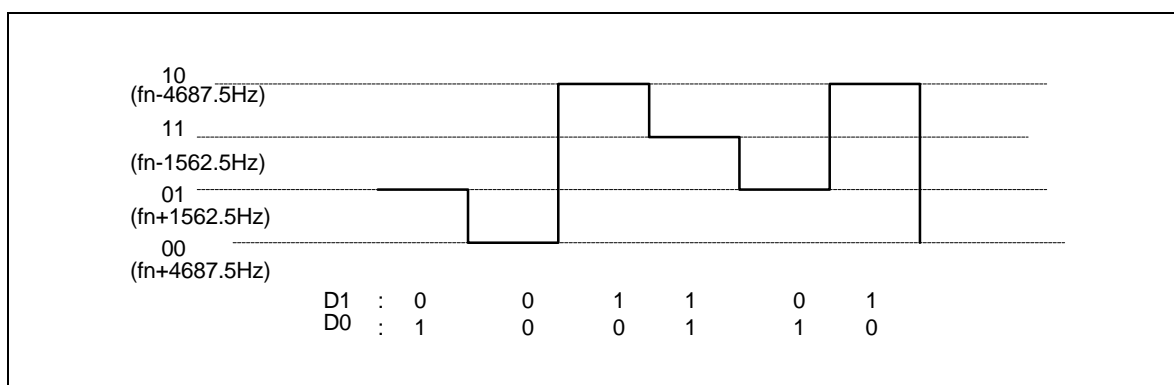


Figure 11. 4 PAM mapping to D1, D0(f_n is the channel carrier frequency)



DIGITAL FILTER & POWER SAVING

The W93910 provides different digital filter to remove the noise of the 4FSK signal. The enhanced filtering require higher power consumption. Table 14 shows different combinations of digital filtering and power saving.

OPTION BIT		FUNCTION
FILT1	LPWR	Digital filter & power saving
0	0	Low power consumption, normal filtering
1	1	Enhanced filtering, high power consumption

Table 14. Digital filter and power saving option

DE-INTERLEAVER AND ERROR CORRECTION

The W93910 performs 2 bits random error correction for system information, address partition as well as message partition, and codeword de-interleaving for message partition.

TIME OUT CONTROL

When the decoder recognizes a valid initial address it will start to search the associated paging message. Time out criteria will stop message searching at once. While the searching is stopped due to time out issue, the "epa" and "etm" in EDW format will be set to indicated the time out situation. At the mean time, the RF control signal will become inactive at once when ending message delimiter (MD) has been detected.

• For Individual calls

Two time out criteria shall apply. The earliest detected shall prevail:

1. If PA5–PA0 in paging message is not consistent throughout the receiving, then the epa flag will be set to "1".
2. If the paging message lasts more than 12 sec, then etm flag will be set to "1".

• For group calls

Individual member shall cease message search if:

1. If PA5–PA0 in paging message is not consistent throughout the receiving, then the epa flag will be set to "1".
2. If the paging message lasts more than 12 sec, then etm flag will be set to "1".

• For long message calls

The time out criteria for each sub-message is the same as for individual call. The time out of the whole long message should be proceeded by the software to meet the ERMES protocol.



DATA OUTPUT CONTROL

When the chip detects the proper address, the chip will first activate ADRVAL pin to inform the μ C and then send the de-interleaved paging message and related system information to the μ C through MCLK and MDATA pin. The format and timing of the data output is shown in Figure 12. The data output is packed into a 3-byte word format. The function of each word is defined by the **Function Code**, the first 4 bits of byte3, as shown in Table 15. The format of the rest 20 bits will depend on the function code.

HIGH NIBBLE OF BYTE 3	FUNCTION CODE
0000	System Information Word (SIW)
0010	ComMand Word (CMW)
010x	Addition Information Word (AIW)
0110	Message data Word (MDW)
1110	EnD message Word (EDW)
Others	RESERVED

Table 15. Data Output Function Code

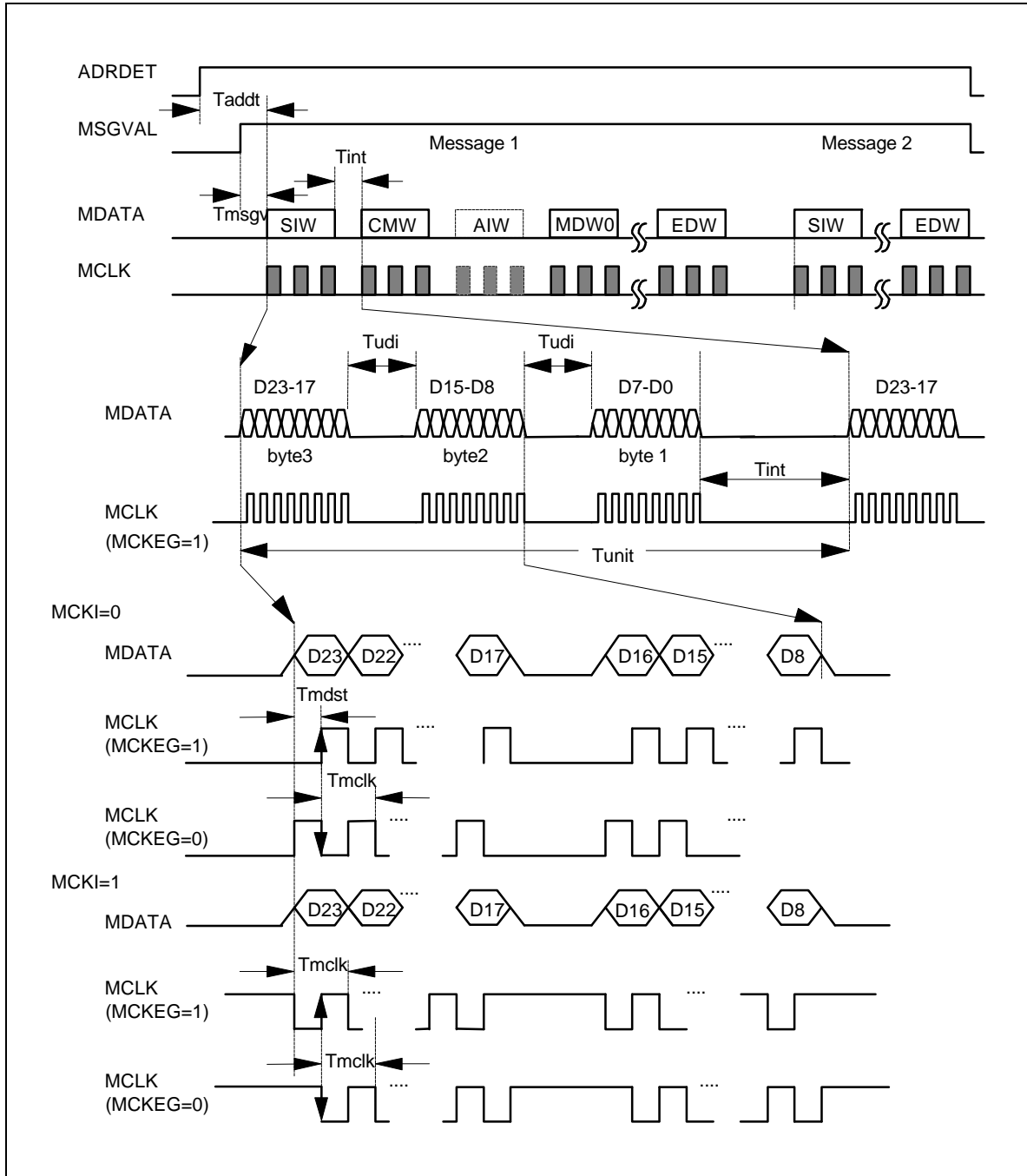


Figure 12. Data Output Timing



Table 16–Table 19 list the active level and timing option bit settings of the data output format. MCLK clock rate is defined by option bit MCK1–0. The duration between each word, Tint, and the duration between each byte, Tudi, are defined by option bit UDI1–UDI0. Option bit MCKEG defines MCLK active edge. MCKI, MSGI and MDAI option bits set MCLK, MSGVAL and MDATA pin initial and active state.

The output sequence of MDATA pin is SIW, CMW, MDW0, MDW1...MDWn, EDW for all the message types except long message. For long message, an extra AIW is added between CMW and MDW0. Please refer to **Summary of Data Output Format** for different paging message format.

OPTION BIT	FUNCTION
MCKEG	MCLK active edge
0	Falling edge active
1	Rising edge active

Table 16. Data output pin option

OPTION BIT	FUNCTION
MSGI	MSGVAL active level
0	active low
1	active high

Table 17. Data output pin option

OPTION BIT	FUNCTION
MDAI, MCKI	MDATA, MCKI pin initial state
0	Initial low
1	Initial high

Table 18. Data output pin option

OPTION		FUNCTION	
MCK1, MCK0	UD1, UD0	Tudi timing	Tint timing
00 Tmclk = 80 μ S	00	0	2.08 mS
	01	160 μ S	1.76 mS
	10	320 μ S	1.44 mS
	11	640 μ S	800 μ S
01 Tmclk = 40 μ S	00	0	3.04 mS
	01	160 μ S	2.72 mS
	10	640 μ S	1.76 mS
	11	1 mS	1.04 mS
10 Tmclk = 20 μ S	00	0	3.52 mS
	01	160 μ S	3.2 mS
	10	640 μ S	2.24 mS
	11	1.16 mS	1.2 mS
11 Tmclk = 5 μ S	00	0	3.88 mS
	01	80 μ S	3.72 mS
	10	640 μ S	2.66 mS
	11	1.275 mS	1.33 mS

Table 19. Tudi and Tint timing option (where Tunit = 4 mS minimum)

SIW Definition

When the W93910 receives a message, the MSGVAL pin will be activated first, and then SIW will be the first word to output from the MDATA pin. System information, such as year, month, date, hour, day and OPID, may resolve from SIW.

SIW	b7	b6	b5	b4	b3	b2	b1	b0
byte3	0	0	0	0	fsi	sn2	sn1	sn0
byte2	s13	s12	s11	s10	s9	s8	s7	s6
byte1	s5	s4	s3	s2	s1	s0	X	X

Table 20. SIW format



SIW Description:

fsi	s13	s12	s11	s10	s9	s8	s7	s6	s5	s4	s3	s2	s1	s0
0	z2	z1	z0	h4	h3	h2	h1	h0	d4	d3	d2	d1	d0	rv
1	w2	w1	w0	mt3	mt2	mt1	mt0	yr6	yr5	yr4	yr3	yr2	yr1	yr0

Table 21. s13–s0 format

sn2–sn0 is the subsequence number 0(000) to 4(100) that existed in SI field.

fsi is the function bit of s13–s0 that provides all transmitter time base information.

1. fsi = 0 while SSIT is equal "0000" in SSI field

z2–z0: RIC zone code from 000–111

h4–h0: Local hour from 0(00000)–23(10111)

d4–d0: Local date from 1(00001)–31(11111)

rv: reserve bit for future

(Note: minute will be shown as cy5–cy0 in EDW)

2. fsi = 1 while SSIT is equal "0001" in SSI field

w2–w0: Local day of week from Monday(001)–Sunday(111)

mt4–mt0: Month from January(0001)–December(1100)

yr6–yr0: Year from 1990(0000000)–2117(1111111)

CMW Definition

The second word is CMW, which indicates the message type, message number, paging category, and alert type of received paging message.

CMW	b7	b6	b5	b4	b3	b2	b1	b0
byte3	0	0	1	0	cm3	cm2	cm1	cm0
byte2	eb	g1	g0	mn4	mn3	mn2	mn1	mn0
byte1	0	0	pc1 / f1	pc0 / f0	ain3	ain2	ain1	ain0

Table 22. CMW format

**CMW Description:**

cm3- cm0	message type description
0000	individual call
1000	long message w/o C.S--First submessage.
1001	long message w/o C.S--Others submessage.
1010	remote programming
1100	retransmit latest message no#
1101	long message with C.S--Others submessage.
1110	long message with C.S--First submessage.
1111	Change Character Set (C.S.)
Others	Reserved

Table 23. Message type description (cm3–cm0)

eb	External flag
0	Home Receiver
1	External receiver

Table 24. External receiver index

g1 g0	RIC address index of received message
00	IA17–IA0 available
01	Air Programming RIC
10	GIA17–GIA0 available
11	Group call by CTAP method

Table 25. Received message address index

mn4–mn0	Message number
00000	For group calls the reserved dummy value 00000 shall be used. The reserved dummy value may also be used when the message numbering is deactivated, as with remote programming.
Others	For individual calls the initial value shall be 00001; then mn4–mn0 will be increased by 1 continuously for the following message.

Table 26. Message number description (mn4–mn0)



pc1 pc0	Paging category
00	Tone only
01	Numeric
10	Alphanumeric
11	transparent data

Table 27. Paging category index

The ain3–ain0 is used to indicated the alert type of the message, except in the remote programming situation.

ain3–ain0	Alert type description
0000	non-urgent alert type 0
0001	non-urgent alert type 1
0010	non-urgent alert type 2
0011	non-urgent alert type 3
0100	non-urgent alert type 4
0101	non-urgent alert type 5
0110	non-urgent alert type 6
0111	non-urgent alert type 7
1000	urgent alert type 0
1001	urgent alert type 1
1010	urgent alert type 2
1011	urgent alert type 3
1100	urgent alert type 4
1101	urgent alert type 5
1110	urgent alert type 6
1111	urgent alert type 7

Table 28. Alert type index

CMW for remote programming

When the pager receives the remote programming message, the W93910 will program the internal remote programming addresses automatically, and will also inform the μ C by sending out the received message. For remote programming, the cm3–cm0 of CMW is equal to 1010, the f1–f0 and ain3–ain0 of CMD, and rd17–rd0 of MDW will send out the received programming message to μ C as shown below.

ain3- 0 of CMW	rd17- rd0 definition in MDW	Programmable function
0001	RIA17–RIA0	Initial Address
0010	RPA5–RPA0 + 12 dummy "0"	Paging Area
0100	RZC3 + RCC7 + ROP3 + 5 dummy "0"	OPID
1000	SM5 + HNL3 + 12 dummy "0"	Home receiver battery saving
0111	SM5 + ENL3 + 12 dummy "0"	External receiver battery saving

Table 29. Remote programming MDW format only

f1- f0	Function description
00	Add RIA, RPA, ROPID or replace SM
01	Remove RIA, RPA, ROPID
10	Restore SM, ENL, HNL to Table 1
11	Reserve

Table 30. Remote programming MDW format only

AIW Definition

AIW	b7	b6	b5	b4	b3	b2	b1	b0
byte3	0	1	0	cs4	cs3	cs2	cs1	cs0
byte2	lc15	lc14	lc13	lc12	lc11	lc10	lc9	lc8
byte1	lc7	lc6	lc5	lc4	lc3	lc2	lc1	lc0

Table 31. AIW format

The AIW is only available for long message (cm3–cm0 = 1000,1001,1101,1110) or changing character set (cm3–cm0 = 1111), otherwise it's absent. The cs4–0 indicate character set and lc15–lc0 indicate link counter. The different formats of AIW for the four different types of long message and changing character set are listed in **Summary of Data Output Format**.

Each long message is divided into many submessages. The first submessage (cm3–cm0 = 1000 or 1110) must be transmitted first, then other submessages follow in sequence. Each submessage has its own link counter lc15–lc0, which indicates how many message bits remain to be transmitted. The ter flag is defined to indicate the end of the long message as shown in Table 28. When ter flag is 1, it means the long message is completed. Otherwise, it means there are still some other submessages in the coming signal.

For a long message, the W93910 will store all the received submessages including the EOM and filler bits in MDW and then send to UC. The filler bits and EOM are the last message part of MDW group, MDW1, MDW2...MDWn, and need to be removed to construct the long message. The following equation shows how many message bits of the previous MDW group need to be truncated. The long message can then be reproduced by connecting all the submessages except the truncated parts.



No. of message bits needing to be truncated in previous MDW group

= Total message bits of previous MDW group - [(lc15–lc0)_{previous} - (lc15–lc0)_{current}]

ter flag in EDW	Status
ter = 1	long message is completed
ter = 0	long message is not completed

Table 32. ter flag of EDW for long message

MDW Definition

The received paging message will be output as MDW1, MDW2 ...MDWn format (MDW group). md17–md0 are the actual paging message data resolved from the message partition, including terminator character EOM and any dummy bit such as a filler. For any submessage of a long message, μ C needs to use AIW's lc15–lc0 to truncate terminator or dummy bit from md17–md0 according to AIW description. While remote programming, rd17–rd0 is used for remote programming data only. RPI is the remote programming index received from system. This bit should be loaded into b147 of option bit during the re-initialization stage if the remote address is programmed.

MDW	b7	b6	b5	b4	b3	b2	b1	b0
byte3	0	1	1	0	md17/ rd17	md16/ rd16	md15/ rd15	md14/ rd14
byte2	md13/ rd13	md12/ rd12	md11/ rd11	md10/ rd10	md9/ rd9	md8/ rd8	md7/ rd7	md6/ rd6
byte1	md5/rd5	md4/rd4	md3/rd3	md2/rd2	md1/rd1	md0/rd0	er1	RPI

Table 33. MDW format

MDW Description:

BIT	FUNCTION
md17–md0 (normal message)	Available paging message
rd17–rd0 (remote programming)	Remote programming data only
er1	set to 1 if the random error can't be corrected in this message word
rsv	don't care, reserved for future

Table 34. MDW bit description

Any paging message such as 7 bit alphanumeric, 4 numeric or transparent data will be placed continuously in the 18 bit information field, md17–md0. After the last character (or bit) of message the following message termination procedures shall be used:

- Alphanumeric: an EOM character (0010001) shall be appended;
- Numeric: no terminating character required;
- Transparent data: a single bit set to one shall be appended;



Unused bit in message shall be set as the following default values:

- Alphanumeric: EOM character and partial EOM character (MSB used first) shall be repeated to fill the remaining bits;
- Numeric: space character and partial space character (MSB used first) shall be repeated to fill the remaining bits;
- Transparent data: binary zeros shall be used to fill the remaining bits;

The bit mapping in MDW unit for numeric and 7 bit alphanumeric are as follows.

For numeric format, bit17–14 of MDW0 construct the first numeric, bit13–10 are the second... bit1–0 of MDW0 and bit17–16 of MDW1 are the fifth numeric.... Therefore, two MDWs will construct 9 numeric.

For 7 bit alphanumeric format, bit17–11 of MDW0 construct the first character, bit10–4 of MDW0 are the second character, bit 3–0 of MDW0 and bit17–15 of MDW1 are the third character... The alphanumeric definition is depended on Character Set (C.S.). The default C.S. is 00000.

EDW Definition

The EDW will follow the last MDW while the paging message is completed. Normally, the ter flag is "0" except in a long message completion situation. For any submessage of a long message except the last one, the ter flag of EDW is "0". Only when the long message is completed will the ter flag of EDW be "1". There is some other system information in byte2 of EDW such as eti flag, bai flag and current cycle number, cy5–cy0. The ch3–0 of byte3 indicate which frequency channel the current paging message is caught from and the bn3–bn0 of byte3 indicate which batch the message is completed in.

EDW	b7	b6	b5	b4	b3	b2	b1	b0
byte3	1	1	1	0	0	ter	epa	etm
byte2	eti	bai	cy5	cy4	cy3	cy2	cy1	cy0
byte1	bn3	bn2	bn1	bn0	ch3	ch2	ch1	ch0

Table 35. EDW format

EDW description:

BIT	FUNCTION
ter	set to "1" while current long message is completed, otherwise ter flag is "0" for any individual call or submessage.
epa	set to "1" if paging message searching is stopped due to PA inconsistency
etm	set to "1" if paging message searching is stopped due to 12 sec time out
cy5–cy0	cycle number from 0(000000) –59(111011) as minute index.
eti	External Traffic indicator in SI field
bai	Border Area Indicator flag in SI field

Table 36. EDW description



Summary of Data Output Format

message type (cm3-0)	byte	SIW (D23-D0)	CMW (D23-D0)	AIW (D23-D0)	MDW (D23-D0)	EDW (D23-D0)
Individual 0000	3	0000 fsi sn2-sn0	0010 cm3-cm0	X	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	X	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	X	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
0XXX(Reserved)						
Long w/o C.S. (First submessage) 1000	3	0000 fsi sn2-sn0	0010 cm3-cm0	010 xxxxx	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	lc15-lc8	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	lc7-lc0	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
Long w/o C.S. (Other submessages) 1001	3	0000 fsi sn2-sn0	0010 cm3-cm0	010 xxxxx	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	lc15-lc8	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	lc7-lc0	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
Remote Programming 1010	3	0000 fsi sn2-sn0	0010 cm3-cm0	X	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	X	rd13-rd6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 f1-f0 ain3-ain0	X	rd5-rd0 er1 rsv	bn3-bn0 ch3-ch0
1011(reserved)						
Retransmit Latest msg no 1100	3	0000 fsi sn2-sn0	0010 cm3-cm0	X	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	X	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	X	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
Long with C.S. (First submessage) 1101	3	0000 fsi sn2-sn0	0010 cm3-cm0	010 cs5-cs0	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	lc15-lc8	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	lc7-lc0	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
Long with C.S. (Other submessages) 1110	3	0000 fsi sn2-sn0	0010 cm3-cm0	010 cs5-cs0	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	lc15-lc8	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	lc7-lc0	md5-md0 er1 rsv	bn3-bn0 ch3-ch0
Change Character Set 1111	3	0000 fsi sn2-sn0	0010 cm3-cm0	010 cs5-cs0	0110 md17-md14	1110 0 ter epa etm
	2	s13-s6	eb g1 g0 mn4-mn0	xxxx xxxx	md13-md6	eti bai cy5-cy0
	1	s5-s0 0 0	0 0 pc1-pc0 ain3-ain0	xxxx xxxx	md5-md0 er1 rsv	bn3-bn0 ch3-ch0

Table 37. MDATA output summary

Note: where "x" means don't care



LED CONTROL

LEDO will output a frequency while ENLED is in high level. The LEDO output frequency is selected by option bit LEDF and PLEN condition as described in table 38. When the LEDF is set to 1, the TCTL1 and TCTL2 control pin will also be activated to output the control signal. The TCTL1 and TCTL2 timing is shown in figure 3.

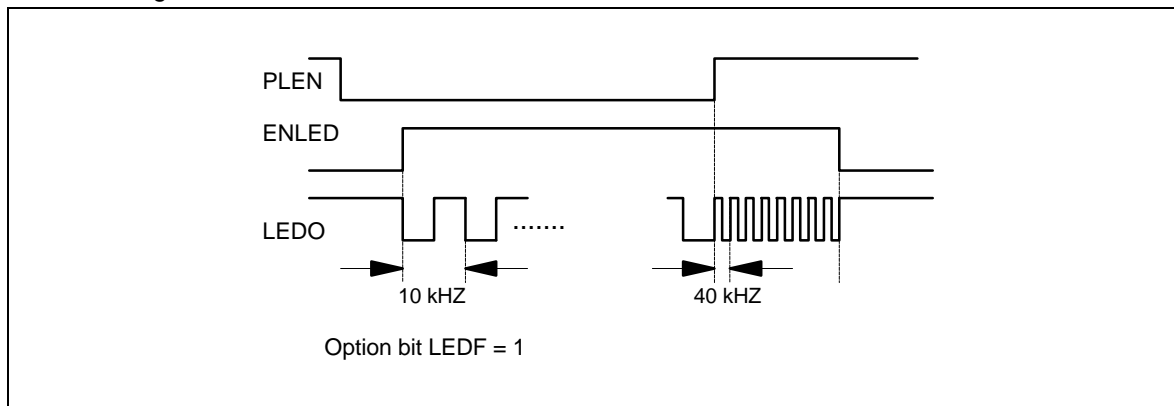


Figure 13. LEDO Timing

OPTION BIT AND PLEN PIN		FUNCTION
LEDF	PLEN Status	LEDO output frequency
0	inactive	4 kHz
0	active	16 kHz
1	inactive	10 kHz
1	active	40 kHz

Table 38. LED option bit

RESET CONDITION

The W93910 has two reset conditions.

Power on & XRST active

- Reset all 192 option bits and all remote programming registers
- RFEN, PLEN, QC1, QC2, LOCK, MSGVAL, MCLK, MDATA in non-active state

ON pin rising edge is occurred

- Oscillator start oscillation
- Reset channel number to CH3–CH0 of the 192 option bits
- The values of remote programming registers is not changed



ABSOLUTE MAXIMUM RATINGS

PARAMETER	RATING	UNIT
Supply Voltage to Ground Potential	-0.3 to +7.0	V
Applied Input/Output Voltage	-0.3 to +7.0	V
Power Dissipation	120	mW
Ambient Operating Temperature	-20 to +70	°C
Storage temperature	-55 to +155	°C

Note: The device should be operated under the above conditions. Operation beyond these conditions may result in permanent damage to the device.

DC/AC ELECTRONIC CHARACTERISTICS

($V_{DD} = 3$ volt, $F_{osc} = 100$ kHz, $T_a = 25^\circ$ C)

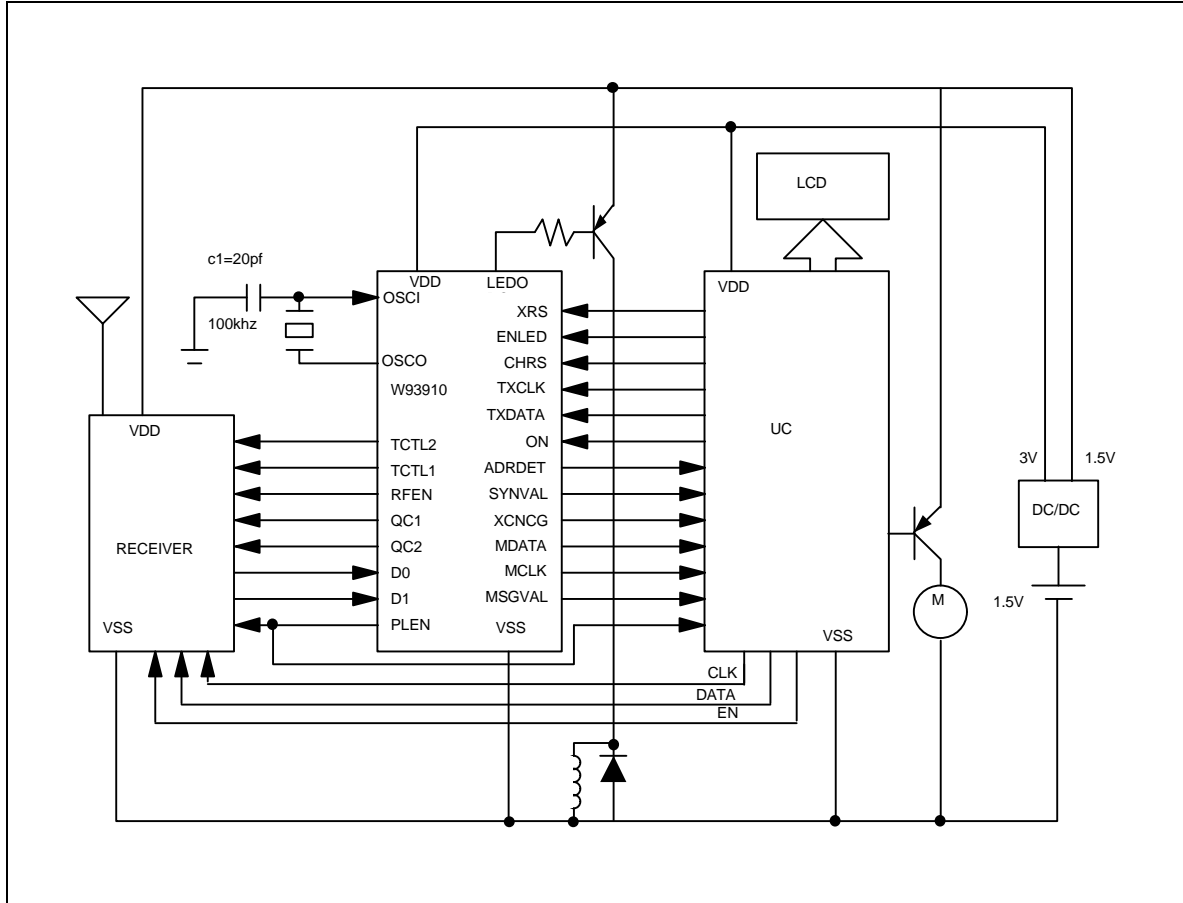
SYMBOL	PARAMETER	CONDITION	MIN.	TYP	MAX.	UNIT	NOTE
VDD	Operating Voltage		2.5	3	3.5	V	
IOP	Operating Current	$V_{DD} = 3$ volt		25	100	μ A	
ISB	Stand By current	ON = 0 volt		1	2	μ A	
VOH	Output high voltage		2.4			V	
VOL	Output Low voltage				0.4	V	
VIH	Input high voltage		2			V	
VIL	Input low voltage				0.8	V	
IOH	Output High Current	$V_O = 2.1$ volt	500			μ A	
IOL	Output Low Current	$V_O = 0.4$ volt	500			μ A	
TCHRS	CHRS Active Width		1			μ S	
TXCNCG	XCNCG Active Width		4		4.5	mS	
TTXCK	TXCLK Period		1			μ S	
TTDST	TXDATA Setup Time		20			nS	
TTDHD	TXDATA Hold Time		20			nS	
TOSC	OSCO Stable Time				1	S	
TXRST	XRST Active Width		10			μ S	
TPG	Programming setup		1			μ S	
TON	TXCLK to ON delay		3			Txclk	



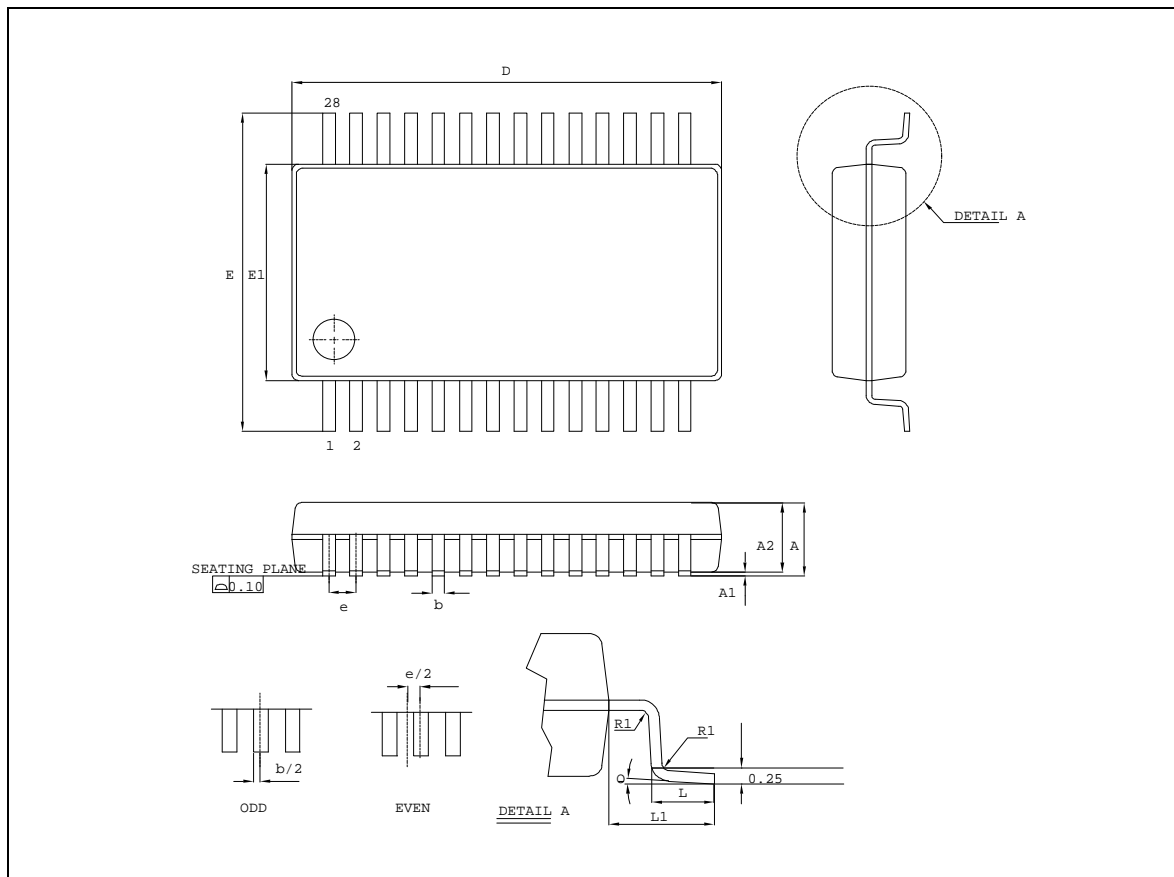
DC/AC Electronic Charac, continued

SYMBOL	PARAMETER	CONDITION	MIN.	TYP	MAX.	UNIT	NOTE
TOP	ON active to PLEN active delay			4		S	
TADDT	ADRDET active to MCLK active		45			mS	
TMSGV	MSGAVL active to MCLK active			700		μS	
TMCLK	MCLK Period	MCK1-0 = 00		80		μS	
		MCK1-0 = 01		40		μS	
		MCK1-0 = 10		20		μS	
		MCK1-0 = 11		5		μS	
TMDST	MDATA Setup Time	MCLK active edge	1/4			Tmclk	
TMDHD	MDATA Hold Time	MCLK active edge	1/4			Tmclk	
TPLST	PLEN Pre-Active Time	PL1-0 = 00		9.6		mS	
		PL1-0 = 01		19.2		mS	
		PL1-0 = 10		28.8		mS	
		PL1-0 = 11		38		mS	
TRFDY	RFEN Delay to Preamble	RFON = 0		4.8		mS	
		RFON = 1		9.6		mS	
TQC1W	QC1 Active Width	QC1WTH = 0	2.5			mS	
		QC1WTH = 1	3.8			mS	
TUNIT	MDATA D23 to Next unit D23		4			mS	
TUDI	MCLK Stop Clock per byte	MCK1-0 = 11 UDI1-0 = 11	1.2		1.3	mS	
TINT	MDATA D0 Delay to Next D23	MCK1-0 = 00 UDI1-0 = 00	2		2.1	mS	

TYPICAL APPLICATION CIRCUIT



Package Information



Symbol	Common Dimension (Millimeters)			Common Dimension (Inches)		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A			2.0			0.079
A1	0.05			0.002		
A2	1.65	1.75	1.85	0.065	0.069	0.073
b	0.22		0.38	0.009		0.015
D	9.9	10.2	10.5	0.390	0.401	0.413
E	7.40	7.80	8.20	0.291	0.307	0.323
E1	5.00	5.30	5.60	0.197	0.209	0.220
e	0.65			0.0256		
L	0.55	0.75	0.95	0.021	0.030	0.037
L1	1.25			0.050		
R1	0.09			0.004		
O	0	4	8	0	4	8



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Note: All data and specifications are subject to change without notice.