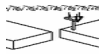
Block Interleaver

Sync Channel

- Used to provide essential system parameters
- Used during system acquisition stage
- The bit rate is 1200 bps
- The Sync channel has a frame duration of 26 $^{2}/_{3}$ ms
  - this frame duration matches the period of repetition of the PN Short Sequences
  - this simplifies the acquisition of the Sync Channel once the Pilot Channel has been acquired
- The Mobile Station re-synchronizes at the end of every call

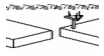




(Acquired Pilot)



Sync Channel

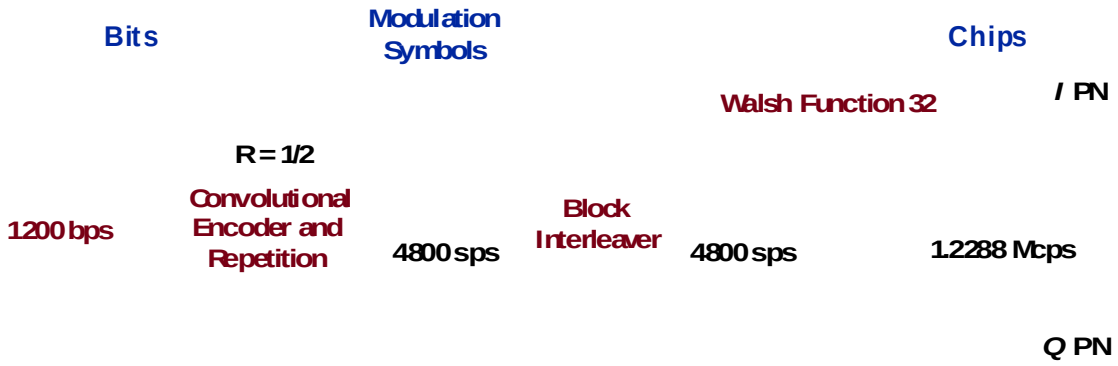


The **Pilot** channel carries no data, therefore it has **no frames**.

The **Sync** channel uses **26 $^{2}/_{3}$ ms** frames.

All other forward and reverse code channels use **20 ms** frames.

Sync Channel Generation



- There are 32 bits (1200 bps x 0.02666... second) in one Sync Channel frame
- The Rate 1/2 convolutional encoder doubles the bit rate, and the resulting 0s and 1s are now called “code symbols”
  - there are 64 code symbols in a Sync Channel frame
- The repetition process doubles the rate again, and each repetition of a code symbol is now called a “modulation symbol”
  - there are 128 modulation symbols in a Sync Channel frame
- Four copies of Walsh code #32 are used to spread each modulation symbol, resulting in a x256 rate increase; the resulting 0s and 1s are now called “ chips”
  - there are 32,768 chips in a Sync Channel frame (1024 chips per original bit)

Sync Channel Modulation Parameters

Data Rate	1200	Bits Per Second
PN Chip Rate	1.2288	Mega Chips Per Second
Code Rate	1 / 2	Bits Per Code Symbol
Code Repetition	2	Modulation Symbols* Per Code Symbol
Modulation Symbol Rate	4800	Symbols Per Second
PN Chips / Modulation Symbol	256	PN Chips / Modulation Symbol
PN Chips / Bit	1024	PN Chips / Bit

* In the CDMA Forward Code Channels, each repetition of a code symbol is called a modulation symbol

Sync Channel Block Interleaver (Input Matrix)

1	9	17	25	33	41	49	57
1	9	17	25	33	41	49	57
2	10	18	26	34	42	50	58
2	10	18	26	34	42	50	58
3	11	19	27	35	43	51	59
3	11	19	27	35	43	51	59
4	12	20	28	36	44	52	60
4	12	20	28	36	44	52	60
5	13	21	29	37	45	53	61
5	13	21	29	37	45	53	61
6	14	22	30	38	46	54	62
6	14	22	30	38	46	54	62
7	15	23	31	39	47	55	63
7	15	23	31	39	47	55	63
8	16	24	32	40	48	56	64
8	16	24	32	40	48	56	64

Sync Channel Block Interleaver (Output Matrix)

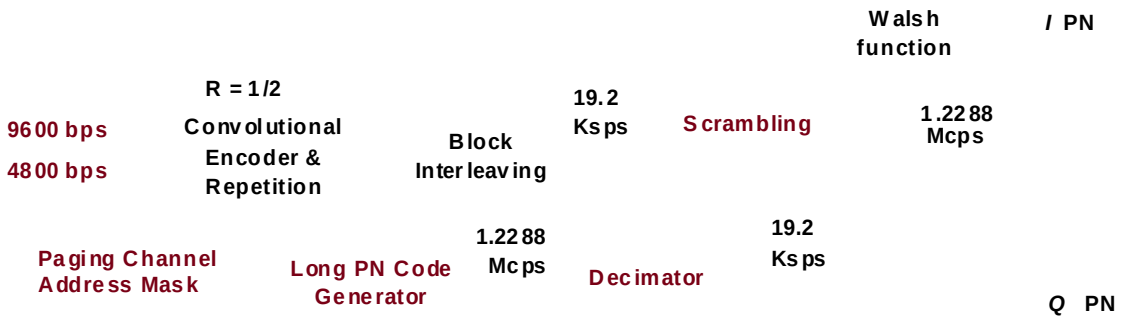
assume that a burst of noise affects these symbols

1	3	2	4	1	3	2	4
33	35	34	36	33	35	34	36
17	19	18	20	17	19	18	20
49	51	50	52	49	51	50	52
9	11	10	12	9	11	10	12
41	43	42	44	41	43	42	44
25	27	26	28	25	27	26	28
57	59	58	60	57	59	58	60
5	7	6	8	5	7	6	8
37	39	38	40	37	39	38	40
21	23	22	24	21	23	22	24
53	55	54	56	53	55	54	56
13	15	14	16	13	15	14	16
45	47	46	48	45	47	46	48
29	31	30	32	29	31	30	32
61	63	62	64	61	63	62	64

Sync Channel Block Interleaver (Block Restored)

1	9	17	25	33	41	49	57
1	9	17	25	33	41	49	57
2	10	18	26	34	42	50	58
2	10	18	26	34	42	50	58
3	11	19	27	35	43	51	59
3	11	19	27	35	43	51	59
4	12	20	28	36	44	52	60
4	12	20	28	36	44	52	60
5	13	21	29	37	45	53	61
5	13	21	29	37	45	53	61
6	14	22	30	38	46	54	62
6	14	22	30	38	46	54	62
7	15	23	31	39	47	55	63
7	15	23	31	39	47	55	63
8	16	24	32	40	48	56	64
8	16	24	32	40	48	56	64

Paging Channel Generation



- There are 192 [96] bits (9600 [4800] bps x 0.020 second) in one Paging Channel frame
- The Rate 1/2 convolutional encoder doubles the bit rate, resulting" 384 [192] code symbols in a Paging Channel frame
- If the 4800 bps rate is used, the repetition process doubles the rate again, so that, at either rate, 384 modulation symbols per Paging Channel frame result
- 384 modulation symbols per frame times 50 frames per second = 19.2 Ksps
- One copy of Walsh code #1 (or #2, ... or #7) is used to spread each modulation symbol. This results in a x64 rate increase to 1.2288 Mcps
  - that is, 24,576 chips per Paging Channel frame, or 128 [256] chips per original bit at 9600 [4800] bps

Paging Channel Modulation Parameters

Data Rate	9600	4800	Bits Per Second
PN Chip Rate	1.2288	1.2288	Mega Chips Per Second
Code Rate	1/2	1/2	Bits Per Code Symbol
Code Repetition	1	2	Modulation symbols * per code symbol
Modulation Symbol Rate	19200	19200	Code Symbols Per Second
PN Chips / Modulation Symbol	64	64	PN Chips Per Modulation Symbol
PN Chips / Bit	128	256	PN Chips Per Bit

* Each repetition of a code symbol is a modulation symbol

Paging Channel - 9600 bps Block Interleaver (Input Array)

16 Columns

24 rows

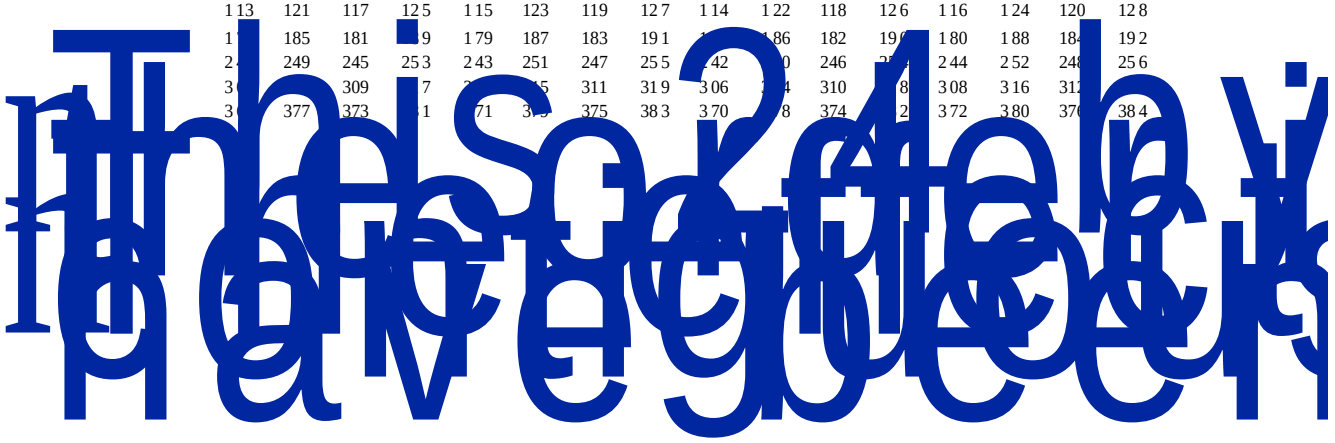
1	25	49	73	97	121	145	169	193	217	241	265	289	313	337	361
2	26	50	74	98	122	146	170	194	218	242	266	290	314	338	362
3	27	51	75	99	123	147	171	195	219	243	267	291	315	339	363
4	28	52	76	100	124	148	172	196	220	244	268	292	316	340	364
5	29	53	77	101	125	149	173	197	221	245	269	293	317	341	365
6	30	54	78	102	126	150	174	198	222	246	270	294	318	342	366
7	31	55	79	103	127	151	175	199	223	247	271	295	319	343	367
8	32	56	80	104	128	152	176	200	224	248	272	296	320	344	368
9	33	57	81	105	129	153	177	201	225	249	273	297	321	345	369
10	34	58	82	106	130	154	178	202	226	250	274	298	322	346	370
11	35	59	83	107	131	155	179	203	227	251	275	299	323	347	371
12	36	60	84	108	132	156	180	204	228	252	276	300	324	348	372
13	37	61	85	109	133	157	181	205	229	253	277	301	325	349	373
14	38	62	86	110	134	158	182	206	230	254	278	302	326	350	374
15	39	63	87	111	135	159	183	207	231	255	279	303	327	351	375
16	40	64	88	112	136	160	184	208	232	256	280	304	328	352	376
17	41	65	89	113	137	161	185	209	233	257	281	305	329	353	377
18	42	66	90	114	138	162	186	210	234	258	282	306	330	354	378
19	43	67	91	115	139	163	187	211	235	259	283	307	331	355	379
20	44	68	92	116	140	164	188	212	236	260	284	308	332	356	380
21	45	69	93	117	141	165	189	213	237	261	285	309	333	357	381
22	46	70	94	118	142	166	190	214	238	262	286	310	334	358	382
23	47	71	95	119	143	167	191	215	239	263	287	311	335	359	383
24	48	72	96	120	144	168	192	216	240	264	288	312	336	360	384

- The 384 modulation symbols in a frame are input into a 24 by 16 block interleaver array (read down by columns, from left to right)
- The array represents a 20 ms interval worth of information

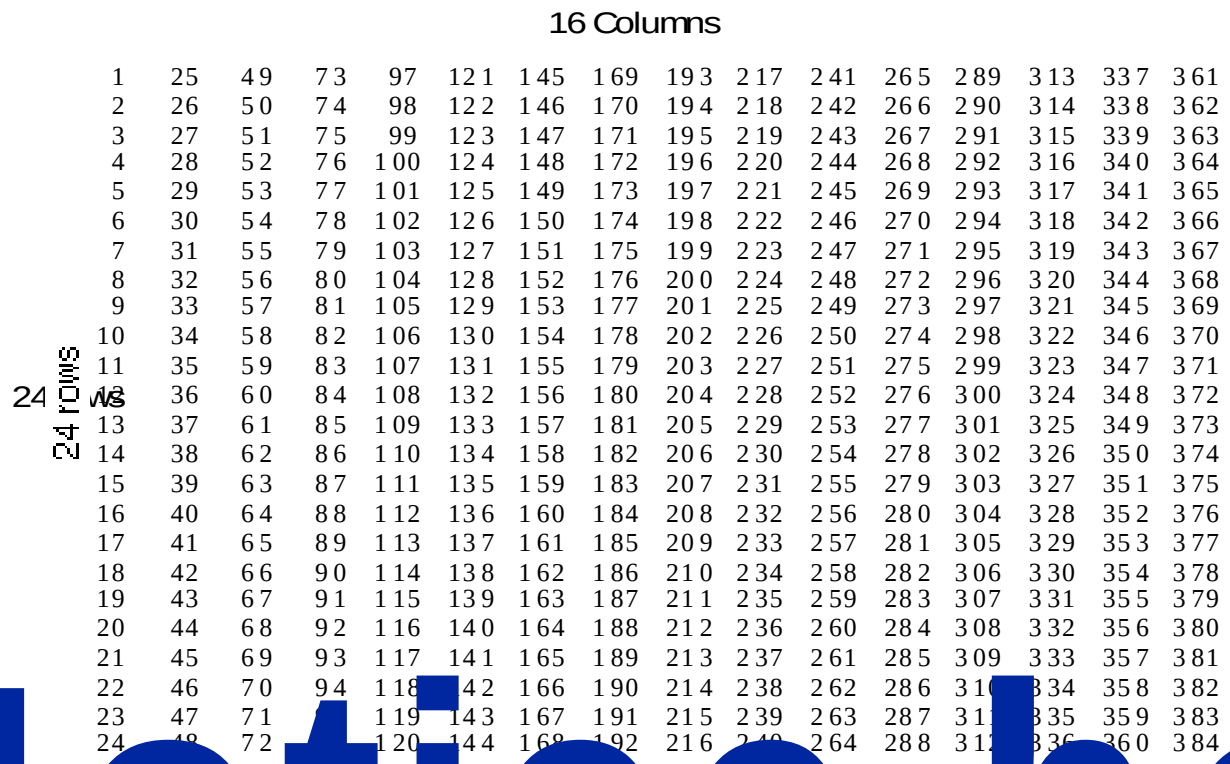
9600 bps Block Interleaver (Output Array)

Assume that a burst of noise damages all these bits

1	9	5	13	3	11	7	15	2	10	6	14	4	12	8	16
65	73	69	77	67	75	71	79	66	74	70	78	68	76	72	80
129	137	133	141	131	139	135	143	130	138	134	142	132	140	136	144
193	201	197	205	195	203	199	207	194	202	198	206	196	204	200	208
257	265	261	269	259	267	263	271	258	266	262	270	260	268	264	272
321	329	325	333	323	331	327	335	322	330	326	334	324	332	328	336
33	41	37	45	35	43	39	47	34	42	38	46	36	44	40	48
97	105	101	109	99	107	103	111	98	106	102	110	100	108	104	112
161	169	165	173	163	171	167	175	162	170	166	174	164	172	168	176
225	233	229	237	227	235	231	239	226	234	230	238	228	236	232	240
289	297	293	301	291	299	295	303	290	298	294	302	292	300	296	304
353	361	357	365	355	363	359	367	354	362	358	366	356	364	360	368
17	25	21	29	19	27	23	31	18	26	22	30	20	28	24	32
81	89	85	93	83	91	87	95	82	90	86	94	84	92	88	96
145	153	149	157	147	155	151	159	146	154	150	158	148	156	152	160
209	217	213	221	211	219	215	223	210	218	214	222	212	220	216	224
273	281	277	285	275	283	279	287	274	282	278	286	276	284	280	288
337	345	341	349	339	347	343	351	338	346	342	350	340	348	344	352
49	57	53	61	51	59	55	63	50	58	54	62	52	60	56	64
113	121	117	125	115	123	119	127	114	122	118	126	116	124	120	128
177	185	181	189	179	187	183	191	178	186	182	190	180	188	184	192
241	249	245	253	243	251	247	255	242	250	246	254	244	252	248	256
305	313	309	317	307	315	311	319	306	314	310	318	308	316	312	320
369	377	373	381	371	379	375	383	370	378	374	382	372	380	376	384



9600 bps De-interleaving



1	25	49	73	97	121	145	169	193	217	241	265	289	313	337	361
2	26	50	74	98	122	146	170	194	218	242	266	290	314	338	362
3	27	51	75	99	123	147	171	195	219	243	267	291	315	339	363
4	28	52	76	100	124	148	172	196	220	244	268	292	316	340	364
5	29	53	77	101	125	149	173	197	221	245	269	293	317	341	365
6	30	54	78	102	126	150	174	198	222	246	270	294	318	342	366
7	31	55	79	103	127	151	175	199	223	247	271	295	319	343	367
8	32	56	80	104	128	152	176	200	224	248	272	296	320	344	368
9	33	57	81	105	129	153	177	201	225	249	273	297	321	345	369
10	34	58	82	106	130	154	178	202	226	250	274	298	322	346	370
11	35	59	83	107	131	155	179	203	227	251	275	299	323	347	371
12	36	60	84	108	132	156	180	204	228	252	276	300	324	348	372
13	37	61	85	109	133	157	181	205	229	253	277	301	325	349	373
14	38	62	86	110	134	158	182	206	230	254	278	302	326	350	374
15	39	63	87	111	135	159	183	207	231	255	279	303	327	351	375
16	40	64	88	112	136	160	184	208	232	256	280	304	328	352	376
17	41	65	89	113	137	161	185	209	233	257	281	305	329	353	377
18	42	66	90	114	138	162	186	210	234	258	282	306	330	354	378
19	43	67	91	115	139	163	187	211	235	259	283	307	331	355	379
20	44	68	92	116	140	164	188	212	236	260	284	308	332	356	380
21	45	69	93	117	141	165	189	213	237	261	285	309	333	357	381
22	46	70	94	118	142	166	190	214	238	262	286	310	334	358	382
23	47	71	95	119	143	167	191	215	239	263	287	311	335	359	383
24	48	72	96	120	144	168	192	216	240	264	288	312	336	360	384

Notice ho