Locata.	**ICD-LOC-100A**

LocataNet Positioning Signal Interface Control Document 2011

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Locata Corporation Pty Ltd
111 Canberra Avenue
GRIFFITH ACT 2607
Australia

Phone: +61 2 6126 5700
Fax: +61 2 6126 5704
Email: icd@locatacorp.com

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1. INTRODUCTION

1.1 Purpose

This document contains the LocataNet positioning signal interface specification describing signals wirelessly transmitted among Terrestrial Segment and User Segment elements.

1.2 Scope

This interface specification limits itself to describing the radio interface among elements of the terrestrial segment (TS) and the user segment (US) of the Locata System. It does not describe electrical interfaces to the equipment, or describe in detail how the signals are to be used to calculate positions or time within receivers. It assumes a fixed TS, but fixed or moving elements within the US.

1.3 GPS Heritage and LocataNet Distinctions

A careful comparison of this document with its GPS equivalent (Reference 1) will reveal many of the similarities and differences that exist between the two networks. The following paragraphs summarize some of these similarities and differences both as a convenience to the reader and in order to provide a framework within which to understand the structure and intent of the LocataNet positioning signal interface.

A LocataNet includes a TS and a US. There is no separate control segment. The TS includes a number of LocataLite transceivers located within or around a defined service area. The US includes any number of fixed or moving Locata user receivers (Rovers) operating within the service area and deriving locations and time within the area using signals emitted by the LocataLites in the TS. LocataNets can span areas as large as several tens of kilometers in extent, being for the most part limited by the availability of adequate line-of-sight geometries between the various elements of the LocataNet. With adequate signal power, working networks have demonstrated LocataLite-Rover operating ranges of up to 50 kilometers. LocataNets can adopt any convenient coordinate reference system, including WGS-84, or other global, regional, local, or custom grids.

LocataNet's overall concept derives from the Navstar Global Positioning System (GPS). Many of its underlying elements therefore are similar to GPS. The LocataLites assume the same role as GPS satellites, and the Locata user receiver operates much like a GPS receiver. Position and time calculations for the most part use techniques similar to those of GPS. Given these similarities and the likely familiarity of many readers with GPS, this document presents the LocataNet system interface in the same overall form as used by IS-GPS-200E, Reference 1.

Locata Rovers use the fine time definition supplied by the pseudorandom spreading codes impressed on LocataLite transmitted signals, along with data supplied by a data overlay on those signals, for calculating positions and time using techniques well known to GPS users. The Locata network design also lends itself to integrated carrier phase position determination techniques for high location accuracy.

In several respects the LocataNet position solution is simplified relative to that of GPS. Unlike the GPS satellites, all emitters are fixed, local, ground-based emitters for networks covered by this specification. Hence there is no need to solve for emitter position as a function of time. The position of each emitter in the network is broadcast by that emitter in its "ephemeris" data, part of the data overlay stream on the positioning signal. But transmission of successive, frequently changed data sets of orbital parameters and curve fit coefficients for calculating LocataLite positions is not necessary.

LocataNets can operate their data overlay streams at either 100 bits per second or 50 bits per second. Normally the former is preferred to speed acquisition and information updates. The lower 50 bits per second speed provides more data robustness in the presence of marginal links or interference.

All valid emitters in a given LocataNet are synchronized to a Master station in the network, either directly or indirectly, to within very tight tolerances[1], using a proprietary TimeLoc time synchronization process. TimeLoc maintains set phase differences among signals emitted by the various LocataLites in a LocataNet. Since all clocks track a master, the TimeLoc process compensates for differences in clock drift and aging among emitters, which therefore are not factors in position solutions. The LocataNet therefore does not need to transmit or use clock drift and aging coefficients.

A LocataNet can operate completely autonomously, using its own relative and independent time reference generated by a designated Master LocataLite in the network. LocataNets can synchronize to any time source providing a 1 pulse-per-second (PPS) time reference, or operate independent of any such reference. Therefore, LocataNets can, for example, optionally synchronize themselves to GPS time, and transfer GPS time to any associated Locata user receiver, to within 100 nanoseconds of a one-1 PPS GPS time base supplied by an appropriate GPS time receiver at the Master LocataLite. How closely this transferred time will track actual GPS time will depend on the quality of the GPS time supplied to the Master LocataLite.

LocataNets operate using a continuous time base, of which GPS time is an example and network option. Rovers provide a UTC conversion for the user.

This edition of the Locata Interface Specification assumes that the LocataLites are stationary devices. It does not contain those data elements needed to support moving LocataLites. But since they do not move, the stationary emitters contribute no Doppler shift to the frequency uncertainty of the received signal. The limited network sizes, specified in the data overlay, also limit relative delay uncertainty among the received signals, so that synchronization to one signal significantly limits the time uncertainty of other signals in the network. Both of these factors reduce the uncertainty space in delay and Doppler over which a receiver must search for other LocataLites in the network.

LocataNet signals only traverse the troposphere, and not the ionosphere. Therefore no ionospheric corrections are needed, and are not accounted for in the specification. However network signals remain subject to troposphere-induced delays due to local tropospheric conditions. The specification supports the dissemination of temperature, pressure, and

[1] Tolerances stated in Table 11, TimeLoc synchronization quality, single hop, Page 59

humidity local to the network for use as input factors to user-furnished models supplying troposphere-induced delay compensation.

Since the LocataNet emitters and the Locata Rovers share the same local geographic area (i.e. within a few kilometers of each other), average received signal strengths are often significantly higher than those for GPS, where in contrast all users are at extreme range (over 20,200 kilometers for most users) relative to the emitters. However strengths of the various network signals within a Rover can span a much wider range than is normally true for GPS. These signal differences can easily exceed the dynamic range available by exploiting the pseudorandom spreading code's processing gain to supply code division multiple access.

Hence, the positioning signal interface described by this specification introduces a time division multiple access scheme for LocataLite emissions to supplement the code division multiple access. The LocataNet pseudo-random spreading codes, derived from GPS C/A codes, run at ten times the rate of the C/A code in GPS, but with only a ten-percent transmit duty cycle within which an entire code epoch is transmitted. Each code therefore completes the entire code epoch in 100 microseconds, but sends its code sequence in only one time slot in each successive millisecond interval. The added signal orthogonality introduced by assigning different time slots to different emitters, assuming appropriate receiver design, supplies adequate signal discrimination to overcome the significant "near-far" problem local networks can otherwise introduce to their receivers. LocataNet receiver designers should bear in mind the wide dynamic range needed in LocataNet Rovers.

Since the Locata spreading code runs at 10 times the GPS C/A rate, the waveform requires a 10-fold larger bandwidth. The LocataNet's faster chip rate increases time resolution, but the ten percent duty cycle requires correspondingly greater transmitter power to conserve integrated energy per code epoch. The higher power levels necessary are easily achieved in the relatively short ranges over which LocataNets operate. For most applications, transmit powers of less than one Watt suffice.

The LocataNet broadcasts signals on two frequencies within the 2.4 gigahertz license-free Industrial, Scientific, and Medical (ISM) band. Using a non-GPS band avoids interference issues with GPS. The two S-band frequencies in use provide frequency diversity to aid in multipath mitigation, and a "wide lane" phase difference beat to aid in integrated carrier phase techniques. The specification also supports transmit antenna spatial diversity at each frequency at each LocataLite. There is nothing inherent in the design of the LocataNet that would prohibit using other frequencies if desired.

2. REFERENCE DOCUMENTS

2.1 Internal Documents

None

2.2 External Documents

1. Interface Specification IS-GPS-200 Revision E, 8 June 2010, Navstar GPS Space Segment/Navigation User Interfaces, Global Positioning System Wing (GPSW) Systems Engineering and Integration; available at http://www.gps.gov/technical/icwg/

3. INTERFACE DESCRIPTION

3.1 Interface Definition

The interface between the Locata terrestrial segment[2] (TS) and the user segment (US) includes signals from various LocataLites in the TS emitted on one of two RF frequencies, S1 and S6. The network distributes these signals to provide continuous line-of-sight local area coverage to the user segment, providing the ranging codes and the system data needed to accomplish the Locata navigation (NAV) mission.

3.2 Interface Identification

The S1 and S6 carriers are modulated by bit trains, each of which is a composite generated by the modulo-2 addition of a pseudo-random noise (PRN) ranging code and the downlink system data (referred to as NAV data). The signals also use time-division-multiple-access techniques to reduce interference between signals from different LocataLites.

3.2.1 Ranging Codes

LocataLites transmit one pseudo-random ranging code on each carrier. This code is similar to the GPS coarse acquisition (C/A) code and is therefore called herein by the same name, even though it does not fulfill a coarse acquisition role. Code-division-multiple-access techniques, wherein receivers matched to a signal modulated by one spreading code can extract it from among signals modulated by other codes, assist in part in distinguishing among Locata signals even though they may transmit at the same frequencies. Time slot orthogonality, discussed in section 3.2.2, provides additional signal discrimination supplementing that obtained using code discrimination.

The PRN C/A-code for Locata signal ID number 'i' is a Gold code, $G_i(t)$, of 100μs length at a chipping rate of 10.23 Mbps[3]. The $G_i(t)$ sequence is a linear pattern generated by the modulo-2 addition of two sub-sequences, G1 and $G2_i$, each of which is a 1023 chip long linear pattern. As shown in Table 1, the $G2_i$ sequence is a G2 sequence selectively delayed by pre-assigned number of chips, thereby generating a set of different C/A-codes.

Table 1 assigns a Locata PRN signal number to each G2i sequence. The PRN signal numbers refer to the same codes as identified in Reference 1. LocataNets adopt the same PRN codes as the respective GPS C/A PRN codes by number, with the exception of code 37, which uses GPS code number 210 to eliminate code 37's duplication of code 34 in the GPS codes of Table 3-I of Reference 1. Table 1 assumes that the codes are generated by initializing the G1 shift register with all ones and the G2 shift register with the value shown in the table. This results in the code delay shown in column 2 of the table.

The first column of the table cites the transmitter ID to which the PRN code is assigned. This is a fixed assignment. The table assigns unique codes to 200 transmitters. This corresponds to 50 LocataLites, each with 4 transmitters, as shown in Table 8, Derivation of Transmitted

[2] The Terrestrial Segment is analogous to the Space Segment in GPS.
[3] Note that this is a factor of 10 faster than GPS C/A code.

Signal Identities. Code assignments shown in Table 1 minimize cross-correlation between signals from the same LocataLite on the same frequency (see Section 3.3.1.1 Frequency Plan).

Configuration information loaded during network installation into each LocataLite specifies the identity of the LocataLite, the identities of the other members of the network, and transmit and receive antenna locations. This information is also available from the data overlay on the transmitted signals, enabling LocataLites to learn the network configuration thereby (see Appendix I: Locata Navigation Data Structure).

Table 1, Code Phase Assignments

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
01A	94	814	1550	0227
01B	19	471	0144	1633
01C	151	484	0142	1635
01D	166	12	0201	1576
02A	1	5	0337	1440
02B	34	950	0064	1713
02C	172	503	1460	0317
02D	180	995	0501	1276
03A	26	514	0016	1761
03B	5	17	0644	1133
03C	199	663	0727	1050
03D	186	109	1665	0112
04A	18	470	0310	1467
04B	6	18	0322	1455
04C	118	647	0557	1220
04D	106	461	0435	1342
05A	44	625	0543	1234
05B	3	7	0067	1710
05C	138	386	0450	1327
05D	165	932	1573	0204
06A	2	6	0157	1620
06B	82	653	0365	1412
06C	127	657	0717	1060

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
06D	169	212	1670	0107
07A	28	516	0003	1774
07B	17	469	0621	1156
07C	125	235	1076	0701
07D	200	942	0147	1630
08A	13	255	0013	1764
08B	51	710	1716	0061
08C	115	632	0552	1225
08D	136	595	0740	1037
09A	16	258	0001	1776
09B	22	474	0014	1763
09C	143	307	1312	0465
09D	132	176	0520	1257
10A	32	862	0065	1712
10B	25	513	0034	1743
10C	174	395	1654	0123
10D	155	1021	1774	0003
11A	83	699	0270	1507
11B	56	220	0177	1600
11C	102	957	0710	1067
11D	130	355	0341	1436
12A	53	775	1002	0775
12B	33	863	0032	1745
12C	191	292	0764	1013
12D	163	309	1662	0115
13A	7	139	0646	1131
13B	11	252	0135	1642
13C	168	891	1737	0040
13D	122	52	0267	1510
14A	88	539	1674	0103
14B	14	256	0005	1772
14C	159	670	1223	0554

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
14D	157	568	1153	0624
15A	21	473	0031	1746
15B	67	801	1114	0663
15C	141	499	1411	0366
15D	105	885	1751	0026
16A	45	946	1506	0271
16B	68	788	1342	0435
16C	137	68	1007	0770
16D	181	877	0455	1322
17A	69	732	0025	1752
17B	49	554	1541	0236
17C	140	456	1653	0124
17D	173	150	1362	0415
18A	55	558	1666	0111
18B	64	729	0254	1523
18C	134	130	0706	1071
18D	120	145	1106	0671
19A	43	225	0103	1674
19B	29	859	0650	1127
19C	135	359	1216	0561
19D	113	197	0462	1315
20A	42	679	1651	0126
20B	74	407	1054	0723
20C	188	291	1750	0027
20D	195	711	1747	0030
21A	23	509	0714	1063
21B	63	1018	1745	0032
21C	119	203	0364	1413
21D	175	345	0510	1267
22A	58	55	0426	1351
22B	8	140	0323	1454
22C	183	144	0215	1562

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
22D	142	883	1644	0133
23A	37**	310	0731	1046
23B	72	327	0404	1373
23C	131	1012	0551	1226
23D	153	811	1504	0273
24A	36	948	0321	1456
24B	78	761	0521	1256
24C	121	175	1241	0536
24D	116	771	0045	1732
25A	24	512	0071	1706
25B	20	472	0062	1715
25C	107	248	0735	1042
25D	171	675	1224	0553
26A	30	860	0324	1453
26B	31	861	0152	1625
26C	187	445	0471	1306
26D	103	159	0721	1056
27A	9	141	0151	1626
27B	15	257	0002	1775
27C	164	644	1570	0207
27D	184	476	1003	0774
28A	35	947	0643	1134
28B	27	515	0007	1770
28C	146	121	0035	1742
28D	147	118	0355	1422
29A	4	8	0033	1744
29B	87	959	1562	0215
29C	160	230	1702	0075
29D	139	797	0305	1472
30A	62	299	1333	0444
30B	54	864	1015	0762
30C	133	603	1731	0046

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
30D	194	208	1607	0170
31A	61	367	0336	1441
31B	40	91	1714	0063
31C	176	846	0242	1535
31D	156	463	0107	1670
32A	41	19	1151	0626
32B	65	695	1602	0175
32C	129	762	1250	0527
32D	189	87	0307	1470
33A	52	709	1635	0142
33B	39	103	0541	1236
33C	110	807	0111	1666
33D	126	886	1764	0013
34A	50	280	1327	0450
34B	66	780	1160	0617
34C	149	628	1254	0523
34D	197	263	0540	1237
35A	38	67	0017	1760
35B	80	326	1010	0767
35C	196	189	1305	0472
35D	104	712	1763	0014
36A	75	525	0072	1705
36B	48	1001	1365	0412
36C	178	992	1017	0760
36D	170	185	0134	1643
37A	47	161	1564	0213
37B	57	397	1353	0424
37C	123	21	0232	1545
37D	109	126	0140	1637
38A	60	759	0506	1271
38B	76	405	0262	1515
38C	128	634	1532	0245

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
38D	190	399	0272	1505
39A	12	254	0027	1750
39B	86	438	0277	1500
39C	167	314	0635	1142
39D	114	693	1011	0766
40A	70	34	1523	0254
40B	91	586	0606	1171
40C	182	112	1566	0211
40D	101	156	1213	0564
41A	84	422	0263	1514
41B	46	638	1065	0712
41C	162	684	1735	0042
41D	198	537	1363	0414
42A	59	898	0227	1550
42B	77	221	0077	1700
42C	192	901	1422	0355
42D	150	853	1041	0736
43A	89	879	1113	0664
43B	73	389	1445	0332
43C	193	339	1050	0727
43D	152	289	1641	0136
44A	97	1015	1455	0322
44B	92	153	0136	1641
44C	124	237	1617	0160
44D	145	211	1560	0217
45A	90	677	1245	0532
45B	79	260	1400	0377
45C	158	904	1542	0235
45D	179	357	1070	0707
46A	81	955	1441	0336
46B	85	188	0613	1164
46C	117	467	1104	0673

Table 1, Code Phase Assignments

(continued)

Code Phase Assignments				
Transmitter ID	**PRN Signal No.**	**G2 Code Delay (Chips)**	**Initial G2 Setting (Octal)***	**First 10 chips (Octal)***
46D	154	202	0751	1026
47A	10	251	0273	1504
47B	93	792	0256	1521
47C	177	798	1142	0635
47D	108	713	0771	1006
48A	71	320	1046	0731
48B	96	264	0260	1517
48C	112	122	1016	0761
48D	148	163	0335	1442
49A	98	278	1535	0242
49B	99	536	0746	1031
49C	111	279	0656	1121
49D	185	193	1454	0323
50A	95	446	1234	0543
50B	100	819	1033	0744
50C	161	911	0436	1341
50D	144	127	1060	0717

* The first digit (1) represents a “1” for the first chip, and the last three digits are the conventional octal representation of the remaining 9 chips. For example, the first 10 chips of the C/A code for PRN Signal No. 1 are: 1100100000.

** PRN code 37 has been changed from code 37 in Reference 1, which is the same as code 34 there, to code 210 in that reference to avoid code duplication

3.2.2 Timeslot Structure and TDMA Assignments

In all LocataNets, each millisecond period is divided into 10 contiguous timeslots of 100 microseconds each, with no guard band between slots. The ten slots lying between successive integer millisecond time values are together referred to as a time division multiple access (TDMA) frame. Frames begin on 0-time boundaries modulo 1 millisecond. Two hundred timeslot frames together make a Timeslot Superframe, lasting 200 milliseconds. Timeslot Superframes begin on 0-time boundaries modulo 200 milliseconds. Figure 1 illustrates the TDMA scheme.

LocataLites operating in a given LocataNet are divided on a geographic basis[4] into Subnets of up to 10 LocataLites each. The timeslots within each frame are assigned on a non-overlapping basis to each of the LocataLites within a Subnet. Each LocataLite transmitter within a Subnet transmits during the LocataLite's assigned time slot within a frame and is silent during the remaining slots of that frame. This assignment among the timeslots within a frame changes for each successive frame within a Superframe in such a way as to randomize assignment adjacencies. This smoothes and distributes any residual interference effects among timeslots seen by a receiver over time. This assignment pattern repeats during each Superframe.

Up to five distinct Subnets, each with a different sequence of timeslot assignments among members over a Superframe, are defined for use within a single LocataNet. Each of these Subnets reuses the same 10 timeslots per frame. Consequently, when multiple fully populated subnets are in use in a LocataNet, for any given timeslot in a given frame, a LocataLite from one Subnet will be operating on the same timeslot as a LocataLite in a different active Subnet. The patterns between subnets are designed to randomize overlaps among all members of a Subnet from a different Subnet as evenly as possible. This applies for all combinations over the 5 subnets. Subnets should be geographically separated or otherwise operated in such a way as to reduce signal levels from one Subnet to another.

Five Subnets support up to 50 LocataLites within a LocataNet. A larger number of Subnets could be assigned to a single LocataNet, in which case new Subnets would reuse the timeslot pattern of selected existing Subnets and rely upon geographic separation or other isolating factors to minimize interference[5].

Table 2 through Table 6 present for each of the 200 TDMA frames the LocataLite number assigned to each timeslot within the frame for each of all five Subnets. LocataLites are numbered 1 through 10 for Subnet 1, 11 through 20 for Subnet 2, 21 through 30 for Subnet 3, 31 through 40 for Subnet 4, and 41 through 50 for Subnet 5.

[4] Or other basis yielding augmented attenuation between Subnets.
[5] Operation beyond 5 Subnets has not been demonstrated.

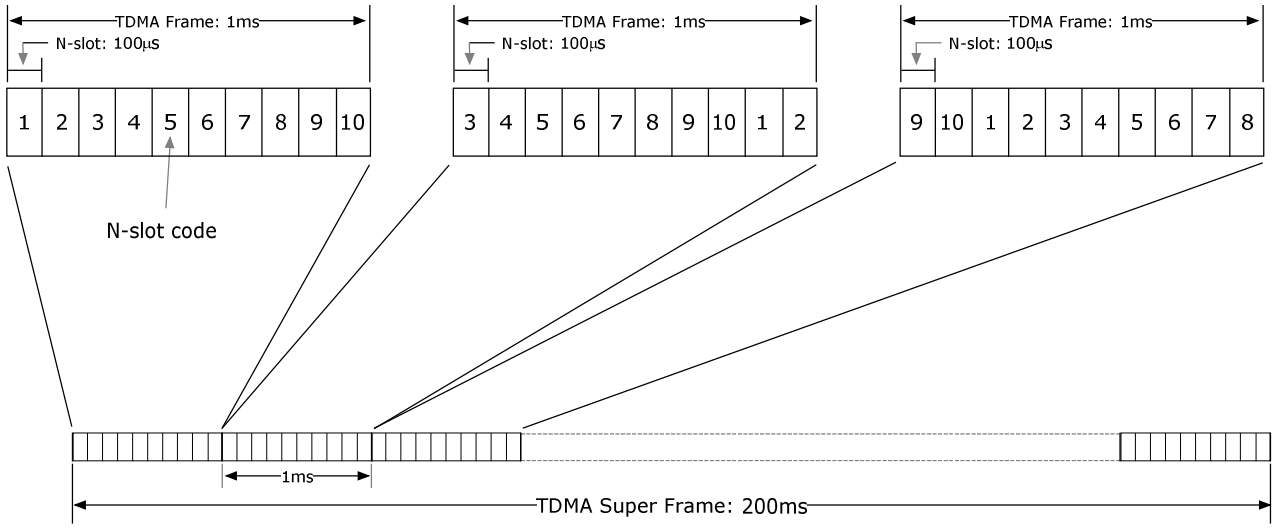

Figure 1: TDMA Scheme

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
1	1	9	2	5	10	8	6	4	3	7
2	5	8	4	2	9	7	1	6	10	3
3	10	2	6	1	3	4	5	7	9	8
4	3	2	8	7	4	9	10	1	5	6
5	5	1	2	3	8	10	4	7	6	9
6	3	5	4	8	1	7	2	10	9	6
7	7	10	5	9	4	1	3	6	8	2
8	10	7	8	6	2	3	9	5	1	4
9	6	4	10	3	1	2	7	8	9	5
10	2	1	4	8	5	10	6	3	7	9
11	1	6	10	5	3	8	9	2	4	7
12	4	3	9	6	7	5	2	1	8	10
13	1	10	6	9	7	3	5	8	2	4
14	6	3	1	10	9	4	8	7	2	5
15	9	1	7	10	2	6	8	4	5	3
16	4	9	3	2	6	1	8	5	10	7
17	9	8	3	10	4	2	5	7	6	1
18	3	6	5	4	10	9	7	8	1	2
19	8	7	1	5	3	6	2	9	10	4
20	9	4	10	1	8	2	7	3	5	6
21	7	5	1	4	6	9	10	2	3	8
22	4	1	9	6	3	5	8	10	7	2
23	7	10	8	3	6	5	9	2	4	1
24	9	8	2	1	7	3	4	5	6	10
25	2	8	5	7	9	1	6	4	3	10
26	6	9	7	4	2	10	3	1	8	5
27	2	3	9	5	4	1	10	8	7	6
28	8	6	3	1	5	10	2	9	4	7
29	10	9	3	4	5	7	1	6	2	8
30	3	2	6	7	5	8	1	4	9	10
31	5	6	7	1	2	4	10	3	8	9
32	8	4	5	2	10	7	6	9	1	3
33	7	5	4	8	10	3	2	9	6	1
34	2	1	5	9	7	4	3	10	6	8
35	5	7	2	10	8	6	4	3	1	9
36	3	7	8	1	9	10	4	6	2	5

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

(continued)

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
37	1	10	7	8	9	6	4	2	5	3
38	5	2	6	10	1	8	9	4	7	3
39	6	5	8	1	3	9	2	7	10	4
40	8	3	2	7	4	9	5	10	1	6
41	2	4	10	6	8	7	3	1	5	9
42	8	4	10	5	6	1	7	3	9	2
43	6	5	4	2	1	10	7	9	3	8
44	2	9	1	3	4	7	6	8	10	5
45	7	2	1	4	6	3	10	9	5	8
46	10	8	9	7	6	4	1	5	3	2
47	3	7	1	6	10	5	8	2	4	9
48	10	2	9	3	8	6	7	5	1	4
49	1	10	6	9	7	2	8	4	3	5
50	4	6	2	3	9	5	10	1	7	8
51	9	4	7	10	2	8	5	3	6	1
52	7	4	8	2	5	9	6	10	3	1
53	2	10	6	3	4	5	1	8	7	9
54	5	7	1	9	8	3	6	10	4	2
55	6	5	7	4	3	10	9	2	8	1
56	4	10	3	5	6	8	9	1	2	7
57	8	6	9	1	7	2	3	4	5	10
58	8	10	5	9	3	7	1	6	2	4
59	7	3	9	10	5	2	1	8	4	6
60	4	1	10	2	5	3	8	7	9	6
61	1	5	2	7	10	8	4	9	6	3
62	9	8	3	6	10	4	2	5	1	7
63	6	9	4	8	1	5	2	3	7	10
64	7	5	4	2	10	1	9	8	6	3
65	4	1	3	10	9	2	5	6	8	7
66	2	9	5	6	7	8	3	1	10	4
67	9	1	6	5	3	2	10	7	4	8
68	6	7	10	8	2	9	4	5	1	3
69	10	1	4	3	7	6	8	5	9	2
70	1	2	9	7	4	6	5	3	8	10
71	5	10	6	4	8	1	7	9	3	2
72	4	3	5	8	1	10	6	2	7	9

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

(continued)

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
73	10	4	7	1	9	3	6	2	8	5
74	1	3	7	5	8	4	10	9	2	6
75	3	8	10	7	5	4	2	6	9	1
76	8	5	6	7	2	10	3	1	9	4
77	10	9	8	2	3	5	7	4	6	1
78	2	8	3	10	1	6	9	5	4	7
79	6	4	8	9	2	7	3	10	1	5
80	3	9	7	8	6	1	10	5	2	4
81	9	6	2	5	10	8	7	1	4	3
82	4	7	3	1	8	2	9	6	5	10
83	3	2	1	4	5	9	8	6	7	10
84	7	3	4	9	1	8	5	6	10	2
85	7	6	5	8	1	9	4	2	10	3
86	5	2	4	1	6	3	7	9	10	8
87	7	1	2	6	10	9	3	8	4	5
88	4	6	10	2	8	3	9	7	5	1
89	10	2	3	6	4	1	7	8	9	5
90	3	1	5	9	2	7	4	10	6	8
91	5	7	9	10	4	1	3	2	8	6
92	1	8	10	5	9	4	6	3	7	2
93	5	10	6	4	7	2	1	3	8	9
94	10	8	1	5	2	6	9	7	3	4
95	9	8	2	4	3	10	1	6	5	7
96	6	7	1	3	9	5	8	10	4	2
97	9	3	6	2	1	7	8	4	10	5
98	8	3	7	10	9	5	6	1	2	4
99	8	5	1	9	4	6	3	2	10	7
100	6	4	2	3	5	9	1	10	8	7
101	2	6	8	1	7	4	5	9	3	10
102	3	9	8	2	10	4	5	7	1	6
103	1	2	9	6	8	7	3	5	4	10
104	7	5	4	8	3	6	2	10	9	1
105	8	7	5	3	2	1	4	9	6	10
106	2	3	10	6	5	8	4	7	9	1
107	4	3	1	5	6	7	2	8	9	10
108	1	2	9	7	6	5	10	3	4	8

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

(continued)

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
109	2	5	6	3	7	8	10	4	1	9
110	7	10	9	4	5	2	1	3	8	6
111	4	6	9	2	7	3	5	1	10	8
112	9	8	3	7	10	6	1	4	2	5
113	3	2	8	4	9	10	5	7	1	6
114	9	6	7	8	2	1	5	10	3	4
115	10	4	7	9	2	6	3	8	5	1
116	8	1	4	9	6	10	7	5	2	3
117	5	4	7	10	1	9	8	3	6	2
118	8	10	3	1	7	4	2	9	5	6
119	8	10	6	5	3	2	4	1	7	9
120	3	9	2	4	10	5	8	6	1	7
121	1	9	10	2	7	8	6	4	3	5
122	10	9	5	7	3	4	6	8	1	2
123	5	1	8	6	2	10	7	4	3	9
124	4	7	2	6	9	1	10	8	5	3
125	8	7	5	9	4	3	1	6	10	2
126	6	7	3	10	1	2	5	4	8	9
127	3	6	1	8	4	5	2	9	10	7
128	10	8	4	5	1	3	9	7	6	2
129	1	5	3	10	6	9	8	2	7	4
130	6	8	4	1	10	9	7	5	2	3
131	1	5	4	8	3	6	10	2	7	9
132	5	7	2	3	8	1	9	10	4	6
133	7	1	3	2	8	5	10	4	9	6
134	2	4	1	6	5	9	3	8	7	10
135	7	8	9	1	6	3	4	2	10	5
136	1	4	7	6	9	2	10	3	5	8
137	10	5	8	3	6	4	9	1	2	7
138	2	6	3	7	1	5	4	10	8	9
139	3	2	10	9	5	7	6	1	4	8
140	10	3	7	4	2	9	8	5	6	1
141	9	4	5	10	1	8	6	2	7	3
142	4	1	8	7	5	6	10	9	2	3
143	5	9	6	8	4	10	7	2	3	1
144	10	6	5	8	2	4	1	3	9	7

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

(continued)

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
145	4	3	1	5	6	7	9	10	2	8
146	6	4	10	2	8	1	3	7	5	9
147	2	5	9	4	3	10	1	6	7	8
148	9	3	2	4	8	10	1	7	6	5
149	4	10	6	3	9	5	2	1	7	8
150	5	3	10	1	4	7	9	6	8	2
151	9	7	4	6	10	3	8	1	2	5
152	2	5	1	10	7	6	4	9	8	3
153	6	10	5	7	3	8	9	1	4	2
154	10	8	7	2	6	9	3	4	5	1
155	9	3	2	7	1	8	6	5	10	4
156	1	2	9	8	4	3	7	10	5	6
157	3	10	8	5	7	2	1	9	6	4
158	6	9	5	3	4	2	8	7	1	10
159	6	9	1	7	10	2	4	8	3	5
160	4	6	7	9	10	8	2	3	1	5
161	10	2	6	8	9	4	5	7	1	3
162	8	10	3	2	1	7	5	6	4	9
163	7	5	2	9	8	1	10	4	3	6
164	1	8	4	7	3	6	2	5	9	10
165	4	7	10	9	2	1	3	5	8	6
166	2	4	8	1	5	10	6	7	3	9
167	5	8	2	3	1	6	4	10	9	7
168	2	1	9	4	5	3	7	8	6	10
169	7	6	8	5	3	4	9	1	2	10
170	8	1	10	3	7	9	2	6	5	4
171	2	3	9	6	5	7	8	10	4	1
172	6	2	8	3	10	5	1	7	9	4
173	3	6	1	9	8	5	10	2	7	4
174	8	3	5	2	6	1	4	9	10	7
175	10	1	2	9	8	7	5	4	6	3
176	9	7	10	1	3	4	5	6	8	2
177	5	9	2	4	7	6	3	8	10	1
178	4	2	3	10	9	1	6	7	5	8
179	9	3	6	2	10	8	7	4	1	5
180	3	9	6	10	4	8	1	5	2	7

Table 2, TDMA slot assignment to LocataLite number, Subnet 1

(continued)

TDMA Frame	Timeslot within Frame (slot sequence number)									
	1	2	3	4	5	6	7	8	9	10
181	1	8	7	3	4	10	6	9	2	5
182	7	4	10	5	9	3	2	6	1	8
183	9	5	1	6	7	8	4	3	10	2
184	4	9	5	2	7	6	8	10	3	1
185	10	7	9	4	2	1	3	5	8	6
186	5	6	7	8	3	2	4	1	9	10
187	6	9	1	2	8	4	7	3	10	5
188	1	7	4	6	5	10	3	8	2	9
189	7	2	8	10	6	3	1	5	4	9
190	6	8	3	7	1	2	5	10	9	4
191	5	1	6	4	9	8	7	2	10	3
192	8	5	10	1	4	2	6	9	3	7
193	1	4	3	7	5	9	2	8	6	10
194	8	10	5	6	2	9	1	3	4	7
195	3	5	4	8	1	10	2	7	9	6
196	4	10	7	9	8	5	2	3	6	1
197	7	6	10	5	2	3	9	4	1	8
198	2	10	4	3	6	1	9	5	7	8
199	5	3	1	10	9	7	8	2	4	6
200	2	1	9	5	8	7	10	4	6	3

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
1	16	20	13	14	11	12	18	17	19	15
2	12	16	14	15	18	19	11	13	20	17
3	14	19	16	17	13	15	20	12	11	18
4	13	18	11	19	14	17	20	15	16	12
5	13	12	14	18	20	11	17	16	15	19
6	20	14	17	12	19	18	15	13	16	11
7	17	15	11	20	16	13	19	18	14	12
8	18	12	15	17	11	14	16	19	13	20
9	19	17	18	11	16	15	14	20	12	13
10	17	19	12	20	15	13	11	16	18	14
11	20	18	19	16	17	12	15	14	13	11
12	19	14	20	11	15	18	16	12	17	13
13	15	17	20	19	12	11	13	14	16	18
14	12	15	16	13	18	20	17	11	14	19
15	17	16	20	14	18	13	12	19	11	15
16	11	20	16	12	17	14	18	15	19	13
17	19	12	14	15	13	16	11	18	17	20
18	14	11	18	12	16	20	13	17	15	19
19	15	20	13	16	19	18	17	11	12	14
20	13	15	12	19	20	11	16	17	18	14
21	16	13	11	18	19	15	14	12	20	17
22	15	11	17	13	12	20	18	14	19	16
23	18	16	15	11	19	17	14	13	20	12
24	11	13	19	18	12	17	20	16	14	15
25	20	19	13	17	14	11	12	15	18	16
26	14	13	18	11	20	15	12	16	19	17
27	16	11	15	17	12	19	14	20	18	13
28	14	12	18	20	15	19	11	17	13	16
29	17	18	15	16	11	14	12	20	13	19
30	12	13	17	19	14	16	15	18	20	11
31	20	18	11	14	17	19	13	15	12	16
32	13	11	19	20	12	17	16	18	15	14
33	17	15	20	14	11	16	19	13	12	18
34	19	20	11	12	13	18	17	14	15	16
35	12	15	13	16	14	20	19	11	17	18
36	13	20	12	11	15	17	18	16	14	19

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
37	18	19	16	13	14	15	17	12	11	20
38	17	11	14	18	20	16	19	15	12	13
39	19	17	13	15	18	12	14	16	20	11
40	18	17	12	14	13	11	16	20	19	15
41	11	13	12	19	16	18	15	14	20	17
42	16	12	18	13	20	14	17	19	11	15
43	19	14	16	15	13	12	20	18	17	11
44	15	16	17	20	19	14	12	11	13	18
45	14	18	13	17	20	15	19	12	16	11
46	18	14	19	12	17	11	13	20	16	15
47	20	17	19	18	11	16	13	14	15	12
48	15	14	18	19	17	16	20	13	11	12
49	13	17	14	11	19	20	15	16	18	12
50	19	16	20	13	14	12	18	11	17	15
51	12	14	11	20	18	13	16	19	15	17
52	11	19	15	20	12	17	13	18	16	14
53	11	16	17	18	15	19	14	13	12	20
54	18	20	12	16	15	13	19	11	14	17
55	15	18	19	13	14	16	11	17	12	20
56	14	19	12	15	11	20	16	18	17	13
57	20	15	17	16	13	18	11	12	14	19
58	11	17	14	13	15	18	16	12	19	20
59	11	12	16	17	18	14	15	19	20	13
60	15	11	19	14	17	12	18	20	13	16
61	12	13	17	11	16	19	18	15	20	14
62	15	14	20	17	16	19	13	11	18	12
63	18	16	14	12	17	20	11	15	13	19
64	16	11	18	15	13	20	19	17	12	14
65	16	12	11	14	13	15	20	19	18	17
66	13	17	15	12	20	16	14	18	19	11
67	14	18	13	15	16	11	12	19	17	20
68	16	13	11	19	12	14	20	17	15	18
69	11	13	16	18	14	12	17	19	15	20
70	12	15	16	18	19	13	14	17	11	20
71	12	11	15	16	17	18	20	14	13	19
72	12	16	20	15	11	13	17	14	19	18
73	15	13	12	14	11	17	19	20	18	16

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
74	17	20	19	11	15	14	18	12	16	13
75	20	14	15	17	18	12	13	16	11	19
76	16	15	14	12	20	17	19	11	13	18
77	17	16	20	13	14	19	15	12	18	11
78	16	19	14	17	15	11	12	13	20	18
79	20	18	13	19	16	14	11	15	12	17
80	13	12	15	18	16	19	14	20	11	17
81	13	11	18	12	19	20	17	14	16	15
82	17	19	13	18	11	20	15	14	16	12
83	11	18	14	16	20	15	19	13	17	12
84	13	15	11	14	18	19	12	17	20	16
85	18	16	17	20	12	15	13	11	14	19
86	17	12	11	20	14	13	19	18	15	16
87	15	20	19	17	11	13	16	12	18	14
88	11	19	20	18	17	12	16	13	14	15
89	18	19	16	11	12	13	15	17	14	20
90	13	14	17	15	11	18	20	16	12	19
91	14	13	12	20	19	17	18	15	11	16
92	14	20	12	15	19	16	17	11	13	18
93	19	15	20	11	17	16	14	18	13	12
94	14	12	18	13	19	20	17	15	16	11
95	19	18	12	20	16	13	11	15	17	14
96	20	14	15	19	13	12	11	16	18	17
97	18	11	14	13	20	15	12	17	19	16
98	20	18	16	19	14	11	12	13	17	15
99	18	14	17	12	16	19	11	20	15	13
100	16	12	15	17	13	18	20	14	19	11
101	20	11	13	17	18	16	15	14	19	12
102	20	13	18	16	17	14	12	19	15	11
103	19	17	16	14	12	11	13	20	15	18
104	12	17	13	14	16	15	19	20	11	18
105	17	20	19	15	16	12	18	11	14	13
106	15	20	12	19	18	14	17	16	13	11
107	16	19	13	12	14	11	15	18	20	17
108	19	17	20	11	15	12	16	18	13	14
109	18	15	14	12	17	19	20	13	16	11
110	12	14	19	16	20	18	13	11	17	15

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
111	14	18	17	13	20	16	11	19	12	15
112	13	19	14	16	18	15	20	12	11	17
113	19	12	16	14	15	17	11	18	20	13
114	19	13	16	15	12	17	18	11	14	20
115	15	19	11	20	14	17	12	13	18	16
116	17	16	15	13	18	12	20	19	14	11
117	12	20	17	11	18	14	19	15	16	13
118	11	16	20	14	15	13	17	12	19	18
119	13	15	18	11	19	17	14	16	20	12
120	18	12	19	11	20	16	13	17	15	14
121	11	13	20	17	16	14	18	19	12	15
122	20	11	14	15	12	18	19	16	17	13
123	19	17	11	12	13	15	14	20	16	18
124	14	17	18	13	19	20	15	12	11	16
125	14	19	15	16	11	13	12	20	18	17
126	12	14	17	20	13	11	16	18	15	19
127	20	19	13	16	12	15	18	11	17	14
128	15	17	13	14	12	11	16	19	18	20
129	17	16	12	19	18	20	11	15	13	14
130	16	17	11	19	12	18	15	20	14	13
131	17	18	19	16	13	20	15	11	12	14
132	12	11	18	17	15	19	14	13	16	20
133	19	15	20	18	17	14	13	12	16	11
134	14	16	15	19	11	17	20	13	18	12
135	13	15	11	18	20	12	16	19	14	17
136	11	13	12	15	17	19	18	16	14	20
137	16	20	14	18	11	15	12	17	13	19
138	11	20	16	18	14	12	19	13	17	15
139	18	12	16	13	15	17	14	20	11	19
140	13	11	17	20	12	18	14	19	15	16
141	17	12	13	18	19	16	20	14	11	15
142	11	14	18	15	13	16	19	20	12	17
143	15	18	11	20	13	19	17	16	12	14
144	16	15	13	14	11	12	18	17	19	20
145	19	12	15	16	11	14	17	18	13	20
146	18	13	11	12	19	16	14	15	20	17
147	16	18	20	15	14	11	13	17	19	12

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
148	20	19	17	14	15	11	18	12	16	13
149	18	20	19	11	17	13	16	15	14	12
150	15	20	18	19	14	13	12	17	11	16
151	17	15	12	20	16	11	13	14	19	18
152	12	14	18	16	13	20	17	11	15	19
153	15	16	19	12	11	20	13	14	17	18
154	14	11	19	17	20	18	16	12	15	13
155	19	14	20	17	18	15	11	16	12	13
156	16	18	19	13	15	17	12	11	20	14
157	13	20	11	17	19	18	15	14	12	16
158	14	16	20	13	18	19	11	15	17	12
159	14	15	18	13	17	16	11	12	19	20
160	17	13	15	16	20	12	14	18	11	19
161	12	17	14	19	16	11	18	13	20	15
162	20	11	14	13	12	18	17	16	15	19
163	13	11	12	17	20	16	19	15	14	18
164	16	19	13	11	15	12	20	18	14	17
165	20	14	13	12	16	17	15	19	18	11
166	18	16	17	12	11	13	14	20	19	15
167	11	14	15	12	13	19	17	18	20	16
168	12	13	17	19	18	15	16	14	11	20
169	13	11	16	18	17	14	19	12	20	15
170	11	17	15	13	18	14	12	19	16	20
171	14	20	12	18	19	15	16	13	17	11
172	16	15	18	12	14	17	13	20	11	19
173	18	12	19	14	16	13	15	17	11	20
174	18	13	16	14	15	20	12	17	19	11
175	17	16	19	20	11	14	18	15	13	12
176	15	18	16	11	19	12	20	17	13	14
177	11	16	17	18	20	13	15	19	14	12
178	11	12	18	20	13	19	16	15	17	14
179	19	17	20	15	14	12	11	18	16	13
180	16	18	14	20	17	11	13	19	15	12
181	15	19	20	16	12	17	14	11	18	13
182	20	19	11	15	16	12	13	18	14	17
183	15	14	19	13	18	11	17	20	12	16
184	14	18	17	19	20	11	15	13	12	16

Table 3, TDMA slot assignment to LocataLite number, Subnet 2

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
185	18	17	12	11	14	15	20	13	16	19
186	12	13	11	20	19	14	16	15	18	17
187	12	20	15	11	13	17	18	19	14	16
188	20	17	13	15	12	14	18	11	19	16
189	18	13	14	19	17	16	11	12	20	15
190	13	19	11	16	14	20	12	18	15	17
191	15	11	20	14	13	12	19	16	17	18
192	20	18	12	19	13	17	11	14	16	15
193	12	16	11	17	15	19	20	14	13	18
194	19	13	11	18	12	15	20	16	17	14
195	17	19	18	14	11	13	15	16	20	12
196	13	14	16	19	15	20	17	12	18	11
197	14	15	16	12	20	18	11	19	17	13
198	16	15	12	14	17	18	13	20	19	11
199	12	14	20	11	15	18	16	17	19	13
200	14	12	17	20	18	16	13	15	11	19

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
1	22	23	26	30	28	29	21	27	24	25
2	27	25	24	22	26	28	23	29	30	21
3	26	21	25	28	22	30	29	24	27	23
4	30	22	27	21	29	25	26	23	28	24
5	21	30	23	25	27	22	24	28	26	29
6	27	28	21	23	24	26	30	25	29	22
7	29	24	23	22	21	28	25	30	27	26
8	24	22	30	26	25	23	27	29	21	28
9	23	24	29	26	30	25	21	22	28	27
10	29	27	22	25	23	26	28	21	24	30
11	24	29	28	26	27	30	25	22	23	21
12	23	27	25	28	30	21	29	26	22	24
13	26	25	21	24	30	27	28	29	23	22
14	28	30	24	27	23	21	26	22	25	29
15	22	29	30	21	27	24	23	28	25	26
16	27	26	29	28	23	25	22	24	21	30
17	26	21	28	29	25	24	30	23	22	27
18	30	29	23	25	21	22	26	24	28	27
19	21	30	22	27	26	23	29	24	25	28
20	24	27	23	30	28	26	22	29	21	25
21	26	28	22	21	27	29	25	30	24	23
22	28	25	24	22	21	29	27	30	26	23
23	29	23	21	24	25	30	28	27	22	26
24	21	26	27	28	22	25	23	30	29	24
25	28	22	30	24	21	23	27	25	29	26
26	25	26	24	29	28	21	27	23	30	22
27	28	24	29	30	26	22	23	25	27	21
28	22	23	26	29	27	21	24	28	30	25
29	30	28	29	22	25	27	24	26	23	21
30	29	21	30	23	24	26	28	25	22	27
31	25	21	28	27	26	29	30	23	24	22
32	29	23	22	28	30	27	24	21	26	25
33	23	26	27	22	29	28	21	25	24	30
34	24	27	29	25	28	23	22	26	30	21
35	27	28	24	23	29	26	25	22	21	30
36	25	29	26	21	23	28	30	27	22	24

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
37	25	28	26	30	22	27	24	21	29	23
38	21	25	27	30	22	24	23	26	29	28
39	25	30	23	27	26	24	21	22	28	29
40	28	24	27	29	22	30	26	21	25	23
41	30	29	25	26	28	24	22	21	23	27
42	25	21	22	23	30	29	27	28	26	24
43	26	24	30	21	28	22	25	27	23	29
44	30	28	23	25	29	21	24	26	27	22
45	24	25	21	26	29	22	30	27	23	28
46	21	26	23	27	30	28	29	24	25	22
47	26	22	25	29	23	24	27	30	21	28
48	22	23	29	24	28	27	21	25	30	26
49	23	27	28	21	24	29	26	22	30	25
50	28	30	24	22	21	23	25	26	27	29
51	30	23	26	28	25	21	22	29	27	24
52	30	27	25	24	23	22	21	29	28	26
53	21	22	28	27	24	29	26	30	25	23
54	28	23	21	30	27	26	25	24	22	29
55	22	27	21	23	24	28	30	25	26	29
56	23	21	22	26	24	30	29	25	28	27
57	26	21	27	29	25	22	28	24	23	30
58	28	22	25	24	29	21	27	23	26	30
59	22	30	21	25	26	27	28	23	29	24
60	25	30	26	23	22	27	24	28	29	21
61	29	22	23	24	26	25	28	27	21	30
62	24	29	27	30	23	25	21	26	22	28
63	22	26	30	28	25	23	29	21	24	27
64	22	24	21	30	29	27	23	28	26	25
65	29	25	27	26	21	28	30	22	24	23
66	27	25	22	28	29	30	26	23	24	21
67	27	30	28	21	25	23	22	29	26	24
68	27	25	29	22	23	30	24	28	21	26
69	23	24	26	27	29	30	22	21	28	25
70	21	29	24	25	30	23	26	28	22	27
71	28	23	25	22	21	26	29	24	30	27
72	21	24	22	25	30	27	29	23	28	26
73	29	26	28	23	21	24	27	22	30	25

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
74	24	21	23	25	27	28	29	30	26	22
75	23	28	24	29	25	22	26	30	21	27
76	24	28	30	29	21	25	23	27	22	26
77	27	30	23	26	24	25	28	21	29	22
78	25	29	28	30	22	24	23	27	26	21
79	30	27	25	24	22	26	21	23	29	28
80	24	22	30	29	27	21	28	26	25	23
81	26	22	29	21	28	24	30	25	27	23
82	21	22	23	30	24	25	26	28	27	29
83	27	24	26	29	23	22	30	21	25	28
84	25	26	28	22	27	30	24	23	21	29
85	23	30	29	24	26	25	22	27	28	21
86	26	30	22	21	24	28	25	27	23	29
87	25	21	30	23	22	29	28	27	26	24
88	29	26	27	28	30	21	23	25	24	22
89	29	27	25	26	28	23	21	22	24	30
90	25	29	21	27	23	24	30	26	22	28
91	26	23	28	22	21	29	30	24	27	25
92	21	26	24	27	22	25	23	29	30	28
93	23	24	21	27	26	30	29	22	28	25
94	30	23	26	24	28	29	22	27	21	25
95	30	28	29	25	27	22	24	26	23	21
96	28	27	24	23	30	22	25	21	29	26
97	27	21	24	22	30	26	25	29	28	23
98	24	29	22	26	25	23	27	28	21	30
99	28	30	27	29	24	26	21	23	25	22
100	23	26	22	21	28	24	25	29	27	30
101	21	22	30	25	28	27	26	29	23	24
102	28	26	22	25	24	21	27	30	23	29
103	24	21	25	26	27	23	28	29	30	22
104	27	29	21	23	22	28	26	24	25	30
105	26	25	22	23	29	28	24	30	27	21
106	30	28	25	27	23	21	22	24	29	26
107	23	25	26	30	29	28	21	22	24	27
108	22	27	26	28	21	24	23	30	29	25
109	27	25	28	22	24	30	21	26	29	23
110	22	29	21	30	27	26	23	28	25	24

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
111	22	29	30	24	23	27	25	28	26	21
112	23	24	27	21	26	29	30	25	22	28
113	24	21	29	22	26	27	28	23	25	30
114	23	28	27	24	29	26	21	25	22	30
115	22	23	26	28	30	29	27	24	21	25
116	21	22	28	29	25	23	27	30	26	24
117	26	27	29	23	22	25	24	21	28	30
118	24	28	26	25	29	27	22	21	30	23
119	25	23	30	21	22	26	29	24	27	28
120	29	25	24	26	30	28	22	21	23	27
121	29	26	22	28	23	21	24	25	30	27
122	24	23	28	21	26	30	25	27	22	29
123	22	24	25	29	21	27	23	30	26	28
124	24	30	23	27	21	29	28	22	25	26
125	21	28	27	30	24	25	29	22	23	26
126	28	25	30	21	24	22	27	26	23	29
127	27	25	28	23	21	24	29	26	30	22
128	29	23	22	26	25	30	21	27	24	28
129	26	22	30	28	25	23	27	29	24	21
130	25	21	23	30	26	27	28	29	24	22
131	23	24	29	30	27	22	25	28	21	26
132	22	26	27	23	29	21	30	25	28	24
133	30	27	25	24	26	29	28	22	21	23
134	26	24	28	25	21	30	29	23	22	27
135	21	28	29	25	22	23	26	24	27	30
136	21	29	24	23	28	30	22	25	27	26
137	21	26	23	22	30	25	24	28	27	29
138	28	30	24	27	22	21	25	26	29	23
139	25	23	21	27	30	26	22	24	29	28
140	27	21	24	26	23	25	29	22	30	28
141	22	27	29	26	28	23	24	30	25	21
142	30	29	25	22	26	24	23	27	28	21
143	27	23	21	28	24	26	25	29	30	22
144	29	24	21	27	25	22	30	23	28	26
145	25	28	26	30	27	24	22	21	23	29
146	21	22	28	24	27	23	30	29	25	26
147	30	21	26	28	23	29	27	24	22	25

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
148	30	24	25	27	26	28	21	29	23	22
149	23	26	21	29	22	27	28	30	24	25
150	26	27	30	29	23	28	25	21	22	24
151	29	25	23	24	27	22	26	21	30	28
152	22	28	29	21	30	26	27	25	24	23
153	28	22	29	26	25	24	30	23	27	21
154	28	30	26	29	22	21	24	23	25	27
155	28	29	27	24	25	21	23	30	26	22
156	27	30	22	29	28	23	26	24	21	25
157	29	30	23	25	22	24	28	27	26	21
158	29	27	21	22	25	28	26	23	30	24
159	26	23	24	21	27	29	30	22	28	25
160	27	25	30	28	23	29	26	22	21	24
161	30	27	22	26	29	25	23	21	28	24
162	22	29	24	23	28	30	21	26	25	27
163	23	22	30	21	25	26	27	29	24	28
164	27	22	23	26	30	24	29	28	21	25
165	30	25	28	24	26	29	21	27	23	22
166	24	28	27	21	29	30	23	25	26	22
167	25	21	27	23	24	22	28	26	29	30
168	25	21	26	24	30	28	22	27	29	23
169	30	27	26	28	25	22	23	21	24	29
170	21	24	25	23	29	27	26	30	22	28
171	22	26	25	29	24	30	27	28	21	23
172	26	21	28	24	29	25	22	23	27	30
173	29	23	25	24	21	22	30	26	28	27
174	24	26	23	22	27	25	30	28	29	21
175	23	28	21	30	24	27	25	26	22	29
176	28	23	24	27	22	21	29	26	30	25
177	27	24	25	26	21	28	29	22	23	30
178	29	26	27	28	25	23	21	22	24	30
179	22	25	29	27	26	23	24	28	30	21
180	29	27	21	25	28	26	24	23	22	30
181	23	25	27	30	24	22	28	21	26	29
182	22	26	30	21	23	29	28	25	24	27
183	25	30	22	21	26	28	23	27	29	24
184	26	24	29	25	27	21	22	30	28	23

Table 4, TDMA slot assignment to LocataLite Number, Subnet 3

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
185	30	25	22	27	23	26	21	24	28	29
186	21	30	26	22	29	23	25	24	27	28
187	27	30	21	25	28	24	23	29	22	26
188	28	22	24	25	23	21	29	30	27	26
189	24	22	25	21	28	26	27	29	30	23
190	30	29	27	22	23	28	24	21	26	25
191	29	22	28	30	21	27	23	26	25	24
192	26	23	22	27	24	30	25	28	29	21
193	27	21	30	29	26	23	24	28	25	22
194	29	26	30	23	27	24	22	25	21	28
195	26	21	22	30	28	29	24	25	23	27
196	25	24	29	28	30	27	21	23	22	26
197	22	30	24	28	21	25	26	29	27	23
198	25	29	23	28	21	24	27	30	26	22
199	21	30	24	23	29	25	26	28	27	22
200	25	27	28	22	23	21	29	24	26	30

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
1	32	40	35	34	31	39	33	38	36	37
2	33	34	39	38	37	40	36	32	31	35
3	36	38	31	37	34	33	32	35	40	39
4	37	36	35	31	40	34	38	33	39	32
5	38	35	33	40	32	39	31	36	34	37
6	39	35	37	31	38	32	36	40	33	34
7	40	37	35	39	36	31	33	38	34	32
8	33	37	32	40	35	38	39	31	34	36
9	35	39	34	36	40	31	32	37	38	33
10	39	40	38	35	32	36	37	34	33	31
11	34	32	39	38	36	33	35	31	37	40
12	32	34	37	33	36	31	40	39	35	38
13	40	33	36	39	34	38	32	37	31	35
14	37	32	31	38	39	33	40	34	35	36
15	38	31	33	39	37	35	40	36	32	34
16	35	38	36	33	31	32	34	40	37	39
17	34	31	32	35	33	37	38	36	39	40
18	31	33	37	36	35	34	39	32	38	40
19	38	35	33	32	39	40	37	31	36	34
20	36	31	40	34	39	37	35	32	33	38
21	31	39	36	32	33	35	34	40	37	38
22	37	39	40	36	38	34	31	35	32	33
23	34	38	39	33	31	36	37	32	40	35
24	31	37	34	35	39	36	40	38	33	32
25	35	40	32	37	36	34	31	39	38	33
26	40	31	38	32	36	33	35	34	37	39
27	32	31	38	34	33	37	36	40	39	35
28	33	36	39	35	37	40	32	31	34	38
29	35	36	31	40	32	38	37	33	39	34
30	33	32	36	38	40	35	34	39	31	37
31	31	34	40	33	35	32	38	39	36	37
32	38	37	33	31	32	40	34	35	36	39
33	37	32	34	36	33	40	39	38	35	31
34	35	39	38	37	40	31	33	34	32	36
35	39	33	36	34	38	32	31	37	35	40
36	37	39	31	36	34	32	35	38	40	33

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
37	36	35	37	40	38	31	34	33	39	32
38	37	36	38	34	32	39	33	35	40	31
39	39	33	34	37	31	36	32	35	38	40
40	33	38	31	32	34	39	35	37	40	36
41	40	39	32	37	34	38	33	31	35	36
42	32	38	34	31	37	35	39	36	33	40
43	35	40	38	39	34	36	31	33	32	37
44	34	35	33	38	36	37	32	40	31	39
45	31	33	35	32	39	37	38	34	40	36
46	40	34	39	38	37	33	36	35	32	31
47	38	33	37	34	35	31	40	39	36	32
48	36	39	40	35	31	38	34	37	32	33
49	39	40	33	31	35	36	37	38	32	34
50	31	36	34	40	32	38	39	33	37	35
51	39	37	36	35	38	32	31	40	34	33
52	32	35	38	36	33	34	40	37	39	31
53	34	37	35	33	40	38	36	39	31	32
54	40	32	37	31	33	39	35	34	36	38
55	40	36	34	35	31	39	32	33	38	37
56	34	38	31	40	37	33	36	32	39	35
57	33	34	32	39	36	40	38	35	37	31
58	38	40	35	39	34	37	32	36	31	33
59	32	34	33	40	39	37	38	31	35	36
60	34	31	32	33	35	37	40	36	38	39
61	36	31	38	32	40	33	37	39	34	35
62	36	37	40	31	39	32	35	33	38	34
63	32	33	31	34	38	35	39	40	37	36
64	31	37	39	38	33	32	36	35	40	34
65	39	32	35	37	38	40	34	31	36	33
66	34	36	35	32	38	31	39	37	33	40
67	31	32	40	36	35	34	33	39	38	37
68	33	35	31	37	32	36	39	34	40	38
69	36	38	33	37	40	39	35	32	34	31
70	40	31	36	33	37	35	38	32	39	34
71	36	40	39	33	31	35	34	32	37	38
72	39	40	32	36	37	31	33	38	35	34
73	37	36	34	38	35	39	31	40	33	32

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
74	38	37	34	39	33	31	35	40	36	32
75	31	38	32	34	40	35	37	36	33	39
76	32	39	40	37	31	34	36	38	33	35
77	40	35	38	34	32	37	33	36	31	39
78	37	34	33	40	32	38	39	36	35	31
79	38	34	37	35	33	36	39	31	32	40
80	33	32	39	31	36	38	40	34	35	37
81	33	38	36	37	39	40	31	34	32	35
82	36	32	40	39	35	33	31	37	34	38
83	35	34	39	38	36	33	40	37	32	31
84	33	35	39	32	34	36	40	38	31	37
85	31	40	36	39	34	35	32	33	37	38
86	32	35	40	33	34	39	38	31	36	37
87	40	38	39	35	31	34	37	36	32	33
88	34	31	39	32	37	35	38	33	36	40
89	35	36	31	40	32	39	37	34	33	38
90	35	33	31	32	38	40	34	37	39	36
91	39	33	40	38	37	32	36	31	35	34
92	40	37	35	36	34	32	31	33	39	38
93	37	39	35	31	32	34	36	38	40	33
94	36	33	37	38	34	31	35	32	40	39
95	33	32	37	36	40	31	34	35	38	39
96	40	32	35	39	36	37	33	34	38	31
97	39	34	40	37	31	38	36	32	33	35
98	32	31	36	40	38	33	35	37	34	39
99	37	34	33	40	35	38	32	39	31	36
100	34	33	38	39	31	37	32	36	35	40
101	36	38	32	31	33	39	37	40	35	34
102	32	35	36	33	39	40	34	38	37	31
103	38	36	37	32	40	33	34	35	31	39
104	35	39	32	38	40	34	33	31	37	36
105	39	40	31	35	33	37	38	34	36	32
106	33	36	32	34	37	35	40	39	38	31
107	37	40	36	31	35	34	39	33	38	32
108	38	33	34	31	37	39	36	35	32	40
109	35	31	38	36	39	34	37	33	40	32
110	38	35	33	39	36	40	31	32	34	37

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
111	32	39	31	34	40	33	35	37	36	38
112	34	32	37	35	33	36	38	31	40	39
113	31	33	38	35	39	32	37	40	36	34
114	35	36	33	32	31	40	38	34	39	37
115	38	40	37	33	32	39	34	31	36	35
116	38	35	40	32	36	37	31	39	34	33
117	40	36	34	38	39	33	31	32	35	37
118	39	38	32	35	36	31	34	40	37	33
119	39	37	35	40	34	32	33	36	31	38
120	37	39	32	34	36	31	40	38	33	35
121	32	40	34	36	39	35	31	33	37	38
122	33	37	34	31	38	36	40	39	35	32
123	33	34	39	40	35	38	36	37	31	32
124	34	35	38	37	32	40	33	31	39	36
125	34	36	35	37	40	33	32	39	38	31
126	35	31	33	32	38	39	37	36	34	40
127	36	38	40	32	31	34	35	39	33	37
128	34	31	36	39	33	38	40	32	37	35
129	37	31	35	34	38	32	36	40	39	33
130	40	37	36	33	34	32	38	35	39	31
131	36	32	33	34	40	35	39	38	31	37
132	38	34	37	33	35	32	39	40	31	36
133	35	32	37	40	38	36	33	31	34	39
134	32	38	31	39	33	36	37	35	40	34
135	38	39	35	36	33	40	31	37	32	34
136	31	35	34	33	38	40	32	36	37	39
137	34	40	39	36	31	32	35	37	38	33
138	35	33	38	37	34	36	32	31	39	40
139	31	40	33	39	37	38	35	36	34	32
140	37	36	32	40	39	35	38	34	33	31
141	40	35	33	37	31	34	39	32	36	38
142	37	39	34	38	32	31	35	40	33	36
143	39	31	32	38	33	35	34	37	40	36
144	39	38	40	31	36	37	33	32	34	35
145	38	39	36	35	40	37	31	34	32	33
146	39	37	32	36	35	31	33	34	38	40
147	35	34	31	38	37	36	40	33	32	39

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
148	33	37	40	34	36	31	39	38	32	35
149	31	32	40	36	34	33	38	39	35	37
150	34	39	38	33	31	40	37	35	36	32
151	31	33	39	34	37	38	36	35	40	32
152	33	40	35	32	37	39	36	38	31	34
153	37	32	31	35	39	33	36	40	38	34
154	35	32	39	31	37	34	40	38	36	33
155	36	31	38	33	39	40	34	32	37	35
156	34	38	36	39	32	35	33	31	37	40
157	32	38	34	35	39	36	37	33	31	40
158	36	33	35	31	38	39	32	34	40	37
159	32	36	34	33	40	39	37	35	38	31
160	39	34	40	31	33	37	38	32	35	36
161	38	39	31	32	35	37	33	36	40	34
162	39	35	33	32	40	34	38	37	31	36
163	31	34	36	37	32	39	40	38	35	33
164	37	40	38	35	32	33	34	31	39	36
165	40	39	37	34	36	32	31	33	35	38
166	35	40	37	39	31	38	32	36	34	33
167	40	35	31	32	37	36	33	38	34	39
168	34	31	37	36	39	32	38	40	33	35
169	31	36	38	40	34	35	37	39	33	32
170	40	31	35	36	32	33	39	34	37	38
171	37	33	34	40	38	31	36	35	39	32
172	36	33	34	39	35	38	31	40	32	37
173	31	32	34	38	33	36	35	37	39	40
174	36	34	31	33	40	37	32	35	39	38
175	39	37	36	38	34	32	40	35	33	31
176	39	40	36	37	35	34	33	32	31	38
177	35	36	39	33	38	32	34	37	40	31
178	37	34	35	40	33	38	32	39	31	36
179	32	33	37	36	31	40	35	39	38	34
180	32	38	31	34	36	33	39	35	37	40
181	33	37	31	35	34	39	32	36	40	38
182	36	38	33	39	40	31	35	32	34	37
183	35	34	38	37	39	36	31	33	32	40
184	36	37	32	31	34	35	33	38	40	39

Table 5, TDMA slot assignment to LocataLite number, Subnet 4

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
185	38	36	32	34	31	40	37	33	35	39
186	36	35	40	32	37	31	39	34	38	33
187	34	32	33	31	38	35	36	39	37	40
188	33	36	40	39	35	38	34	31	32	37
189	33	31	38	36	37	34	40	32	39	35
190	38	39	31	37	33	35	32	40	36	34
191	32	38	39	37	31	33	40	34	36	35
192	31	40	34	35	32	38	37	39	33	36
193	31	35	36	38	40	37	34	33	32	39
194	34	33	37	38	31	36	39	40	32	35
195	33	39	32	35	34	40	31	37	36	38
196	40	37	33	38	35	34	39	36	32	31
197	34	37	32	33	40	39	38	31	36	35
198	37	31	39	40	35	38	34	36	33	32
199	36	40	35	31	32	37	38	33	39	34
200	38	37	39	31	32	33	36	34	35	40

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
1	46	49	42	50	45	44	43	41	48	47
2	50	48	46	43	44	42	41	45	47	49
3	43	46	41	44	47	48	42	49	45	50
4	41	50	47	44	49	46	45	42	43	48
5	44	45	48	41	43	49	47	42	46	50
6	43	47	45	46	48	49	44	50	41	42
7	48	42	44	46	47	43	45	50	49	41
8	49	45	41	47	46	42	48	43	50	44
9	45	44	48	43	49	50	42	47	41	46
10	44	41	43	42	45	46	50	49	47	48
11	50	46	47	49	48	45	42	44	43	41
12	47	45	49	43	42	41	46	48	50	44
13	42	47	50	41	44	46	49	48	45	43
14	46	43	45	41	42	49	50	48	44	47
15	42	46	41	45	47	50	43	44	48	49
16	44	50	43	48	49	47	41	46	42	45
17	49	42	50	44	41	48	47	46	45	43
18	42	43	44	49	41	47	48	46	50	45
19	47	43	49	50	46	44	42	45	48	41
20	50	49	46	47	44	45	48	41	42	43
21	50	42	46	48	43	47	41	49	44	45
22	41	49	43	45	50	42	48	47	44	46
23	45	44	50	48	46	41	43	47	49	42
24	48	45	42	49	41	50	47	46	44	43
25	41	48	42	46	49	44	47	45	43	50
26	46	42	47	50	45	41	44	43	49	48
27	47	41	45	42	50	43	46	44	49	48
28	44	47	43	41	48	50	49	45	46	42
29	44	48	49	43	50	45	47	42	41	46
30	45	43	48	44	41	49	46	50	47	42
31	48	41	47	46	43	45	49	50	42	44
32	41	50	44	42	43	47	49	46	48	45
33	49	45	44	46	42	41	43	48	50	47
34	45	50	49	48	46	43	44	41	42	47
35	49	47	48	43	42	45	44	50	46	41

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
36	47	43	46	45	44	48	42	49	41	50
37	43	48	42	50	47	44	45	41	46	49
38	43	42	41	45	46	47	50	48	44	49
39	42	46	50	41	44	43	47	49	45	48
40	45	47	42	50	48	46	41	43	49	44
41	50	46	49	42	45	43	41	44	48	47
42	46	43	45	49	41	48	50	42	47	44
43	43	49	50	45	42	44	46	47	48	41
44	48	44	42	49	47	45	50	41	43	46
45	50	44	47	41	49	46	48	45	42	43
46	46	44	41	45	48	49	43	42	47	50
47	48	50	46	47	45	43	44	49	41	42
48	49	50	44	47	41	42	48	43	45	46
49	41	47	43	44	50	46	49	48	42	45
50	48	47	46	42	43	50	41	44	49	45
51	50	45	47	48	49	44	42	46	43	41
52	49	41	50	43	47	42	45	46	44	48
53	46	44	45	49	42	41	47	43	48	50
54	45	41	44	46	48	43	49	42	50	47
55	42	41	49	47	44	48	45	43	46	50
56	42	44	45	48	41	47	43	50	49	46
57	45	50	48	42	44	49	46	47	41	43
58	47	49	43	42	48	46	50	41	45	44
59	42	50	49	47	45	41	46	48	43	44
60	43	48	44	46	45	42	49	41	50	47
61	48	41	49	44	50	42	47	45	46	43
62	41	42	46	44	47	50	48	43	45	49
63	45	41	46	42	43	50	44	47	48	49
64	46	49	42	48	47	44	41	50	43	45
65	44	43	42	50	46	49	45	47	41	48
66	47	46	41	49	50	43	44	48	45	42
67	49	48	50	45	43	47	42	41	44	46
68	41	45	43	50	49	48	46	47	44	42
69	46	42	47	43	45	48	49	44	50	41
70	43	41	45	42	46	48	44	49	47	50
71	47	48	41	45	50	49	43	46	42	44
72	41	44	48	45	49	50	42	47	46	43

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
73	47	49	48	42	43	41	46	50	44	45
74	44	42	41	48	46	45	50	47	43	49
75	43	48	47	46	41	42	45	44	50	49
76	41	46	45	47	42	49	50	44	43	48
77	42	48	50	41	47	44	43	49	45	46
78	48	49	46	41	43	42	44	45	47	50
79	46	44	47	49	45	48	41	42	50	43
80	50	43	44	41	48	45	46	49	47	42
81	43	46	44	49	42	45	50	48	41	47
82	45	48	43	50	42	46	49	44	47	41
83	50	45	49	48	44	41	43	46	42	47
84	49	46	47	43	44	42	45	41	48	50
85	47	50	45	49	41	44	46	43	42	48
86	46	43	48	47	45	50	41	42	49	44
87	43	45	42	44	49	47	48	41	46	50
88	42	50	48	44	46	41	49	45	43	47
89	46	47	44	48	49	50	42	43	41	45
90	41	49	50	46	48	43	44	45	47	42
91	47	45	41	50	44	46	48	42	43	49
92	42	41	45	46	50	43	47	49	44	48
93	49	43	48	50	47	41	42	45	46	44
94	49	42	47	43	41	48	44	50	46	45
95	44	47	43	45	50	49	41	46	42	48
96	44	42	50	47	46	45	48	43	49	41
97	47	50	41	48	42	44	45	49	43	46
98	42	46	49	45	47	44	50	48	41	43
99	50	44	49	48	46	47	45	43	42	41
100	44	47	46	43	49	48	41	50	45	42
101	49	47	41	50	43	42	45	44	48	46
102	45	42	43	41	44	47	48	50	49	46
103	41	43	50	48	45	46	47	42	49	44
104	41	42	44	43	46	49	50	45	48	47
105	48	45	47	49	50	44	42	41	46	43
106	48	49	46	42	47	50	43	44	45	41
107	45	49	42	44	41	43	47	50	46	48
108	43	45	41	47	44	46	50	42	48	49
109	44	48	43	42	50	41	49	46	47	45

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
110	43	41	48	47	42	49	45	46	44	50
111	44	49	42	46	48	45	43	41	50	47
112	49	47	41	44	48	42	46	43	45	50
113	48	46	45	42	43	49	41	47	44	50
114	45	44	42	41	49	43	50	46	48	47
115	41	48	44	43	45	47	46	49	50	42
116	45	49	46	44	47	43	48	42	50	41
117	42	43	50	49	48	44	46	47	41	45
118	48	50	44	45	46	41	47	42	49	43
119	44	41	49	47	45	42	48	50	43	46
120	50	46	43	42	41	45	44	48	47	49
121	43	47	46	50	45	41	42	48	49	44
122	46	45	49	41	43	47	50	48	42	44
123	47	48	43	44	42	50	49	45	41	46
124	42	46	47	43	49	48	41	44	50	45
125	48	46	43	45	50	42	47	44	41	49
126	42	47	50	41	48	45	43	46	44	49
127	41	42	45	46	49	47	48	50	44	43
128	50	43	49	47	41	46	42	44	45	48
129	46	50	41	44	43	48	49	45	47	42
130	50	48	45	49	42	46	41	47	43	44
131	45	42	49	48	44	50	47	43	46	41
132	49	44	42	43	48	41	50	46	45	47
133	48	43	47	44	49	46	45	50	42	41
134	50	41	44	46	49	45	43	42	48	47
135	45	44	42	46	48	50	47	49	41	43
136	47	49	50	46	44	43	41	45	48	42
137	43	41	48	42	50	45	44	49	47	46
138	50	49	46	47	42	48	44	41	43	45
139	47	44	48	41	46	42	45	49	43	50
140	43	44	41	50	42	49	48	47	45	46
141	48	50	44	45	43	46	49	42	41	47
142	46	41	45	50	48	47	42	43	49	44
143	49	50	42	47	48	43	45	41	46	44
144	46	44	48	45	47	41	43	42	50	49
145	44	47	50	49	46	43	48	45	41	42
146	41	46	43	49	47	44	50	48	42	45

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
147	44	50	47	48	46	41	42	45	49	43
148	50	43	41	45	42	44	46	47	49	48
149	42	46	45	44	41	48	49	43	47	50
150	47	45	43	48	41	49	50	46	42	44
151	49	42	48	43	46	50	45	44	47	41
152	47	46	41	50	43	42	49	44	45	48
153	49	45	46	44	42	48	47	43	50	41
154	42	41	45	50	44	43	47	48	46	49
155	50	49	42	47	45	48	43	41	44	46
156	44	45	43	49	41	47	46	48	50	42
157	45	47	49	41	50	46	42	44	48	43
158	46	43	45	41	49	47	44	42	50	48
159	49	48	46	45	42	43	44	47	41	50
160	41	48	44	43	47	50	42	49	46	45
161	43	48	47	42	41	45	46	50	44	49
162	43	44	50	47	45	49	46	48	41	42
163	46	47	48	49	44	50	45	41	43	42
164	47	41	46	43	48	44	49	45	42	50
165	46	49	42	48	50	47	43	45	44	41
166	44	42	46	41	43	49	50	48	45	47
167	49	45	48	46	50	41	47	44	43	42
168	43	48	45	50	44	47	41	46	42	49
169	43	50	49	41	44	45	42	47	46	48
170	47	42	49	46	45	50	43	41	48	44
171	46	41	49	47	43	44	48	42	50	45
172	48	50	44	45	47	42	41	43	46	49
173	42	44	43	49	50	45	46	47	48	41
174	48	43	42	45	49	47	50	46	44	41
175	45	46	49	48	41	47	44	50	42	43
176	45	43	44	42	48	49	41	46	47	50
177	49	45	41	44	46	48	42	43	50	47
178	45	46	50	48	44	41	42	47	49	43
179	46	42	47	43	50	41	49	48	45	44
180	48	49	44	50	43	42	46	41	47	45
181	41	44	46	43	47	42	45	49	48	50
182	44	47	41	42	50	45	48	43	49	46
183	50	49	47	43	41	46	48	44	45	42

Table 6, TDMA slot assignment to LocataLite Number, Subnet 5

(continued)

TDMA Frame	Device Transmit Sequence									
	1	2	3	4	5	6	7	8	9	10
184	41	50	43	46	42	44	48	47	49	45
185	48	42	44	41	49	43	45	50	47	46
186	44	41	50	42	48	46	47	49	45	43
187	44	42	45	50	46	49	43	48	41	47
188	50	41	42	46	45	44	49	43	47	48
189	42	49	41	45	47	50	48	44	43	46
190	42	50	45	41	48	46	43	49	44	47
191	41	43	45	47	46	49	44	50	42	48
192	45	42	46	44	47	48	50	43	41	49
193	48	46	47	43	50	41	44	45	49	42
194	47	44	48	42	41	43	45	49	50	46
195	49	47	46	41	45	50	44	42	43	48
196	47	44	42	49	45	46	43	41	50	48
197	50	49	42	44	46	48	41	47	45	43
198	42	48	49	50	45	43	47	41	46	44
199	47	42	45	48	43	44	49	46	50	41
200	44	43	48	47	50	42	46	45	49	41

3.2.3 Navigation Data

The NAV data, D(t), is modulo-2 added to the PRN spreading codes to form the composite signal broadcast by each LocataLite. LocataLites normally transmit NAV data at 100 bits per second, although a LocataNet can be configured optionally for NAV data transmission at 50 bits per second for implementations requiring greater NAV data robustness, such as in the presence of jamming or interference. In this case, the NAV data is simply slowed to 50 bps, and NAV data Subframe and Frame durations double over the figures cited herein.

The NAV data includes LocataLite ephemerides, system time, network status, correction factors, and other data. The NAV data is modulo-2 added to the C/A-code; the resultant bit-train is used to modulate the S1 and S6 carriers. The data train for each signal from a given LocataLite is not necessarily the same in content as the data train from the other signals from that LocataLite, although the structure of the data trains is the same in all cases.

The content and characteristics of the NAV data are given in Appendix I: Locata Navigation Data Structure.

3.2.4 S1/S6 Signal Structure

The S1 and S6 signals are both bi-phase shift key (BPSK) modulated by a bit train. The bit train is the modulo-2 sum of the C/A-code and the NAV data. For a particular LocataLite all transmitted signal elements (carriers, codes and data) are coherently derived from the same on-board frequency source.

3.3 Interface Criteria

The criteria specified in the following paragraphs define the characteristics of the LocataNet signals transmitted at the S1 and S6 frequencies.

3.3.1 Composite Signal

The following criteria define the characteristics of the composite signals.

3.3.1.1 Frequency Plan

The signals emitted within the LocataNet are contained within two 20.46MHz bands centered about S1 and S6. The carrier frequencies and the spreading code derive coherently from a common frequency source within the LocataLite. This frequency source is an integer multiple of 10.23 MHz. Table 7 presents the nominal carrier frequencies (f_0). These frequencies are an integer multiple of the 10.23 MHz pseudorandom code rate. Note that these frequencies are not common to GPS.

Table 7, Carrier frequency assignments

Frequency ID	Frequency
S1	2414.28 MHz
S6	2465.43 MHz

LocataLites provide up to four transmit signals each, two on S1 and two on S6. These are mapped to two transmitter signal output ports, labeled TX1 and TX2. Each LocataLite antenna output port carries one transmitted signal at S1 and one at S6 and drives a single antenna. The TX1 and TX2 antennas are typically separated to provide spatial diversity, while S1 and S6 provide frequency diversity.

Each LocataLite in a LocataNet is assigned a unique numerical identity. Each transmitter in a LocataLite receives a suffix identity in accordance with Table 8. Therefore each transmitter in a LocataNet may be known by its LocataLite number and transmitter suffix. Table 1, Code Phase Assignments uses these suffix identifiers in assigning PRN codes to transmitters.

Table 8, Derivation of Transmitted Signal Identities

Frequency ID:	On Antenna Port:	Correspond to Transmitted Signal Identity suffix:
S1	TX1	A
S6	TX1	B
S1	TX2	C
S6	TX2	D

3.3.1.2 Correlation Loss

Correlation loss is defined as the ratio of the signal power received in the operating bandwidth of 20.46 MHz at the input of the correlator and the signal power at the output of the correlator after correlating that received signal. Correlation loss is apportioned as follows:

LocataLite modulation imperfections 0.6 dB

Ideal receiver waveform distortion 0.4 dB (due to filtering)

3.3.1.3 Carrier Phase Noise

Carrier phase noise spectral density of the unmodulated carrier is maintained at or below that level needed to enable a phase locked loop of 10 Hz one-sided noise bandwidth to track the carrier to an accuracy of 0.1 radians rms.

3.3.1.4 Spurious Transmissions

In band spurious transmissions are maintained at least 40 dB below the unmodulated carrier over the 20.46 MHz operating bandwidth.

3.3.1.5 Phase Quadrature

The Locata signals use no phase-based multiplexing.

3.3.1.6 User-Received Signal Levels

Given that user receiver equipment can be located from as close as immediately adjacent to a LocataLite to a separation of tens of kilometers from one it receives, received signal levels can vary widely, by as much as 80 dB or more. The spreading waveforms used within the network provide a dynamic range of approximately 23 dB, which is inadequate to provide frequency reuse using code division multiple access techniques alone. Separating LocataLites using orthogonal time slot assignments within the scheme identified in paragraph 3.2.2 provides the needed additional signal separation to ensure good reception.

User equipment should be designed to take into account the widely varying signal levels possible within a LocataNet. The US equipment receive signal dynamic range should span a range in power spectral density from the level of the receiver Gaussian thermal background noise floor to at least 0.1 dBm/MHz.

3.3.1.7 Equipment Group Delay

Equipment group delay is defined as the delay between the radiated signal output of a specific LocataLite (measured at the antenna phase centre) and the output of that LocataLite's on-board frequency source. The delay consists of a bias term and an uncertainty. The mean group delay bias, the uncertainty (variation) of this delay, as well as the group delay differential between the signals of S1 and S6 are defined in the following.

3.3.1.7.1 Mean Group Delay Bias

LocataLites in a network are all TimeLoc synchronized at their antenna phase centers to a Master LocataLite signal as emitted at the phase centre of its antenna. Hence group delay within the Master LocataLite and within the TXA transmitter of a slave LocataLite do not affect network synchronization. The other signals emitted by a LocataLite (TXB, TXC, and TXD) that are themselves not directly used in the TimeLoc synchronization process, but whose timing is derived from the synchronized timing of TXA, may have a differential delay as emitted at antenna phase centers. LocataLites measure this emitted relative delay and transmit calibrated indications of this measurement in the NAV data (see Section 5.2.3.4.1, Subframe Content).

3.3.1.7.2 Group Delay Differential Uncertainty

The maximum effective uncertainty of the group delay differential among calibrated signals transmitted by a LocataLite is 10 picoseconds.

3.3.1.8 Signal Coherence

All transmitted signals for a particular LocataLite are coherently derived from the same on-board frequency standard. All transmitted digital signals are clocked in coincidence with the PRN transitions for the emitted signal on TXA. All transmitted digital signals are clocked to occur within 0.2 radian of the upwards zero crossing of the transmitted RF carrier.

3.3.1.9 Signal Stability

A LocataNet operating in autonomous mode, that is, without synchronization to an external time source, will provide the timing stability shown in Table 9.

Table 9, LocataNet autonomous stability

LocataNet Autonomous Stability	
Short term stability	1 ppm
Long term stability	1 ppm/year*, maximum 10 ppm
Thermal stability	<1ppm over the operating range -30 to +85 °C

*Uncompensated. Long term drift is tracked and compensated at restart

The LocataNet will reflect the stability of the time source to which it is synchronized when synchronized to an external source. When synchronized to an externally supplied pulse-per-second (PPS), the network will track the PPS source subject to the specifications shown in Table 10.

Table 10, LocataNet Synchronized Stability

LocataNet Synchronized Stability	
Tracking noise relative to the PPS source	10 nanoseconds rms
Tracking bias	Compensated during configuration, <1 nanosecond resolution

Present external network synchronization capabilities support simultaneous, synchronized GNSS/Locata measurement capture to ensure comparable positions under user dynamics.

3.3.1.10 Antenna Position Uncertainty

Positioning accuracy will depend on the accuracy to which the LocataLite transmitting antennas are surveyed and the precision by which this is described to the LocataNet. Antenna position uncertainty is an implementation-dependent variable, and care should be exercised to describe the position of the phase center of the transmitting antennas as accurately and precisely as possible.

For centimeter-level positioning accuracy LocataLite antenna phase centers should be sited to better than 1 centimeter horizontally and 2 centimeters vertically. If the LocataNet is to be used only for code-phase-based positioning, these tolerances may be relaxed by as much as a factor of 10.

3.3.1.11 Signal Polarization

Terrestrial applications typically employ linearly, vertically polarized signals throughout the network, which in general suffer less multipath than horizontally polarized signals. Some applications may instead use right hand circular polarization throughout the network, e.g. aviation applications.

3.3.2 PRN Code Characteristics

LocataNets adopt the Gold code pseudorandom code library used by GPS in order to simplify implementation. Operation at a significantly different carrier frequency prevents interference with GNSS services. The characteristics of the C/A-codes are defined below in terms of their structure and the basic method used for generating them. The output of the code generator is summed modulo 2 with the coded data stream. The resultant composite bit train is then used to modulate the signal carriers.

3.3.2.1 Code Structure

The linear $G_i(t)$ pattern (C/A-code) is the modulo-2 sum of two 1023-bit linear patterns, G1 and $G2_i$. The latter sequence is selectively delayed by an integer number of chips to produce many different G(t) patterns (defined in Table 1, Code Phase Assignments).

3.3.2.2 C/A Code Generation

Each $G_i(t)$ sequence is a 1023-bit Gold-code which is itself the modulo-2 sum of two 1023-bit linear patterns, G1 and $G2_i$. There are several ways of forming the codes in Table 1, Code Phase Assignments. One is shown here, where the $G2_i$ sequence may be formed by delaying

the G2 sequence by an integer number of chips. The G1 and G2 sequences are generated by 10-stage shift registers having the following polynomials as referred to in the shift register input (Figure 2 and Figure 3).

$$G2 = X^{10} + X^{3} + 1$$
$$G2 = X^{10} + X^{9} + X^{8} + X^{6} + X^{3} + X^{2} + 1$$

The initialization vector for the G1 shift register is 1111111111. The initialization vector for the G2 shift register is given in column 3 of Table 1, Code Phase Assignments for each code. The G1 and G2 registers are clocked at 10.23 MHz, and their outputs are modulo-2 added to produce the desired code.

Timing relationships related to the C/A code are shown in Figure 5.

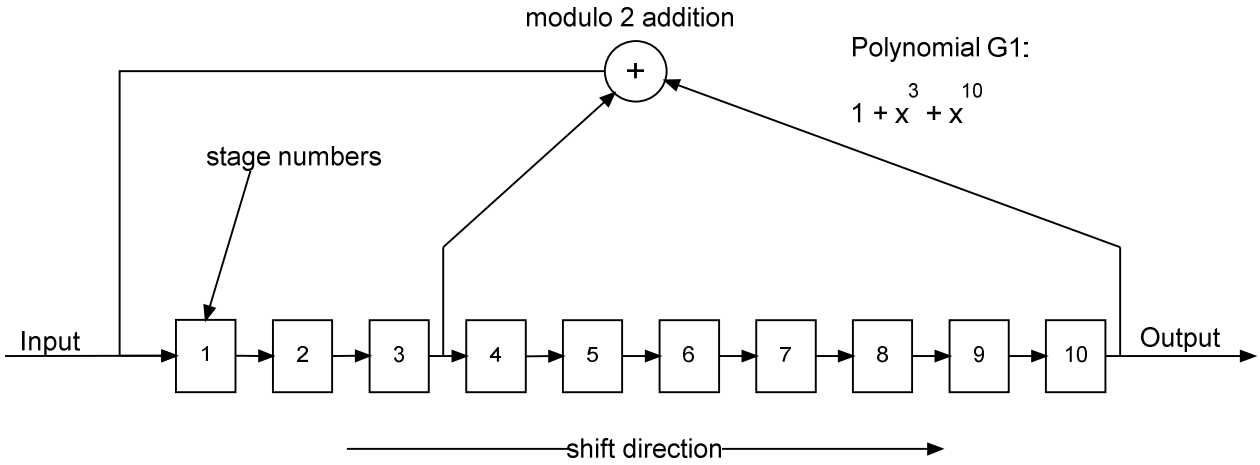

Figure 2: G1 shift register generator configuration

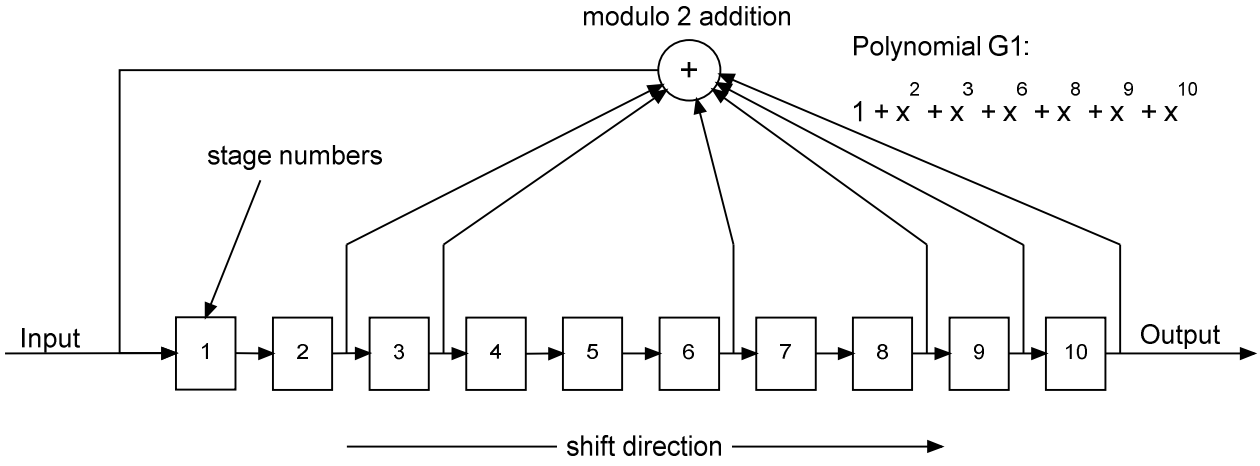

Figure 3: G2 shift register generator configuration

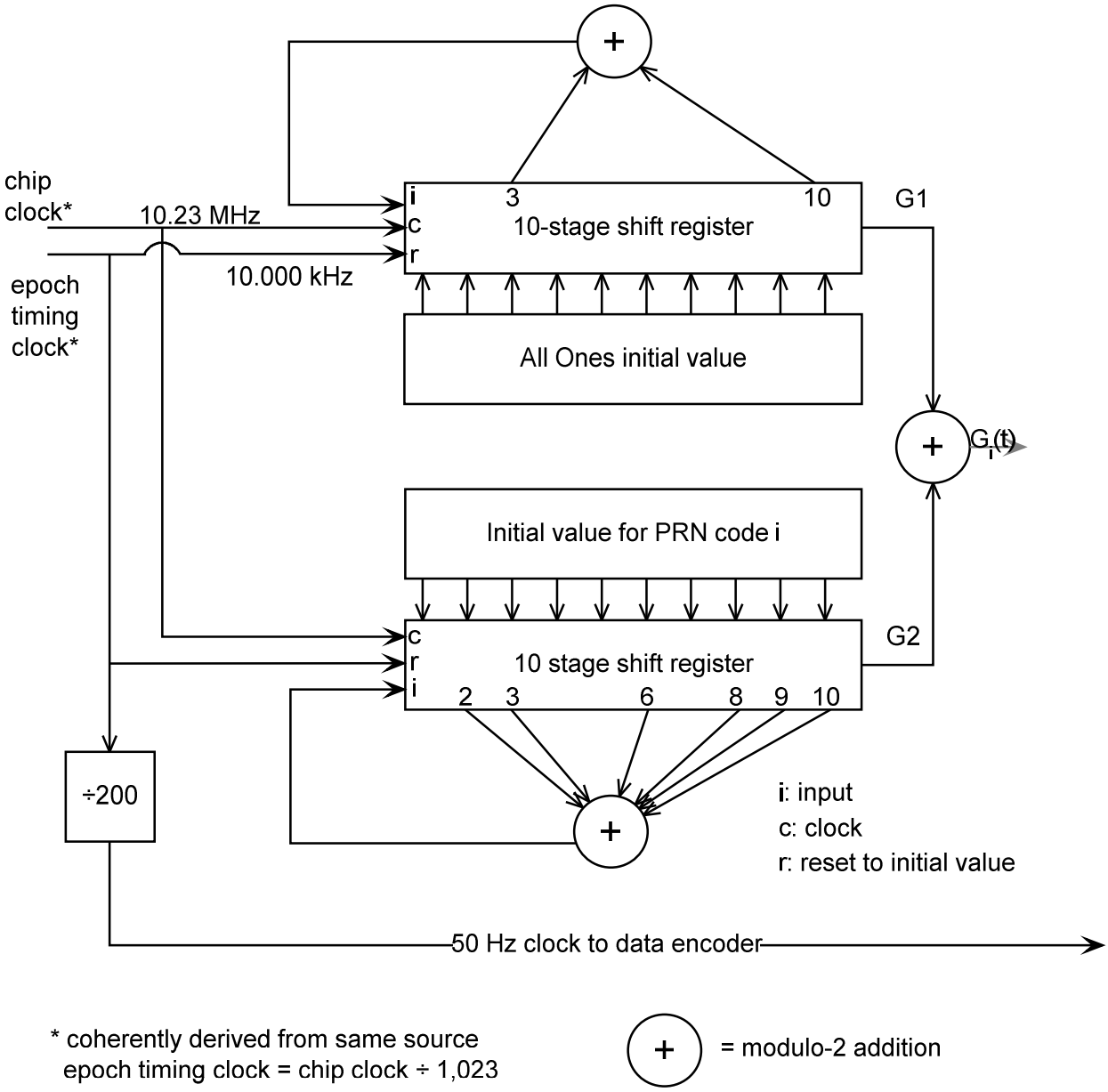

Figure 4: Example C/A-code generation

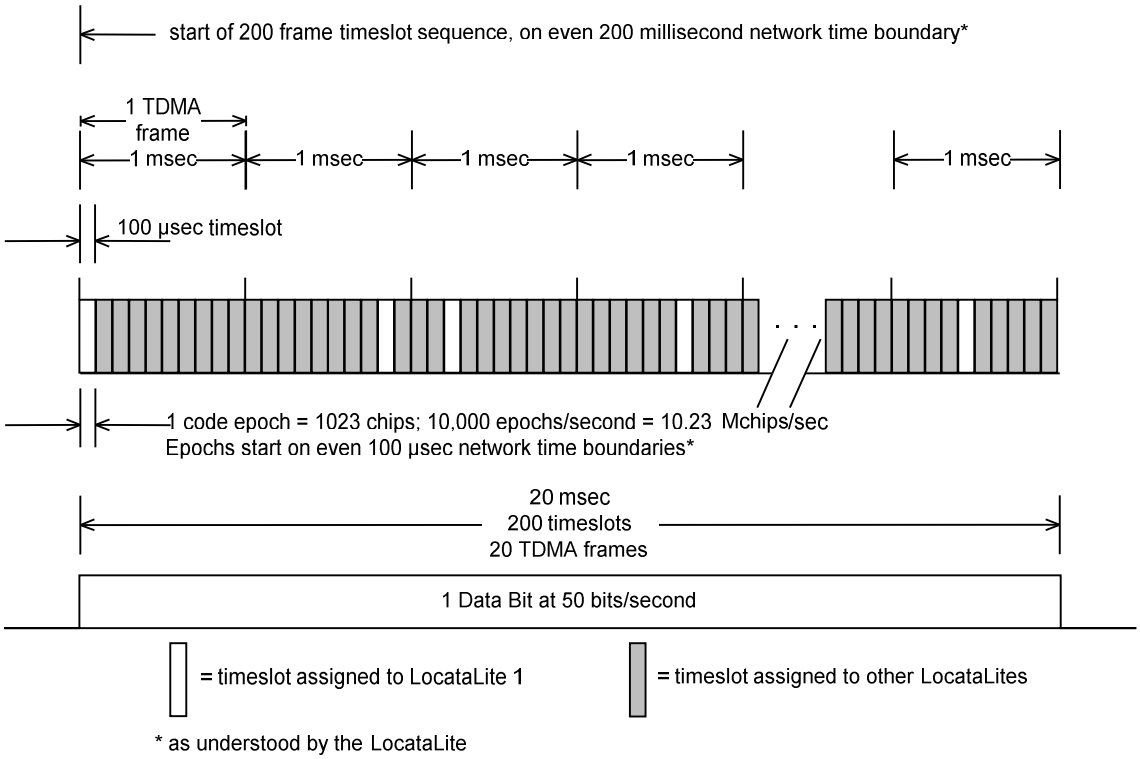

Figure 5, Data, C/A-Code, and Timeslot timing relationships

3.3.2.3 Frequency Mapping

Table 1, Code Phase Assignments includes the mapping of PRNs to transmitters within the Locata System.

3.3.3 Navigation Data

The content and format of the NAV data, D(t) is given in Appendix I: Locata Navigation Data Structure.

3.3.4 Locata Time and LocataLite Z-Count

Each LocataNet has a master LocataLite to which all other LocataLites are synchronized in time and frequency, either directly or indirectly. The master LocataLite may in turn either synchronize itself to an external time base providing a 1 pulse-per-second interface and a serial time stamp message, or remain independent of all external time sources and use its own floating time base.

The process by which a LocataLite synchronizes itself to a reference LocataLite is termed TimeLoc. The TimeLoc synchronization process operates between pairs of LocataLites, a slave and a reference LocataLite. Usually a slave LocataLite will attempt to TimeLoc to the network Master LocataLite as its reference. The Master LocataLite provides the time reference to the entire network. If that is not possible (due for example to visibility constraints), the LocataLite will attempt to synchronize to a LocataLite that is itself synchronized to the network Master LocataLite. LocataLites will choose a LocataLite to

which to TimeLoc that minimizes the number of TimeLoc hops to the Network Master LocataLite. The LocataLite to which a given LocataLite is TimeLoc'd is termed its reference station, which need not be the network master station.

A single TimeLoc synchronization loop between a slave LocataLite and the LocataLite to which it is TimeLoc-referenced maintains clock time within the slave to within a specified tolerance of its reference. The size of this difference is affected by environmental factors, such as multipath and residual tropospheric delays. Table 11 gives the specifications for TimeLoc synchronization quality.

Table 11, TimeLoc synchronization quality, single hop on a clean link

TimeLoc Synchronization Parameter	Value
Maximum phase noise	0.03 cycle (11 psec)* rms
Typical cycle ambiguity	6 cycles (approx 2 nsec)*

*current hardware and network implementations

Normally, local effects due to uncompensated tropospheric delay and multipath will affect the accuracy to which a slave LocataLite can TimeLoc to its reference. The slave knows its surveyed position precisely relative to that of its reference, and can calculate the fractional cycle it should see at its location relative to the reference, adjusting timing as necessary to duplicate it. However, multipath, residual troposphere-induced TimeLoc link delays, and/or signal cross correlations, could cause time biases and the selection of an inappropriate integer cycle count, resulting in integer multiples of one cycle period in timing error. The user is cautioned to employ careful design to minimize the effects of multipath and uncompensated tropospheric delay in deploying a LocataNet.

TimeLoc synchronization to within 2 nanoseconds including the effects of uncompensated tropospheric delay and multipath is typical in deployed networks using standard tropospheric modeling and broad-beam sector LocataLite receive antennas having only moderate discrimination against multipath.

3.3.4.1 GPS Synchronized Time Base

In this mode the master LocataLite synchronizes with GPS in both time and frequency. LocataNet residual time uncertainty relative to GPS time will not exceed 100 nanoseconds.

3.3.4.2 Floating Time Base

In the absence of GPS synchronization the master LocataLite simply counts time from a configurable start point at the rate of its on-board oscillator. In this mode there is no guaranteed time or frequency relationship to any outside source.

3.3.4.3 Time of Week

The time of week, (TOW), represented by 17 bits, is defined as the current incrementing count of 6-second intervals (Subframe interval) since the start of the week. The count is short-cycled such that the range of the TOW-count is from 0 to 403,199 (equaling one week) and is reset to zero at the end of each GPS week. Therefore, the TOW-count's zero state, the

first 6-second interval of the GPS week, applies to the first Subframe interval of the week. This epoch boundary occurs at (approximately) midnight Saturday night-Sunday morning, where midnight is defined as 0000 hours UTC.

On January 1, 1980 GPS time and UTC were coincident. However UTC has accumulated leap seconds since that time at the rate of one every few months to few years to bring it into line with mean solar time, while GPS time is continuous and does not incorporate leap seconds. Therefore over the years the occurrence of the "zero state epoch" may differ by a few seconds from 0000 hours UTC.

The 17-bit TOW is contained in the Time Word (TM) of the NAV data (D(t)) stream.

4. DEFINITIONS AND ACRONYMS

4.1 Definitions

Term	Meaning
Almanac	Collected information on each LocataLite's identity, position, status, and performance, broadcast by all LocataLites, included in Subframe 2
Block	Five successive Frames whose almanac data are devoted to a single LocataLite in the network
Device	LocataLite, in this application
Ephemeris	Identity, position, status, environment, and age information broadcast by each transmitter on itself, included in Subframe 1
Frame	One Subframe 1 followed by one Subframe 2
LocataLite	An emitter within a LocataNet transmitting signals to be used for position and time derivation within the service area. Sometimes known as a LocataLite.
LocataNet	Ensemble of LocataLites and Rovers operating to furnish accurate position and time to Rover-collocated users within the LocataNet's served area
Master LocataLite	LocataLite providing the base timing for the LocataNet, to which all other LocataLites in the LocataNet synchronize, either directly or indirectly. This base timing may be self-generated or obtained from an external reference, such as GPS or an atomic clock.
MET	Meteorological
NAV data	Navigation data incorporated into the data streams transmitted by the LocataLites on S1 and S6 frequencies.
Reference	The LocataLite to which another LocataLite is TimeLoc'd. The Reference may or may not be the Master LocataLite for the LocataNet.
Req	Requirement
Rover	A user operated receiver within a LocataNet deriving position and time from the latter.
Slave LocataLite	LocataLite in a LocataNet that is not the Master LocataLite, and which must TimeLoc to a reference LocataLite for timing.
Subframe	A series of ten 30-bit Words starting with TLM and HOW Words as the first two Words
Sync	Synchronization (referring to time and frequency)

Term	Meaning
TimeLoc	Approach to synchronization to reference LocataLites used by LocataLites within a LocataNet to ensure precise transmission synchronization among all participating LocataLites
Word	30 bits of which the last 6 bits are the results of a parity calculation. A Word may contain one or more items of information

4.2 Acronyms

Acronym	Meaning
AA	Acquisition Assist Word
BPSK	Bi-Phase Shift Key
ECEF	Earth-Centered, Earth-Fixed
GNSS	Global Navigation Satellite System, any of several satellite-based positioning systems
GPS	Global Positioning System, a GNSS system
hPa	Hectopascal. SI unit for measuring atmospheric pressure. Equivalent to 1 millibar of pressure, i.e. 100 newtons/square meter.
Hz	Hertz, SI name for cycles per second
ID	Identification
IOD	Issue of Data
IODE	Issue of Data Ephemeris
IS	Interface Specification
KHz	KiloHertz
LSB	Least Significant Bit
MHz	MegaHertz
MSB	Most Significant Bit
msec	Millisecond: 10^{-3} second
nsec	Nanosecond: 10^{-9} second
NAV	Navigation
Ntwk	Network
P	Parity
psec	Picosecond: 10^{-12} second
PRN	Pseudo-Random Noise
PPS	Pulse Per Second
R	Remainder
RCPI	Receive channel power indicator
RF	Radio Frequency

Acronym	Meaning
RMS	Root Mean Square
RX	Receiver
SF	Subframe
SI	International System of Units, Système International d'unités, internationally agreed system of measurement, the modern form of the metric system
TBD	To be determined
TBR	To be reviewed
TBS	To Be Supplied
TLM	Telemetry Word
TM	Time Word
TOW	Time of Week
TS	Terrestrial Segment, the collection of LocataLites providing positioning signals over a service area
TSF	Tropospheric Scale Factor
TX	Transmitter
US	User Segment:
UTC	Coordinated Universal Time
WGS 84	World Geodetic System 1984, the geodetic reference definition used by the GPS network
WITH	Week IODE TSF Hops: Word 3 of Subframe 1
WN	Week Number
WN_e	Extended Week Number
µs	Microsecond: 10^{-6} second

5. APPENDIX I: LOCATA NAVIGATION DATA STRUCTURE

5.1 Scope

This appendix describes the specific LocataNet navigation (NAV) data structure denoted as D(t).

5.2 Requirements

5.2.1 Data Characteristics

The data streams superimposed on the C/A codes on the S1 and S6 channels operate at a rate of 100 bits per second. Data transitions are synchronous with 1 second boundaries every 100 data bits.

5.2.2 Message Structure

As shown in Figure 6, the message structure is made up of successive Blocks of data. Each Block includes a variable number of Frames depending on the number of almanac pages transmitted per LocataLite. Each Frame contains complete network-level data, data on the transmitting LocataLite, and almanac data for a single LocataLite within the network to which the Subframe 2 of this Block is devoted. Succeeding Blocks for which Subframe 2 describes the same LocataLite increment the Subframe 2 Page number used in succeeding Frames until completing all Pages for the almanac for that LocataLite. Succeeding Blocks will substitute almanac data for succeeding LocataLites in the network in turn.

The transmitter will require (N*P/5) minutes to transmit the almanac data for all N LocataLites in the network, where P is the number of Subframe 2 pages per LocataLite almanac, before restarting the sequence. If for example the network is transmitting two almanac pages per LocataLite, a Block containing all the almanac data for a LocataLite will take 24 seconds to transmit. These times will double when sending the NAV data at 50 bits per second.

Each Frame, 1200 bits long, includes one 600-bit Subframe 1 followed by a single 600-bit Subframe 2 (a “Page” of Subframe 2) providing almanac data for a LocataLite in the network. Successive Subframe 2s describing the almanac for a given LocataLite are referred to as the successive Pages of Subframe 2 for that LocataLite, where each page for an almanac contains distinct information contributing to the body of almanac data for the LocataLite to which it refers. The complete almanac for a LocataLite is transmitted in successive contiguous Frames, each containing the next applicable Page in sequence for the described LocataLite’s almanac, until completing transmission of all almanac Pages for that LocataLite.

For this release of the ICD, only Pages 1 and 2 of Subframe 2 are defined, and networks using this ICD transmit only the first two Pages of Subframe 2 for each LocataLite. Future editions of this ICD may define more Subframe 2 Pages.

Each Subframe consists of twenty Words, each 30 bits long. Word transmission always starts with the most significant bit (MSB). All Subframes with the same Page number have the

same format, but will contain different data for different values of N, i.e. different LocataLite identities as cited in Word 4 of every Subframe 2 Page, to which the almanac refers. All Subframes 1 from a given transmit signal are identical until parameters for that LocataLite change.

All of Subframe 1 and Words 1-3 of Subframe 2 are always devoted to characteristics of the specific transmitter on which the data stream rides or to overall network characteristics. These fields contain frequently repeated data important for rapid acquisition and tracking. Since a LocataLite can have up to four transmit signals, two at frequency S1 and two at frequency S6, Subframe 1 will differ for each of the four transmitted signals emitted by the LocataLite.

Figure 6 through Figure 8 show the relationships between LocataLites, Frames, and Subframes, including the manner in which Subframes 1 and Subframes 2 are interleaved, how LocataLite identities in Subframes 2 succeed each other among Frames, and how Subframes 1 are assigned to LocataLite transmitters. The upper three lines of the figures show how Subframe 2 two-frame Blocks, which give complete almanac data on a LocataLite, sequence through successive LocataLites in the network. A given LocataLite normally staggers Almanac transmission timing among LocataLites to speed acquisition, as described in paragraph 5.2.3.5.[6]

[6] Note that if in future more Pages (total P) are used in Subframe 2 to describe the almanac of a network LocataLite, the Block size will increase to 2P in size, alternating between Subframe 1 and the incrementing Pages in Subframe 2.

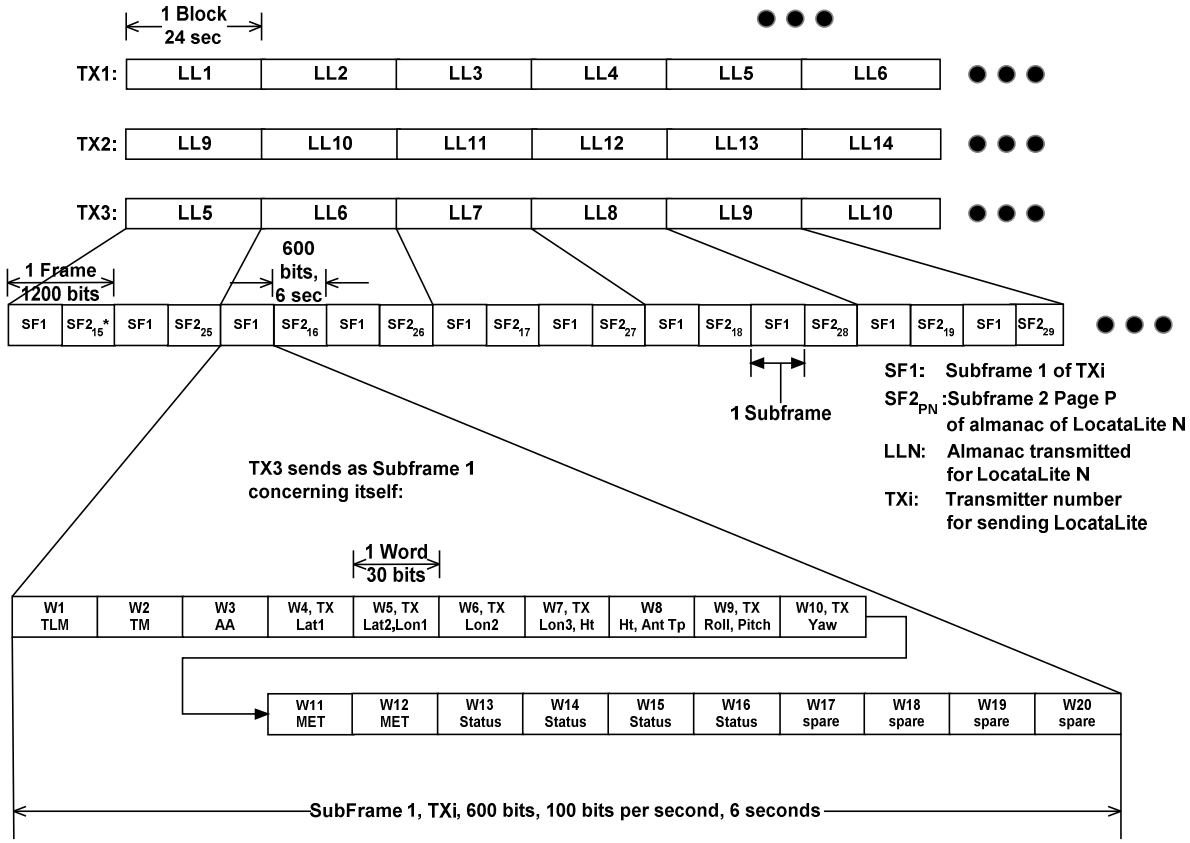

Figure 6, Blocks, Frames and Subframe 1 relationships and timing

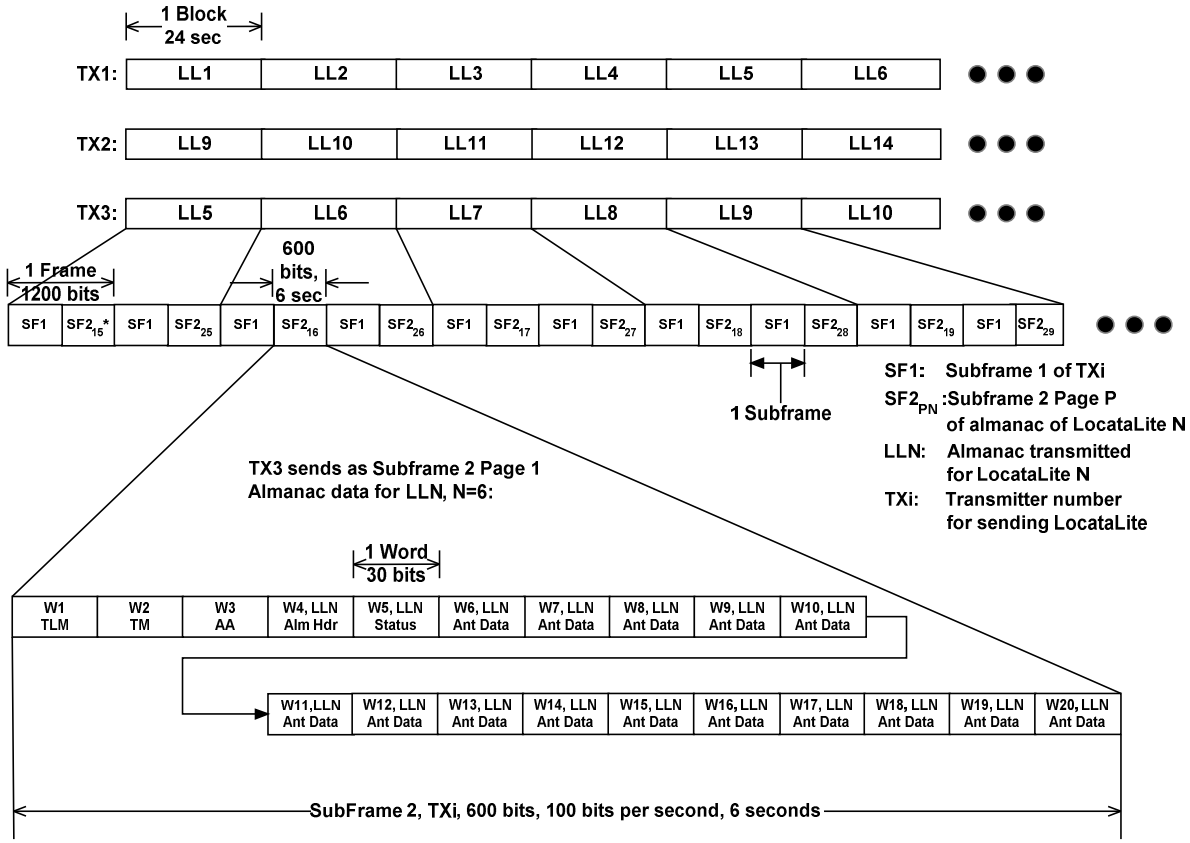

Figure 7, Blocks, Frames and Subframe 2 Page 1 relationships and timing

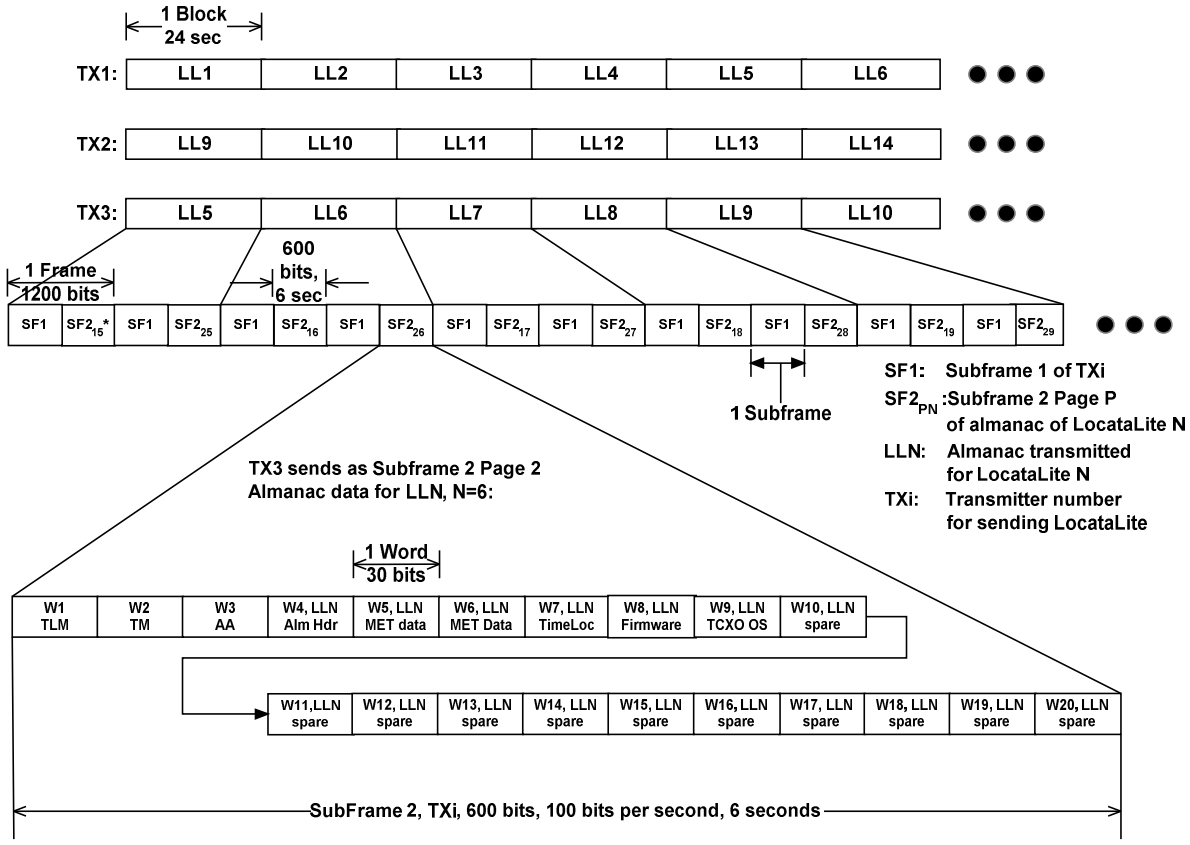

Figure 8, Blocks, Frames and Subframe 2 Page 2 relationships and timing

5.2.3 Message Content

Each Subframe contains a telemetry (TLM) Word, a time (TM) Word, and an Acquisition Assist (AA) Word as Words 1-3 respectively. Seventeen more Words follow these three Words in each Subframe, for a total of 20 Words per Subframe.

Each Word in each Frame ends with a two bit remainder followed by 6 parity bits. The two-bit remainder is always chosen to ensure that the 6 parity bits calculated over the 24-bit contents of the Word end in binary 00. Each Word therefore ends in two zero values, yielding an opportunity with each Word to check on reception for data bit inversions.

The format and contents of the TLM, TW, and AA Words, as well as those of Words three through ten of each Subframe/Page, are described in the following sub-sections. The timing of the Subframes and Pages is covered in Section 5.2.4.

Further editions of this ICD will expand Subframes 1 and 2 to include additional information as conventions for it are developed. Such information could for example include additional data reflecting network integrity.

5.2.3.1 Telemetry Word (TLM)

Each TLM Word is 30 bits long, occurs every 6 seconds in the data Frame (when D(t) operates at 100 bps), and is the first Word in each Subframe. Table 12, Definition of Telemetry Word shows the format of the TLM Word. Bit 1 is transmitted first. Each TLM Word begins with a preamble, followed by the TLM message, the remainder, and six parity bits. The TLM message consists of the elements shown in Table 12.

Table 12, Definition of Telemetry Word

Word 1, Telemetry Word					
Field	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Preamble	1	8	8	8	Same as GPS Preamble. Used for Sync and Data Inversion detection. Value 10001011, MSB first
LocataNet ID	9	11	3	11	The identification of the network to which this LocataLite belongs
LocataLite ID	12	19	8	19	Identity of this LocataLite
LocataLite Signal ID	20	21	2	21	The channel number for this transmit signal Number — Meaning 00 — LocataLite signal A: frequency 1, transmitter 1 01 — LocataLite signal B: frequency 2, transmitter 1 10 — LocataLite signal C: frequency 1, transmitter 2 11 — LocataLite signal D: frequency 2, transmitter 2
spare	22	22	1	22	
Remainder	23	24	2	24	Solved for bits to preserve parity check with zeroes in bits 29 and 30.
Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

5.2.3.2 Time Word (TM)

The TM is 30 bits long and is the second Word in each Subframe/page, immediately following the TLM Word. A TM occurs every 6 seconds in the data Frame (when D(t) operates at 100 bps). Table 13, Definition of Time Word shows the format and content of the TM. The MSB for any Word is transmitted first.

The TM begins with the 17 MSBs of the time-of-week (TOW) count. These 17 bits correspond to the TOW-count at the start (leading edge) of the next following Subframe. The fields of the TM are shown in Table 13.

Table 13, Definition of Time Word

Word 2, Time Word					
Field	**Start Bits**	**End Bit**	**Bits Used**	**Running Total**	**Notes**
Time of Week	1	17	17	17	Time of week count at the start (leading edge) of the next following Subframe, as specified in Reference 1 paragraph 20.3.3.2.
Subframe ID	18	18	1	18	Identifies this Subframe type 0 – Subframe 1 1 – Subframe 2
LocataNet external sync status	19	19	1	19	External time source synchronization status 0 – not synchronized to an external time source 1 – synchronized to an external time source This status information applies to the entire LocataNet identified in the TLM Word. LocataLites broadcast 0 in this field until it either achieves synchronization with an external time source or receives notification from another LocataLite that the network is externally time synchronized.
LocataLite Health	20	20	1	20	Indicates the health of the transmitting LocataLite 0 – unhealthy 1 - healthy
Spare	21	22	2	22	
Remainder	23	24	2	24	Solved for bits to preserve parity check with zeroes in bits 29 and 30.
Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

5.2.3.3 Acquisition Assist Word (AA)

The AA is 30 bits long and is the third Word in each Subframe/Page, immediately following the TM Word. An AA occurs every 6 seconds in the data Frame (with D(t) operating at 100 bps). Table 14 shows the format and content of the AA. The AA begins with week number as defined in Reference 1 paragraph 3.3.4. The fields of the AA are shown in Table 15.

Table 14, Definition of Acquisition Assist Word

Word 2, Time Word					
Field	**Start Bits**	**End Bit**	**Bits Used**	**Running Total**	**Notes**
Week Number	1	10	10	10	Week number as specified in Reference 1
LocataNet size	11	13	3	13	See Table 15, Acquisition Assist Parameters
Neighbor LocataLite ID	14	21	8	21	See Table 15, Acquisition Assist Parameters
Spare	22	22	1	22	
Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30.
Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Week numbers are synchronized to the original GPS week number, and count from 0 to 1023 before rolling over to zero. Week zero started on 00:00:00 UTC 6 January 1980 and rolled over to zero again at 23:59:47 UTC on 21 August, 1999. Weeks increment at 00:00:00 GPS time Sunday morning each week. As for a normal week, a GPS week contains 604,800 seconds (7 days).

Table 15, Acquisition Assist Parameters

Acquisition Assist Parameters				
Parameter	**No. of Bits**	**Scale Factor**	**Effective Range**	**Units**
LocataNet size	3	$240*2^N$	**Value** / **Scaled value** / **Chips** 0 / 240 / 8 1 / 480 / 16 2 / 960 / 32 3 / 1920 / 64 4 / 3840 / 128 5 / 7680 / 256 6 / 15360 / 512 7 / 30720 / 1024	Meters
Neighbor LocataLite ID	8	1	LocataLite ID of one of the 8 closest LocataLite in proximity to the LocataLite providing this ephemeris. - In Subframe 1 the LocataLite ID cycles between the 1 - 4 closest LocataLites. (Repeats Every 48 seconds for D(t) at 100 bps) - In Subframe 2 the LocataLite ID cycles between the 5 - 8 closest LocataLites. (Repeats Every 48 seconds for D(t) at 100 bps) If the LocataLite has no information to populate this field, it will broadcast its own LocataLite ID in this field. The LocataLite will cycle through the shortened list if fewer than 8 LocataLites are known, in which case the list will repeat in fewer than 48 sec.	Integer ID

5.2.3.4 Subframe 1

Figure 9 and Figure 10 show the layout of Subframe 1. The content of Words three through twenty of Subframe 1 are defined in Table 16 through Table 19 below, followed by related algorithms and material pertinent to the data.

5.2.3.4.1 Subframe Content

The fourth through twentieth Words of Subframe 1 each contain six parity bits as the 6 LSBs for the Word. In addition, bits 23 and 24 of all Words are non-information bearing bits used to ensure that the last two parity bits of the Word are zeros. The remaining 352 bits within Words 4 through 20 contain data specific to the transmitted signal or to the transmitting LocataLite and spare bits. This data is analogous to the GPS space vehicle ephemeris data.

The ephemeris information describes the location and orientation of the transmit antenna broadcasting the signal, an issue of ephemeris (IODE) term, temperature, pressure and humidity at the LocataLite, and LocataLite health and status. The IODE provides the user with a convenient means for detecting any change in the ephemeris data, since any change to the information in Subframe 1 will be accompanied by a change in the IODE.

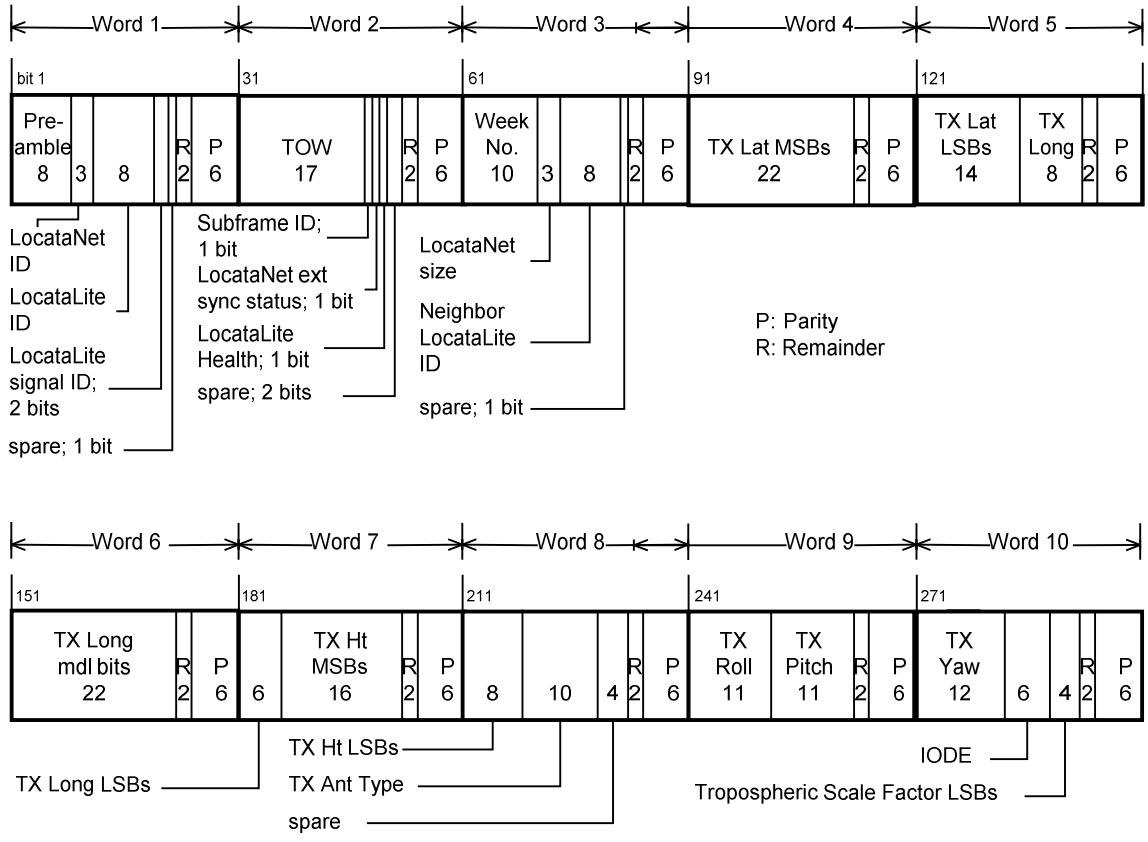

Figure 9, Subframe 1 layout, Words 1-10

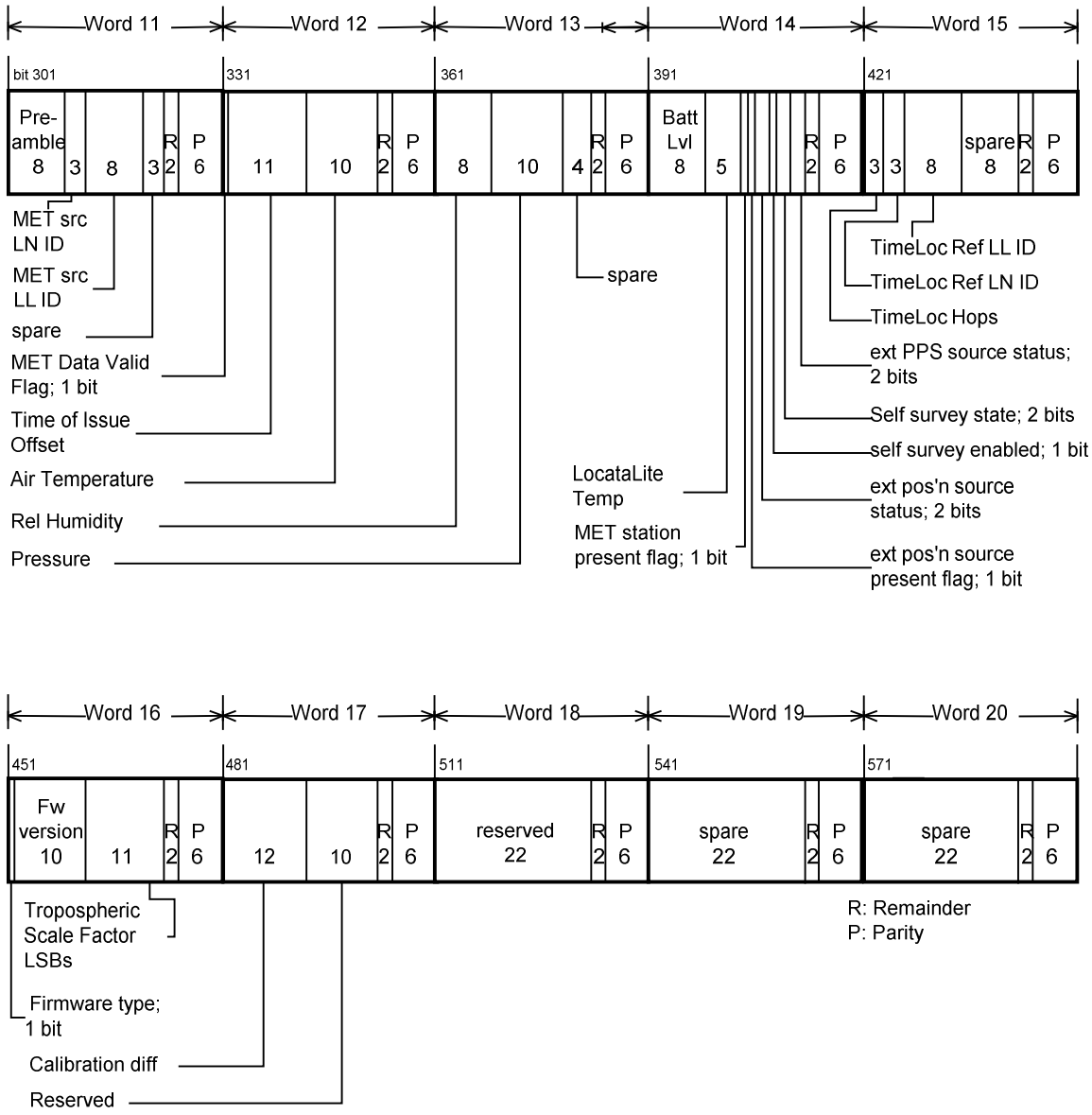

Figure 10, Subframe 1 layout, Words 11-20

Table 16, Definition of Subframe 1, Words 4-8

Subframe 1 Words 4 through 8						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Words 4-8, Ephemeris Words - Position						
Word 4	TX Latitude bits 1-22	1	22	22	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 5	TX Latitude bits 23 -36	1	14	14	14	See Table 21, Subframe 1 parameters
	TX Longitude bits 1- 8	15	22	8	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 6	TX Longitude bits 9-30	1	22	22	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 7	TX Longitude bits 31-36	1	6	6	6	See Table 21, Subframe 1 parameters
	TX Height bits 1-16	7	22	16	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 8	TX Height 17-24	1	8	8	8	See Table 21, Subframe 1 parameters
	TX Antenna type	9	18	10	18	See Table 21, Subframe 1 parameters
	Spare	19	22	4	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Table 17, Definition of Subframe 1, Words 9-12

Subframe 1 Words 9 through 12						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Words 9-10, Ephemeris Words - Orientation						
Word 9	TX Roll bits 1-11	1	11	11	11	See Table 21, Subframe 1 parameters
	TX Pitch bits 1-11	12	22	11	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 10	TX Yaw bits 1-12	1	12	12	12	See Table 21, Subframe 1 parameters
	IODE	13	18	6	18	See Table 21, Subframe 1 parameters
	Tropospheric Scale Factor (LSBs)	19	22	4	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 11, Secondary Preamble and Meteorological Information						
Word 11	Secondary Preamble	1	8	8	8	11011101
	MET source LocataNet ID	9	11	3	11	The LocataNet ID applicable to this MET data
	MET source LocataLite ID	12	19	8	19	The LocataLite ID applicable to this MET data
	Spare	20	22	3	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 12-13, Meteorological Information (continued)						
Word 12	Met Data Valid Flag	1	1	1	1	1: valid 0: invalid
	Time of Issue Offset	2	12	11	12	See Table 21, Subframe 1 parameters
	Air Temperature	13	20	10	20	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Table 18, Definition of Subframe 1, Words 13-14

Subframe 1 Words 13 through 14						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Words 13, Meteorological Information (continued)						
Word 13	Relative Humidity	1	8	8	8	See Table 21, Subframe 1 parameters
	Atmos Pressure	9	18	10	18	See Table 21, Subframe 1 parameters
	Spare	17	22	6	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Words 14, Status and Health						
Word 14	LocataLite battery level	1	8	8	8	See Table 21, Subframe 1 parameters
	LocataLite temperature	9	13	5	13	See Table 21, Subframe 1 parameters
	MET station present flag	14	14	1	14	1: MET station present 0: MET station not present
	External position source present flag	15	15	1	15	1: External Position Source Available 0: External Position Source Unavailable
	External position source status	16	17	2	17	00: no solution 01: standard code solution 10: Differential code solution 11: RTK solution
	Self Survey Enabled flag	18	18	1	18	0: Self survey disabled 1: Self survey enabled
	Self Survey State	19	20	2	20	00: self survey bad quality 01: self survey in progress 10: self survey complete 11: self survey movement detected
	External PPS Source Status	21	22	2	22	00: no external PPS available 01: ext PPS available, but bad health 10: ext PPS available w/ good health, not in use 11: ext PPS available w/ good health, in use
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Table 19, Definition of Subframe 1, Words 15 through 17

Subframe 1 Words 15 through 17						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Words 15-16, Status and Health (continued)						
Word 15	TimeLoc Hops	1	3	3	3	0-7; 0 means this LocataLite is the master
	TimeLoc Reference LocataNet ID	4	6	3	6	LocataNet ID to which this LocataLite is TimeLoc'd
	TimeLoc Reference LocataLite ID	7	14	8	14	LocataLite ID to which this LocataLite is TimeLoc'd
	Spare	15	22	8	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 16	LocataLite Firmware Type	1	1	1	1	1: Released 0: non-released
	LocataLite Firmware Version	2	11	10	11	Firmware number 0-1023
	Tropospheric Scale Factor LSBs	12	22	11	22	See Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Words 17, Calibration Differences						
Word 17	Calibration diff	1	12	12	12	See Table 21, Subframe 1 parameters If transmitter A sending: not used; value 0x000 If transmitter B sending: A-B If transmitter C sending: A-C If transmitter D sending: A-D
	Reserved	13	22	11	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Table 20, Definition of Subframe 1, Words 19 through 20

Subframe 1 Words 18 through 20						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Word 18, Reserved						
	Reserved	1	22	22	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 19 and 20, spare						
Word 19	spare	1	22	22	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 20	Spare	1	22	22	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

5.2.3.4.2 Subframe 1 Parameter Characteristics

Table 21 specifies the number of bits, the scale factor of the LSB (the last bit received), the range and the units for selected parameters contained in Subframe 1.

Table 21, Subframe 1 parameters

Subframe 1 Parameters				
Parameter	**No. of Bits**	**Scale Factor**	**Effective Range**	**Units**
Air Temperature	10	0.1	-45 (0x000) to 57.3 (0x3FF)	°C
Calibration Diff	12	0.5	0 – 2047 in increments of 0.5; distance by which phase of first transmitter cited leads second transmitter cited:	mm
IODE	6	1	0-63 cyclically incremented when ephemeris is changed and with each power cycle. A new IODE value prompts re-reading the ephemeris values for any changes	Integer
LocataLite Battery Level	8	0.1	9.0 (0x00)-30.0 (0xD2)	Volts
LocataLite Temperature	5	4	-20 (0x0) to 104 (0xF)	Degrees Centigrade
Pressure	10	1	75 (all 0's) to 1098 (all 1's)	hPa
Relative Humidity	8	0.4	0 (0x00) to 100 (0xFA)	Percent
Time of Issue Offset	11	12	0 (0x00)-24564 ((0x7FF)	seconds
TimeLoc Hops	3	1	0-7, number of hops from this LocataLite to the TimeLoc Master	Integer
Tropospheric Scale Factor	15		discretionary	
TX Antenna Type	10	1	Coded identifiers for transmit antenna (TBD)	integer
TX Height	24	10^{-3}	-6000 (0x000000) to 10777.215 (0xFFFFFF) relative to WGS-84 geoid	meters
TX Latitude	36	10^{-10}	0 – π (value cited here is WGS-84 latitude plus π/2)	Radians
TX Longitude	36	10^{-10}	0 - 2π proceeding East of WGS-84 prime meridian	Radians
TX Pitch	11	0.1	+/-90	degrees
TX Roll	11	0.1	+/-90	degrees
TX Yaw	12	0.1	+/-180	degrees

5.2.3.4.3 Subframe 1 User Algorithms

5.2.3.4.3.1 TimeLoc Hops

The TimeLoc Hops integer gives the total number of RF hops from this LocataLite to the Master LocataLite to which the network is synchronized. If this LocataLite is the Master, this value will be zero. If this LocataLite is synchronized by a direct RF link to a Master, this value will be 1. If this LocataLite is synchronized to a LocataLite, which in turn is synchronized by direct RF link to a Master, this value will be 2, and so on. This will enable determination of the total path length over which synchronization occurs for a given LocataLite, in order to aid in scaling path-length dependent effects such as residual uncompensated tropospheric delays.

5.2.3.4.3.2 Tropospheric Data

Some LocataLites may be equipped with a meteorological station sensing atmospheric temperature, pressure, and relative humidity. If the transmitting LocataLite is so equipped, it transmits the measured atmospheric values its transmitted Subframe 1 along with the age of those values. It is left to the user to apply the tropospheric pressure, temperature, relative humidity, and age characteristics to an appropriate model to determine tropospheric contributions to path delay.

Note that the Tropospheric Data transmitted in Subframe 2 Pages is for the LocataLite Device ID identified in Subframe 2, Page 1, Word 4, and not for the transmitting LocataLite.

5.2.3.4.3.3 Tropospheric Scale Factor

The tropospheric scale factor is used to reduce residual tropospheric induced path delay after application of the tropospheric model.

5.2.3.5 Subframe 2

Each page of Subframe 2 contains different specific data in Words four through twenty. Page data field descriptions are followed by more details where needed on parameters and algorithms.

5.2.3.5.1 Subframe 2 Relative Timing

As described in Section 5.2.2, from one to seven successive Frames describe the almanac for each LocataLite in the network. Present implementations use two Pages of Subframe 2 to describe each LocataLite. In this case 2*N Frames are needed to describe all LocataLites in the network.

The four transmitters in each LocataLite may offset the LocataLite almanacs described in their Frames in time in such a way that each of the four transmitters is sending almanac data for a different LocataLite at a given time. This enables a receiver to gather almanac information on all LocataLites in the network in the smallest amount of time. Since each Subframe identifies the LocataLite to which it pertains, Subframe 2 pages can be allocated dynamically to LocataLites as needed in order to distribute information on the network in an efficient manner.

5.2.3.5.2 Subframe 2 Content

Words 4 through 20 of each page contain six parity bits as the Word's LSBs. In addition, bits 23 and 24 of all Words are non-information bearing bits used to ensure that the last two parity bits of the Word are zeros. Parity is calculated following the description given in Reference 1 paragraph 20.3.5.

Words 1 through 3 are the same as in Subframe 1. The following sub sections and Figure 11 through Figure 13 describe the data contained in Words 4 through 20 of the two Pages in Subframe 2.

In future implementations, this ICD may define additional Pages in Subframe 2 for disseminating network information. If used, these pages would contain the same data in Words 1 through 4 and in the first 8 bits of Word 11 as used in Pages 1 and 2.

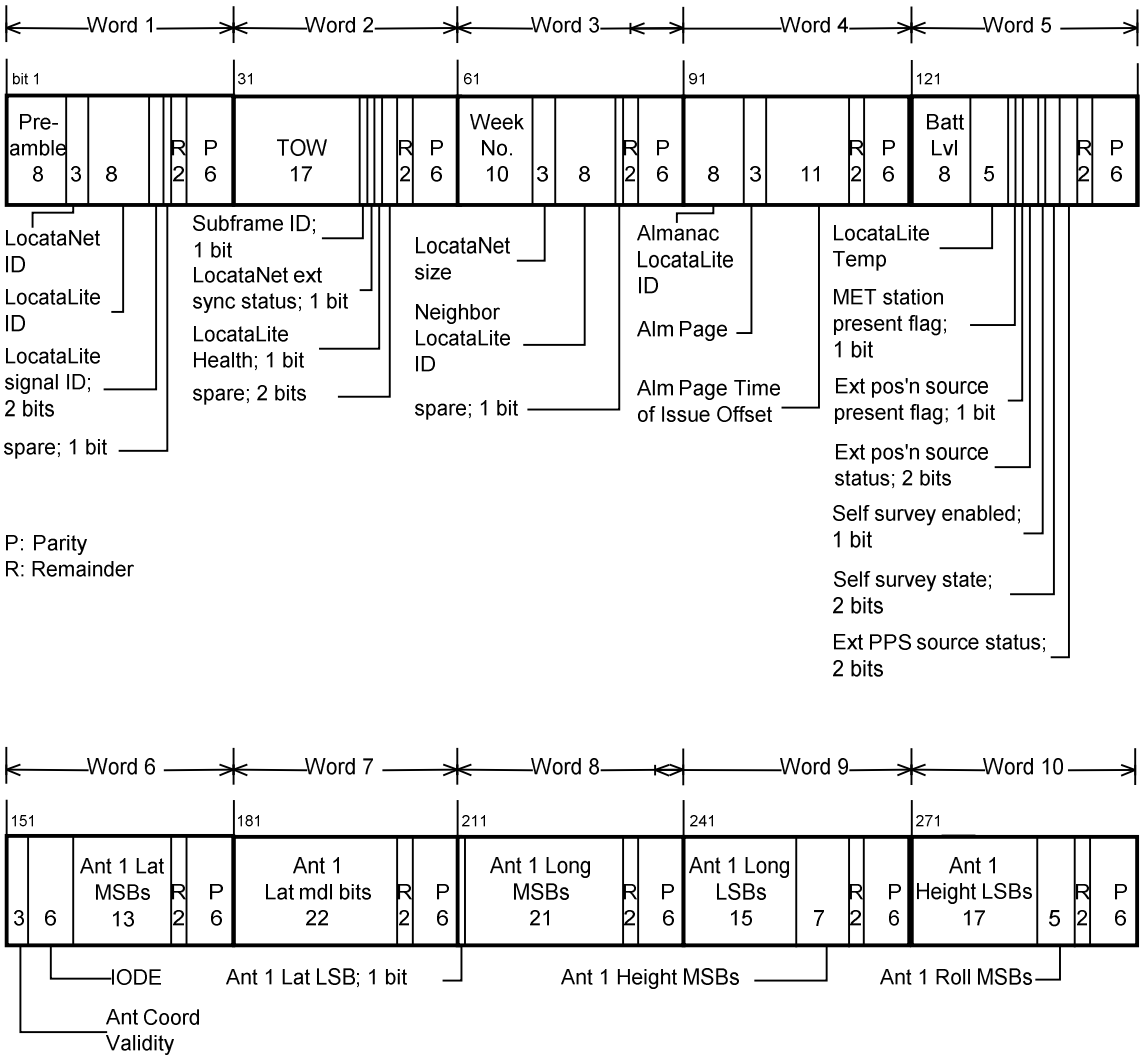

Figure 11, Layout of Subframe 2, Page 1, Words 1-10

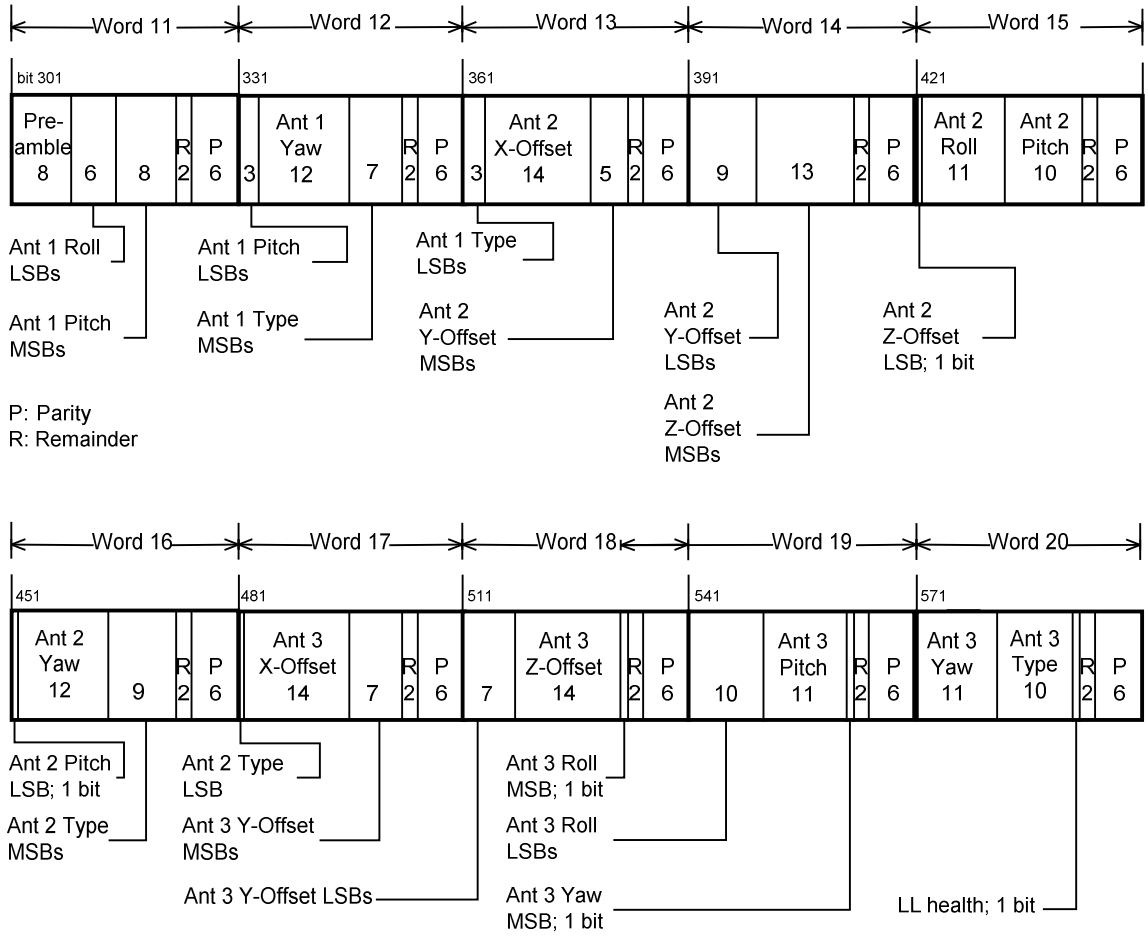

Figure 12, Layout of Subframe 2, Page 1, Words 11-20

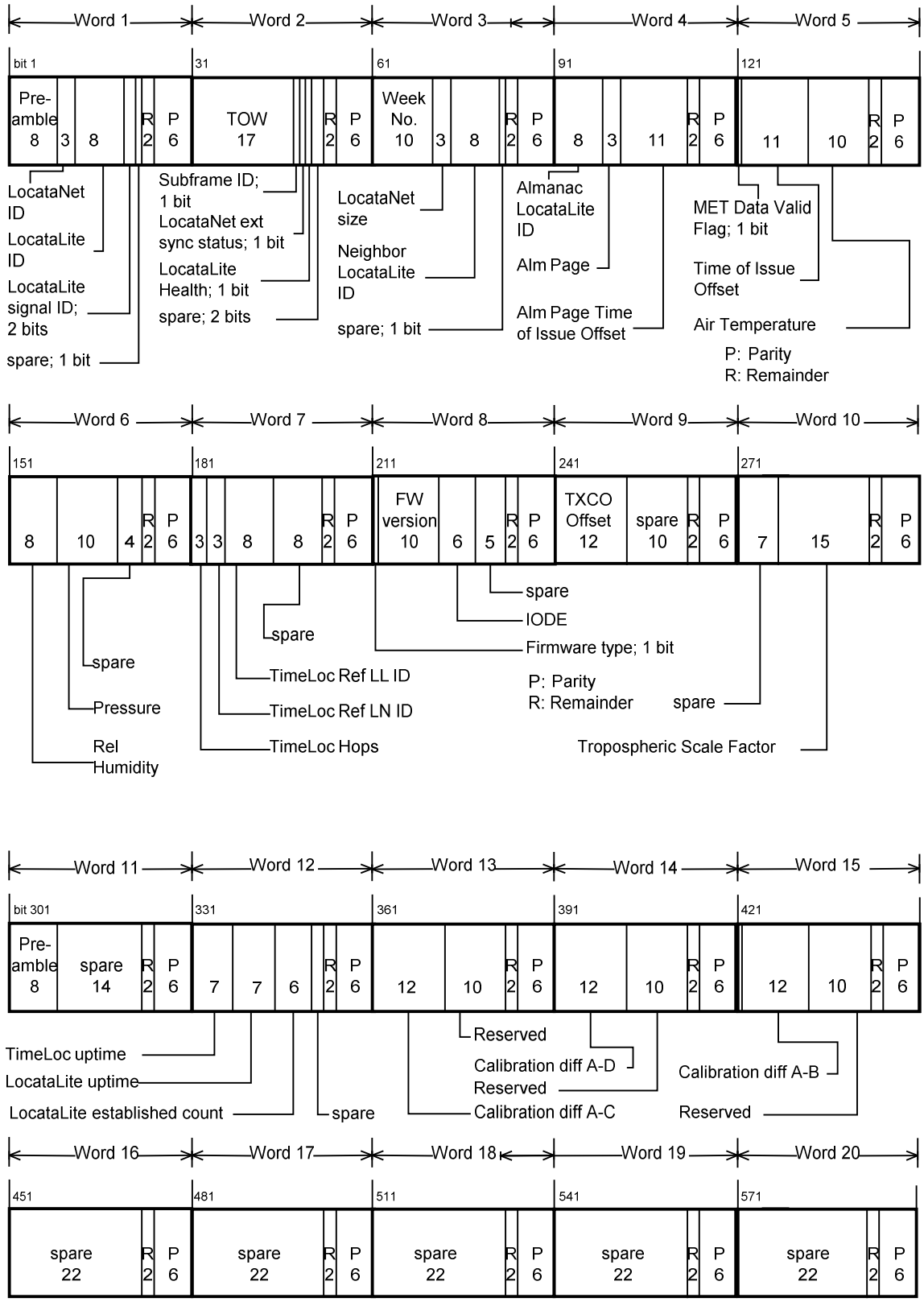

Figure 13, Layout of Subframe 2, Page 2, Words 1-20

5.2.3.5.2.1 Subframe 2 Word 4

Table 22 shows the field structure of Word 4 of Subframe 2. This Word is common to all pages of Subframe 2 and contains the LocataLite ID, LocataNet ID, and almanac age for the LocataLite described by the almanac data in the Subframe.

Table 22, Definition of Subframe 2 Word 4

Subframe 2, Word 4 — Common to All Pages						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Running Bit Total**	**Notes**
Word 3, LocataLite Flags						
Word 4	Almanac LocataLite ID	1	8	8	8	Numeric identifier of LocataLite to which the almanac pertains
	Almanac page ID	9	11	3	11	Page ID of the following almanac data; 0-7
	Almanac data time of issue offset	12	22	11	22	See “Time of Issue Offset”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

5.2.3.5.2.2 Subframe 2 Page 1 Words 5 - 20

Table 23 through Table 28 describe the fields in Words 5 - 20 in Subframe 2 Page 1.

Table 23, Definition of Subframe 2, Page 1, Word 5

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Word 5, Health and Status						
Word 5	LocataLite Battery Level	1	8	8	8	See “LocataLite Battery Level”, Table 21, Subframe 1 parameters
	LocataLite temperature	9	13	5	13	See “LocataLite temperature”, Table 21, Subframe 1 parameters
	MET station present flag	14	14	1	14	1: MET station present 0: MET station not present
	External position source present flag	15	15	1	15	1: External Position Source Available 0: External Position Source Unavailable
	External position source status	16	17	2	17	00: no solution 01: standard code solution 10: Differential code solution 11: RTK solution
	Self Survey enabled Flag	18	18	1	18	0: Self Survey disabled 1: Self Survey enabled
	Self Survey State	19	20	2	20	00: self survey bad quality 01: self survey in progress 10: self survey complete 11: self survey movement detected
	External PPS Source Status	21	22	2	22	00: no external PPS available 01: external PPS available, but bad health 10: external PPS available with good health, not in use 11: external PPS available with good health, in use
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 24, Definition of Subframe 2, Page 1, Words 6-8

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Word 6, Device and Validity						
Word 6	Antenna Coordinate Validity	1	3	3	3	See Table 33, Antenna Coordinate Validity Meanings
	IODE	4	9	6	9	See “IODE”, Table 21, Subframe 1 parameters
	Antenna 1 Latitude (MSBs)	10	22	13	22	See “TX Latitude”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Words 7-8, Antenna Details						
Word 7	Antenna 1 Latitude (middle bits)	1	22	22	22	See “TX Latitude”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5
Word 8	Antenna 1 Latitude (LSB)	1	1	1	1	See “TX Latitude”, Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 Longitude (MSBs)	2	22	21	22	See “TX Longitude”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1paragraph 20.3.5.

Table 25, Definition of Subframe 2, Page 1, Words 9-11

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 9-11, Antenna Details (continued)						
Word 9	Antenna 1 Longitude (LSBs)	1	15	15	15	See “TX Longitude”, Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 height (MSBs)	16	22	7	22	See “TX Height”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 10	Antenna 1 height (LSBs)	1	17	17	17	See “TX Height”, Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 Roll (MSBs)	18	22	5	22	See “TX Roll”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 11	Secondary Preamble	1	8	8	8	11011101
	Antenna 1 Roll (LSBs)	9	14	6	14	See “TX Roll”, Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 Pitch (MSBs)	15	22	8	22	See “TX Pitch”, Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 26, Definition of Subframe 2, Page 1, Words 12-14

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 12-14, Antenna Details (continued)						
Word 12	Antenna 1 Pitch (LSBs)	1	3	3	3	See "TX Pitch", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 Yaw	4	15	12	15	See "TX Yaw", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 1 Type (MSBs)	16	22	7	22	See "TX Antenna Type", Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 13	Antenna 1 Type (LSBs)	1	3	3	3	See "TX Antenna Type", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 2 X-Offset	4	17	14	17	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 2 Y-Offset (MSBs)	18	22	5	22	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5
Word 14	Antenna 2 Y-Offset (LSBs)	1	9	9	9	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 2 Z-Offset (MSBs)	10	22	13	22	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1, paragraph 20.3.5

Table 27, Definition of Subframe 2, Page 1, Words 15-17

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 15-17, Antenna Details (continued)						
Word 15	Antenna 2 Z-Offset (LSB)	1	1	1	1	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 2 Roll	2	12	11	12	See "TX Roll", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 2 Pitch (MSBs)	13	22	10	22	See "TX Pitch", Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 16	Antenna 2 Pitch (LSB)	1	1	1	1	See "TX Pitch", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 2 Yaw	2	13	12	13	See "TX Yaw", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 2 Type	14	22	9	22	See "TX Antenna Type", Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 17	Antenna 2 Type (LSB)	1	1	1	1	See "TX Antenna Type", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 3 X-Offset	2	15	14	15	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 3 Y-Offset (MSBs)	16	22	7	22	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 28, Definition of Subframe 2, Page 1, Words 18-20

Subframe 2, Page 1						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 18-20, Antenna Details (continued)						
Word 18	Antenna 3 Y-Offset (LSBs)	1	7	7	7	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 3 Z-Offset	8	21	14	21	See "Antenna N X/Y/Z-Offset", Table 34, Subframe 2 Parameters for bit interpretation
	Antenna 3 Roll (MSB)	22	22	1	22	See "TX Roll", Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 19	Antenna 3 Roll (LSBs)	1	10	10	10	See "TX Roll", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 3 Pitch	11	21	11	21	See "TX Pitch", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 3 Yaw (MSB)	22	22	1	22	See "TX Yaw", Table 21, Subframe 1 parameters for bit interpretation
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 20	Antenna 3 Yaw (LSBs)	1	11	11	11	See "TX Yaw", Table 21, Subframe 1 parameters for bit interpretation
	Antenna 3 Type	12	21	10	21	See "TX Antenna Type", Table 21, Subframe 1 parameters for bit interpretation
	LocataLite Health	22	22	1	22	0: unhealthy 1: healthy
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

5.2.3.5.2.3 Subframe 2 Page 2 Words 5 - 20

Table 29 through Table 32 describe the fields in Words 5 - 20 in Subframe 2 Page 2. Future editions of this specification will include additional integrity monitoring data in the reserved fields of this page.

Table 29, Definition of Subframe 2, Page 2, Words 5-6

Subframe 2, Page 2						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 5-6, Meteorological Information						
Word 5	Met Data Valid Flag	1	1	1	1	1: valid 0: invalid
	Met Data Time of Issue Offset	2	12	11	12	See "Time of Issue Offset", Table 21, Subframe 1 parameters
	Air Temperature	13	22	10	22	See "Air Temperature", Table 21, Subframe 1 parameters
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 6	Relative Humidity	1	8	8	8	See "Relative Humidity", Table 21, Subframe 1 parameters
	Pressure	9	18	10	18	See "Pressure", Table 21, Subframe 1 parameters
	Spare	19	22	4	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 30, Definition of Subframe 2, Page 2, Words 7-9

Subframe 2, Page 2						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 7-9, Status Information						
Word 7	TimeLoc Hops	1	3	3	3	See "TimeLoc Hops", Table 21, Subframe 1 parameters
	TimeLoc Reference LocataNet ID	4	6	3	6	LocataNet ID to which this LocataLite is TimeLoc'd
	TimeLoc Reference LocataLite ID	7	14	8	14	LocataLite ID to which this LocataLite is TimeLoc'd
	Spare	15	22	8	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 8	LocataLite Firmware Type	1	1	1	1	1: Released 0: non-released
	LocataLite Firmware Version	2	11	10	11	Firmware number 0-1023
	IODE	12	17	6	17	See "IODE ", Table 21, Subframe 1 parameters
	Spare	18	22	5	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 9	TCXO Offset	1	12	12	12	TCXO Offset in Parts Per Billion. 12 bit signed integer. Valid range +/- 2000
	Spare	13	22	10	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 31, Definition of Subframe 2, Page 2, Words 10-12

Subframe 2, Page 2						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 10, Tropospheric Scale Factor; Word 11, Reserved						
Word 10	Spare	1	7	7	7	
	Tropospheric Scale Factor	8	22	15	22	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 11	Secondary Preamble	1	8	8	8	11011101
	Reserved	9	22	14	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Words 12, Uptime						
Word 12	TimeLoc uptime	1	7	7	7	See Table 35, Timestamp values
	LocataLite uptime	8	14	7	14	See Table 35, Timestamp values
	TimeLoc Established count	15	20	6	20	See Table 35, Timestamp values
	Spare	21	22	2	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

Table 32, Definition of Subframe 2, Page 2, Words 13-20

Subframe 2, Page 2						
Word	**Field**	**Start Bit**	**End Bit**	**Bits Used**	**Cum Bit Total**	**Notes**
Words 13-15, Calibration Differences						
Word 13	Calibration diff A-C	1	12	12	12	See Table 34, Subframe 2 Parameters
	Reserved	13	22	10	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 14	Calibration diff A-D	1	12	12	12	See Table 34, Subframe 2 Parameters
	Reserved	13	22	10	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Word 15	Calibration diff A-B	1	12	12	12	See Table 34, Subframe 2 Parameters
	Reserved	13	22	10	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.
Words 16-20, Spare						
Words 16-20	Spare	1	22	22	22	
	Remainder	23	24	2	24	Chosen to ensure that the six parity bits have zeros in bits 29 and 30
	Parity	25	30	6	30	Parity per Reference 1 paragraph 20.3.5.

5.2.3.5.3 Subframe 2 Parameter Characteristics

The following tables give further information on Antenna Coordinate Validity (Table 33) and Antenna Offsets measurements and signal calibration differences (Table 34). Table 35 gives the timestamp values for the timestamps cited in Word 12 of Page 2 of Subframe 2.

Table 33, Antenna Coordinate Validity Meanings

Field value	Antenna 1 refers to:	Antenna 2 refers to:	Antenna 3 refers to:	Notes
000				No Almanac Data
001	TX Ant 1	-	-	Only TX1 valid
010	TX Ant 2	-	-	Only TX2 valid
011	TX Ant 1	TX Ant 2	-	TX1 and TX2 valid
100	RX Ant	-	-	No almanac data
101	RX Ant	TX Ant 1	-	RX and TX1 valid
110	RX Ant	TX Ant 2		RX and TX2 valid
111	RX Ant	TX Ant 1	TX Ant 2	RX, TX1 and TX2 valid

Table 34, Subframe 2 Parameters

Subframe 2 Parameters				
Parameter	**No. of Bits**	**LSB Scale Factor**	**Valid Range**	**Units**
Antenna N X/Y/Z-Offset	14	1	Signed integer, ECEF coordinates MSB is sign bit; 1 is negative, 0 is positive. Range: −8192mm (11111111111111) to +8192 (01111111111111)	mm
Calibration Diff	12	0.5	0 – 2047 in increments of 0.5; distance by which phase of first transmitter cited leads second transmitter cited; transmitters identified by letter	mm

Table 35, Timestamp values

Timestamp Value		
Value	**Represents**	**Unit**
0	< 1	hr
1	1-2	hrs
2	2-3	hrs
3	3-4	hrs
4	4-5	hrs
5	5-6	hrs
6	6-7	hrs
7	7-8	hrs
8	8-9	hrs
9	9-10	hrs
10	10-11	hrs
11	11-12	hrs
12	12-13	hrs
13	13-14	hrs
14	14-15	hrs
15	15-16	hrs
16	16-17	hrs
17	17-18	hrs
18	18-19	hrs
19	19-20	hrs
20	20-21	hrs
21	21-22	hrs
22	22-23	hrs
23	23-24	hrs
24	1-2	days
25	2-3	days
26	3-4	days
27	4-5	days
28	5-6	days
29	6-7	days
30	7-8	days
31	8-9	days
32	9-10	days
33	10-11	days
34	11-12	days
35	12-13	days
36	13-14	days
37	14-15	days
38	15-16	days
39	16-17	days

Table 35, Timestamp values

(continued)

Timestamp Value		
Value	**Represents**	**Unit**
40	17-18	days
41	18-19	days
42	19-20	days
43	20-21	days
44	21-22	days
45	22-23	days
46	23-24	days
47	24-25	days
48	25-26	days
49	26-27	days
50	27-28	days
51	28-29	days
52	29-30	days
53	30-31	days
54	31-32	days
55	32-33	days
56	33-34	days
57	34-35	days
58	35-36	days
59	36-37	days
60	37-38	days
61	38-39	days
62	39-40	days
63	40-41	days
64	41-42	days
65	42-43	days
66	43-44	days
67	44-45	days
68	45-46	days
69	46-47	days
70	47-48	days
71	48-49	days
72	49-50	days
73	50-51	days
74	51-52	days
75	52-53	days
76	53-54	days
77	54-55	days
78	55-56	days
79	8-9	weeks
80	9-10	weeks
81	10-11	weeks

Table 35, Timestamp values

(continued)

Timestamp Value		
Value	**Represents**	**Unit**
82	11-12	weeks
83	12-13	weeks
84	13-14	weeks
85	15-16	weeks
86	16-17	weeks
87	17-18	weeks
88	18-19	weeks
89	19-20	weeks
90	20-21	weeks
91	21-22	weeks
92	22-23	weeks
93	23-24	weeks
94	24-25	weeks
95	25-26	weeks
96	26-27	weeks
97	27-28	weeks
98	28-29	weeks
99	29-30	weeks
100	30-31	weeks
101	31-32	weeks
102	32-33	weeks
103	33-34	weeks
104	34-35	weeks
105	35-36	weeks
106	36-37	weeks
107	37-38	weeks
108	38-39	weeks
109	39-40	weeks
110	40-41	weeks
111	41-42	weeks
112	42-43	weeks
113	43-44	weeks
114	44-45	weeks
115	45-46	weeks
116	46-47	weeks
117	47-48	weeks
118	48-49	weeks
119	49-50	weeks
120	50-51	weeks
121	51-52	weeks
122	52-53	weeks
123	53-54	weeks

Table 35, Timestamp values

(continued)

Timestamp Value		
Value	**Represents**	**Unit**
124	54-55	weeks
125	55-56	weeks
126	57-58	weeks
127	58-59	weeks

5.2.3.5.4 Subframe 2 User Algorithms

Most of the data in Subframe 2 do not require algorithms for interpretation or application, with the exception of the following data:

5.2.3.5.4.1 Antenna Offsets

Offsets from the receiver antenna to the transmitter antennas are given in these fields, 14 bits per field. The distance vector is from the receive antenna in Earth Centered Earth Fixed (ECEF) Cartesian coordinates in units of a millimeter (.001 meter). Note that Antenna 2 and Antenna 3 offsets from Antenna 1 are expressed in Cartesian coordinates, while Antenna 1 coordinates are expressed in polar latitude/longitude/altitude coordinates relative to the WGS-84 geoid.

5.2.3.5.4.2 Meteorological Data

If more than one LocataLite is connected to a meteorological station and supplying meteorological data, users may select which data to use and how to use it. For example, the user may apply data from the nearest LocataLite to a link, or apply an algorithm interpolating MET data for the link. Users furnish the appropriate MET data algorithm for translating atmospheric conditions into additional link delay.

5.2.4 Timing Relationships

The following conventions apply.

5.2.4.1 Paging Restarts and Data Cutovers

The following paragraphs describe the manner in which Frame and Page counts restart and when data is updated.

5.2.4.1.1 Frame Restarts

At the start of week (when TOW resets to zero) the cyclic paging of Subframe 1 through 2 restarts with Subframe 1 regardless of which Subframe was last transmitted prior to end/start of week.

5.2.4.1.2 Subframe Restarts

At the start of week (when TOW resets to zero), the P x N sequence of Subframe 2 Pages, where P is the number of active Subframe 2 Pages and N is the number of LocataLites in the

network, restarts with Page 1 of the first LocataLite, regardless of which Page was the last to be transmitted prior to the end/start of week.

5.2.4.1.3 Data Cutovers

Cutovers to newly updated data for Subframe 1 occur on Frame boundaries (i.e., modulo 12 seconds relative to the end/start of week for D(t) at 100 bps). Cutovers to newly updated data for Subframe 2 occur on multiples of P Frame boundaries (i.e., modulo 12*P seconds relative to the end/start of week) where P is the number of active Pages per LocataLite in the Almanac (Subframe 2).

5.2.4.2 LocataNet Time Maintenance

The following principles apply to the manner in which the LocataNet maintains time and frequency throughout the network.

1. The LocataNet always uses a continuous time base (i.e. one that does not incorporate leap second events as does UTC).

2. Each LocataLite maintains time synchronization with the network using the TimeLoc process. Tolerances for this process are specified in Section 3.3.4.

3. All time-related data in the TLM Word and HOW are in LocataLite (and therefore LocataNet) time.

4. Each LocataLite transmits its NAV data using its own understanding of LocataNet time.

5.2.4.3 Normal Operations

The Subframe 1 and 2 data sets are transmitted by the LocataLites until they receive updated information from an authoritative source. This may occur at any rate up to the limit specified in section 5.2.4.1.

5.2.5 Data Frame Parity

The LocataNet uses the parity encoding algorithms shown in Figure 14.

Figure 15 presents an example flow chart that defines one way of recovering data (d_n) and checking parity. The parity bit D_{30}^* is used for recovering raw data. The parity bits D_{29}^* and D_{30}^*, along with the recovered raw data (d_n) are modulo-2 added in accordance with the equations appearing in Figure 14 for $D_{25}…D_{30}$, which provide parity to compare with transmitted parity $D_{25}…D_{30}$.

$D_1 = d_1 \oplus D_{30}^{\star}$

$D_2 = d_2 \oplus D_{30}^{\star}$

$D_3 = d_3 \oplus D_{30}^{\star}$

• •

• •

• •

• •

$D_{24} = d_{24} \oplus D_{30}^{\star}$

$D_{25} = D_{29}^{\star} \oplus d_1 \oplus d_2 \oplus d_3 \oplus d_5 \oplus d_6 \oplus d_{10} \oplus d_{11} \oplus d_{12} \oplus d_{13} \oplus d_{14} \oplus d_{17} \oplus d_{18} \oplus d_{20} \oplus d_{23}$

$D_{26} = D_{30}^{\star} \oplus d_2 \oplus d_3 \oplus d_4 \oplus d_6 \oplus d_7 \oplus d_{11} \oplus d_{12} \oplus d_{13} \oplus d_{14} \oplus d_{15} \oplus d_{18} \oplus d_{19} \oplus d_{21} \oplus d_{24}$

$D_{27} = D_{29}^{\star} \oplus d_1 \oplus d_3 \oplus d_4 \oplus d_5 \oplus d_7 \oplus d_8 \oplus d_{12} \oplus d_{13} \oplus d_{14} \oplus d_{15} \oplus d_{16} \oplus d_{19} \oplus d_{20} \oplus d_{22}$

$D_{28} = D_{30}^{\star} \oplus d_2 \oplus d_4 \oplus d_5 \oplus d_6 \oplus d_8 \oplus d_9 \oplus d_{13} \oplus d_{14} \oplus d_{15} \oplus d_{16} \oplus d_{17} \oplus d_{20} \oplus d_{21} \oplus d_{23}$

$D_{29} = D_{30}^{\star} \oplus d_1 \oplus d_3 \oplus d_5 \oplus d_6 \oplus d_7 \oplus d_9 \oplus d_{10} \oplus d_{14} \oplus d_{15} \oplus d_{16} \oplus d_{17} \oplus d_{18} \oplus d_{21} \oplus d_{22} \oplus d_{24}$

$D_{30} = D_{29}^{\star} \oplus d_3 \oplus d_5 \oplus d_6 \oplus d_8 \oplus d_9 \oplus d_{10} \oplus d_{11} \oplus d_{13} \oplus d_{15} \oplus d_{19} \oplus d_{22} \oplus d_{23} \oplus d_{24}$

Where

$d_1, d_2, ..., d_{24}$ are the source data bits;

the symbol $\star$ is used to identify the last 2 bits of the previous word of the subframe;

$D_{25}, D_{26}, ..., D_{30}$ are the computed parity bits;

$D_1, D_2, ..., D_{29}, D_{30}$ are the bits transmitted by the SV;

$\oplus$ is the "modulo-2" or "exclusive-or" operation.

Figure 14, Parity encoding equations

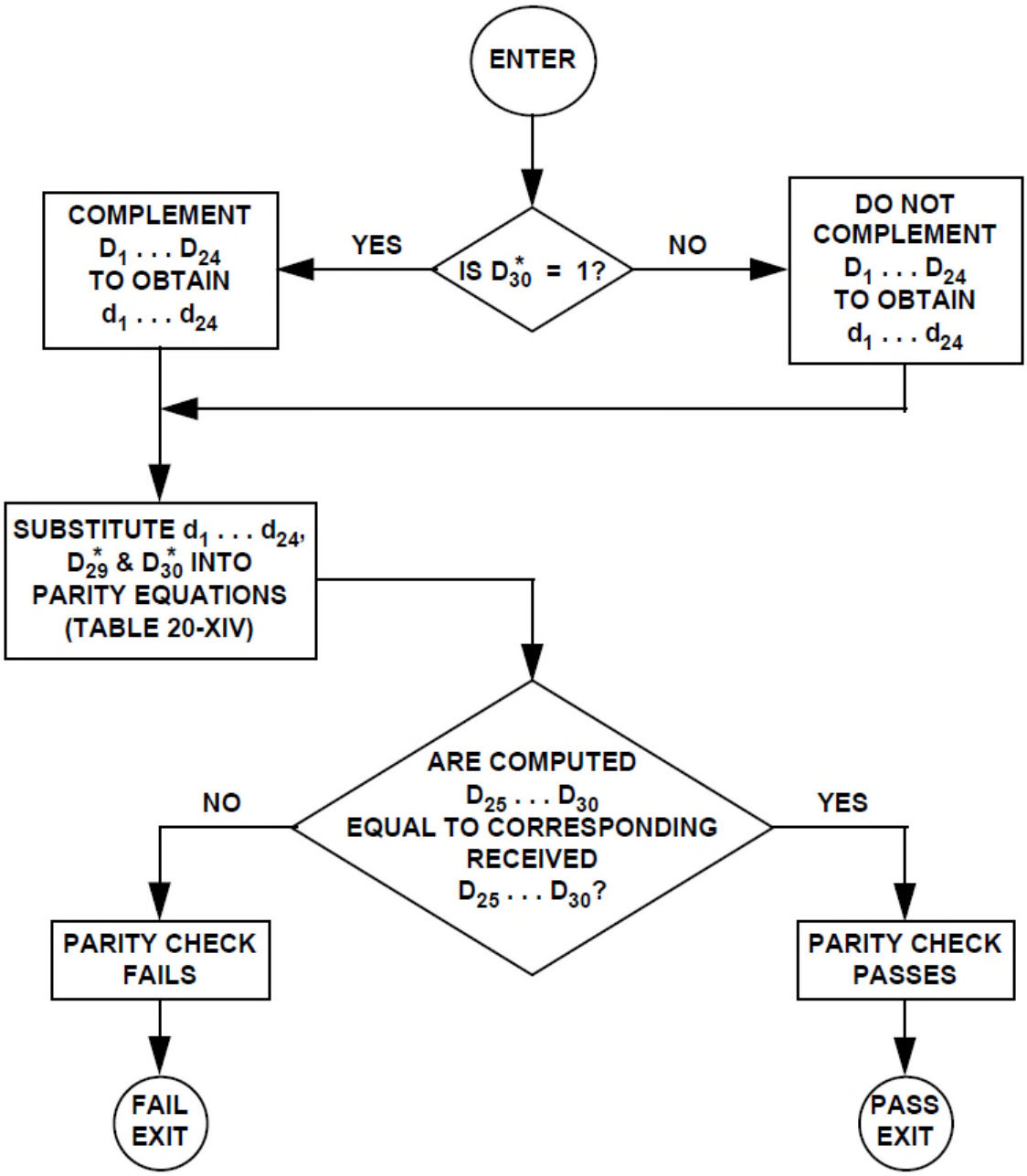

Figure 15, Example parity encoding algorithm

6. DEFINITION OF CONSTANTS

This document adopts the value of physical or mathematical constants used in Reference 1. Where not cited in Reference 1, this document uses the values adopted in WGS-84. For convenience, the values of pi and the speed of light are repeated below.

6.1 Speed of Light

The speed of light used by the Locata Network is

$$c \text{ (speed of light)} = 2.99792458 \times 10^8 \text{ meters per second,}$$

which is the official WGS-84 speed of light. This value should be used for all computations.

6.2 Pi

The value for pi, the ratio of a circle's circumference to its diameter, that should be used in all computations relevant to this interface specification, is

$$\pi = 3.1415926535898$$

7. APPENDIX II: SUMMARY OF DIFFERENCES BETWEEN GPS AND LOCATANET

This appendix provides a summary of differences between GPS and LocataNet system.

Table 36, Comparison of GPS and LocataNet characteristics

Element	GPS	LocataNet
Transmitter Location	Medium Earth Orbit (1/2 geosynchronous)	Terrestrial
Transmitter Name	Space Vehicle (SV)	LocataLite
Control Segment	Earth based control station	Master LocataLite within network
Transmit Antennas per LocataLite	1	2
Signals per Transmitting Antenna	4 (counting L1 and L2 only)	2
Carrier Frequencies	L_1 = 1575.42 MHz L_2 = 1227.60 MHz	S_1 = 2414.28 MHz S_6 = 2465.43 MHz
Ranging Codes	C/A, P, P(Y)	C/A
Code Frequency	C/A = 1.023 MHz	C/A = 10.23 MHz
NAV Data	D(t) 50 bps 5 Subframes of 10 30-bit words each 1 page of SF 1, 2, 3 25 pages of SF 4, 5	D(t) 100 bps (50 bps optional) 2 Subframes of 20 30-bit words each 1 page of SF 1 2 pages of SF 2
Maximum Transmitters in Network	32	undefined
TDMA Scheme	None	10 x 100µs slots per TDMA frame. 200 Frames per TDMA super-frame.
Diversity Schemes at Transmitter	Frequency	Frequency, Spatial
Transmitter Power	≤ 50W	≤ 1W
Assured Minimum RF Signal Strength	-128.5 dBm	N/A

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