ATTACHMENT 1.

"Standard" and "Extended" X-10 Code Formats   September 22, 1993

Rev. 11/20/94, 07/12/96, 12/18/96, 04/02/97, 07/22/97, 05/07/98

Bit Encoding

Data is accepted bit by bit as the presence or absence of 120Khz carrier occurring after the positive or negative power line zero crossing. The acceptance window begins approximately 250 usecs. and ends approximately 900 usecs. after a zero crossing. In this window 48 or more cycles of carrier are accepted as a "1" bit and fewer than 48 as a "0" bit. Except for the Startcode, each bit of data is sent in its true (D8 D4 D2 D1) and complement (D8' D4' D2' D1') form.

Standard Message Format

Mains Cycles

```
   1    2    3    4    5    6    7    8    9   10   11   12   13
*----*----*----*----*----*----*----*----*----*----*----*----*---
  11  10   H8H8'H4H4'H2H2'H1H1'D8D8'D4D4'D2D2'D1D1'F1F1' 00   00
*---------*-------------------*-------------------*----*--------
STARTCODE *    HOUSECODE      *  ADDRESS/FUNCTION *FUNC*  EOM
---------------------------------------------------------------
```

HOUSECODE SETTINGS	H8	H4	H2	H1
A	0	1	1	0
B	1	1	1	0
C	0	0	1	0
D	1	0	1	0
E	0	0	0	1
F	1	0	0	1
G	0	1	0	1
H	1	1	0	1
I	0	1	1	1
J	1	1	1	1
K	0	0	1	1
L	1	0	1	1
M	0	0	0	0
N	1	0	0	0
O	0	1	0	0
P	1	1	0	0

ADDRESS/FUNCTION

If D16 is a "1" the code is a function (command). Otherwise D1-D8 is an
'address'. Once addressed, a module responds to any command code. It becomes
'unaddressed' by the first 'address' message after a command, or by 'All
Units Off'.

CODEWHEEL	D8	D4	D2	D1	D16	
1	0	1	1	0	0	
2	1	1	1	0	0	
3	0	0	1	0	0	
4	1	0	1	0	0	
5	0	0	0	1	0	
6	1	0	0	1	0	
7	0	1	0	1	0	
8	1	1	0	1	0	
9	0	1	1	1	0	
10	1	1	1	1	0	
11	0	0	1	1	0	
12	1	0	1	1	0	
13	0	0	0	0	0	
14	1	0	0	0	0	
15	0	1	0	0	0	
16	1	1	0	0	0	
ON	0	0	1	0	1	(shutters open)
OFF	0	0	1	1	1	(shutters close)
DIM	0	1	0	0	1	(shutters up)
BRIGHT	0	1	0	1	1	(shutters down)
ALL LIGHTS ON	0	0	0	1	1	
ALL UNITS OFF	0	0	0	0	1	
ALL LIGHTS OFF	0	1	1	0	1	
EXTENDED CODE 1	0	1	1	1	1	FOR DATA/CONTROL
HAIL REQUEST		1	0	0	0	1
HAIL ACK.	1	0	0	1	1	
EXTENDED CODE 3	1	0	1	0	1	FOR SECURITY MESSAGES
UNUSED	1	0	1	1	1	
EXTENDED CODE 2	1	1	0	0	1	FOR METER READ & DSM
STATUS "ON"	1	1	0	1	1	

```
STATUS "OFF"                        1     1     1     0     1
STATUS REQUEST              1     1     1     1     1
```

The full message is sent twice without a gap. That is, the second Startcode
begins on the next power line cycle after the Function bit. Standard X-10
modules do not respond to the Extended Code message. This code enables
further bytes to be added to the message without them being "seen" by
Standard X-10 modules. Details of the Extended Code bytes are given below.
Any message containing Extended bytes must contain the Extended Code command
in the first part of the message.

Extended Message Format for EXTENDED MESSAGE 1 (01111)

Cumulative Mains Cycles

```
    2           6              11     15        23                31
1110        HC/HC'                EXT/EXT'  DC/DC'  DATA/DATA'
COMMAND/COMMAND'


Start           House          Extended   Unit    Data        Command
Code            Code           Code       Code    Byte        Byte


4bits           4bits          5bits      4bits   8bits           8bits
```

The coding of the HC and DC bytes is as shown in the Standard Code Tables.
The coding of the Data and Command bytes is shown below.

TYPE = 0   Shutters and Sunshades

```
        DATA                         COMMAND
                                     TYPE    FUNCT
128 64 32 16  8  4  2  1        8 4 2 1 8 4 2 1
x   x  x  D  D  D  D  D         0 0 0 0 0 0 0 1    Open Shutter to amount in
                                                  Data Field. Enable Sun
                                                  Protection.
                                                  (D = 0 is closed, D = 25 is
                                                  fully open)


x   x  x  D  D  D  D  D         0 0 0 0 0 0 1 0    Limit the degree of
```

```
                                     opening to the value in
                                     the Data Field.
                                     (Sun Protection)

x  x  x  D  D  D  D  D     0 0 0 0 0 0 1 1   Open Shutter to amount in
                                            the Data Field. Disable
                                            Sun Protection.

x  x  x  x  x  x  x  x     0 0 0 0 0 1 0 0   Open all shutters on this
                                            Housecode. Disregard the
                                            Unitcode. Disable Sun
                                            Protection.

x  x  x  x  x  x  x  x     0 0 0 0 0 1 0 1   Open all shutters.
                                            Ignore Housecode and
                                            Unit code fields.
                                            Disable Sun Protection.

L4 L2 L1  D  D  D  D  D    0 0 0 0 0 1 1 1   Include this unit in  the
                                            Lifestyle mode L. D is
                                            the degree of opening.

DATA                            COMMAND
                                TYPE   FUNCT

L4 L2 L1  x  x  x  x  x    0 0 0 0 1 0 0 0   Begin Lifestyle mode L.
                                            Disregard HC/DC
                                            (only responds if
                                            previously included)

L4 L2 L1  x  x  x  x  x    0 0 0 0 1 0 0 1   Exclude (erase) this unit
                                            from Lifestyle L

x  x  x  x  x  x  x  x     0 0 0 0 1 0 1 0   Exclude (erase) from  all
                                            Lifestyle modes.
                                            Disregard HC/DC fields

x  x  x  x  x  x  x  x     0 0 0 0 1 0 1 1   Close all shutters on
                                            this HC. Disregard the
                                            Unit   code.   Enable   Sun
```

Protection

```
x  x  x   x  x  x  x  x        0 0 0 0 1 1 0 0     Close all shutters.
                                                   Disregard HC/DC fields
                                                   Enable Sun Protection.


x  x  x   x  x  x  x  x        0 0 0 0 1 1 1 0     Self Test for
                                                   Housecode/Unit Code match
                                                   Drive UP for 1 sec. if
                                                   match.


x  x  x   x  x  x  x  x        0 0 0 0 1 1 1 1     Self Test the EAROM
                                                   addresses. Leave EAROM
                                                   Blank. Drive UP for
                                                   1sec.,then DN for 1sec
```

TYPE = 1   Sensors

```
          DATA                 TYPE/COMMAND
x  x  x  x  x  x  x  x         0 0 0 1 0 0 0 1     Request Average Light
                                                   Data from the Unit
                                                   addressed  in  the  HC/DC
                                                   fields.


x  x  x  x  x  x  x  x         0 0 0 1 0 0 1 0     Request Instant
                                                   Temperature  from  the
                                                   addressed unit.


          DATA                 TYPE/COMMAND
x  x  x  x  x  x  x  x         0 0 0 1 0 0 1 1     Request Status from
                                                   addressed unit.


x  x  x  x  x  x  x  x         0 0 0 1 0 1 0 0     Request Instant Light
                                                   Data from the addressed
                                                   unit.


x  x  x  x  x  x  x  x         0 0 0 1 0 1 0 1     Request Average Temp.
                                                   Data from the addressed
                                                   unit.(16min. average)
```

```
I2 I1 P  P  P  P  P  P        0 0 0 1 1 0 1 1    Ambient Light data
                                                 from the sensor in the
                                                 HC/DC fields.


T  T  T  T  T  T  T  T        0 0 0 1 1 1 0 0    Temperature data from
                                                 the sensor in the HC/DC
                                                 fields.


S  S  S  S  S  S  S  S        0 0 0 1 1 1 0 1    Status data (bit mapped)
                                                 from the unit in the
                                                 HC/DC field
```

TYPE = 2 Reserved for Security

TYPE = 3 Control Modules (Dimmers and Appliances)


```
           DATA                 TYPE/CMD
G1 G0 0  x  x  x  x  x        3  0   INCLUDE IN GROUP G1G0 AT THE CURRENT
                                     OUTPUT SETTING (on this HC,DC). The
                                     GROUP ADDRESS IS ABSOLUTE (no GROUP
                                     REFERENCE)


G1 G0 1  x  S3 S2 S1 S0       3  0   INCLUDE IN GROUP G1G0 AT THE CURRENT
                                     OUTPUT SETTING (on this HC,DC). The
                                     GROUP ADDRESS is RELATIVE to the GRP
                                     REFERENCE S3S2S1S0


x  x  B16 B8 B4 B2 B1 B0      3  1   PRESET RECEIVER O/P on this HC DC
                                     For all units:
                                     'B'FIELD=NZ means 'ON' Zero means 'OFF'.
                                     For Dimmers:
                                     'B'FIELD = H'3F'is 'ON'@ FULL BRIGHT
                                     IMMEDIATE. (63 values)
                                     'B'FIELD = H'01'to H'3E' is ON @
                                     PREVIOUS SETTING IMMEDIATE, brightening
                                     gradually to the new value of 'B'.
                                     If previously OFF, the unit comes ON at
                                     FULL DIM before brightening.
                                     'B' FIELD = '0' is 'OFF'
```

```
G1 G0 B16B8 B4 B2 B1 B0        3  2  INCLUDE IN GROUP 'G' on specified
                                     HC, DC. 'B' defines O/P State, 'G' the
                                     Group to which it applies. Other
                                     Group membership is not affected.
                                     Simultaneous membership of up to 4
                                     Groups is allowed. Group function is
                                     not executed until the EXECUTE GROUP
                                     message is received.


x  x  x  x  x  x  x  x          3  3  ALL UNITS ON on specified HC.


x  x  x  x  x  x  x  x          3  4  ALL UNITS OFF on specified HC


0  0  0  0  G3 G2 G1 G0         3  5  REMOVE FROM GROUP(S) (this HC,DC).
                                      'G' is bit mapped


1  1  1  1  G3 G2 G1 G0         3  5  REMOVE FROM GROUP(S) (this HC)


G1 G0 0  0  x  x  x  x          3  6  EXECUTE GROUP FUNCTION (this HC).
                                      GROUP ADDRESS IS ABSOLUTE
                                      (no GROUP REFERENCE)


G1 G0 1  0  S3 S2 S1 S0         3  6  EXECUTE GROUP FUNCTION (this HC).
                                      The GROUP ADDRESS is relative to the
                                      GRP REFERENCE S3S2S1S0.


G1 G0 0  1  x  x  x  x          3  6  PUT UNITS IN THIS GROUP OFF. THE
                                      GROUP PRESETS ARE UNAFFECTED.GROUP
                                      ADDRESS IS ABSOLUTE.


G1 G0 1  1  S3 S2 S1 S0         3  6  PUT UNITS IN THIS GROUP OFF. THE
                                      GROUP PRESETS ARE UNAFFECTED. GROUP
                                      ADDRESS IS RELATIVE TO S3S2S1S0


x  x  0  0  x  x  x  x          3  7  REQ. OUTPUT STATUS (this HC,DC)
                                      Req. TO module
```

```
          DATA                TYPE/CMD

x x 0 1 x x x x          3  7  REQ.OUTPUT STATUS (this HC,DC)
                               Req. FROM Module after Power Up


G1 G0 1 0 0 0 0 0        3  7  REQ. GROUP STATUS on this HC, DC
                               The GROUP ADDRESS is absolute.
                               Req. TO Module


G1 G0 1 1 S3 S2 S1 S0    3  7  REQ. GROUP STATUS on this HC, DC
                               The GROUP ADDRESS is relative
                               to the GRP REFERENCE S3S2S1S0
                               Req. TO module


A1 A0 B16B8 B4 B2 B1 B0  3  8  OUTPUT STATUS ACK.(this HC,DC)
                               A1 = 1 if load connected
                               A0 = 0 for LAMP, 1 for SWITCH


G1 G0 B16B8 B4 B2 B1 B0  3  9  GROUP STATUS ACK.(this HC, DC)
                               GROUP may be ABS. or REL.,
                               depending on the REQUEST


x x x x x x x x          3  A  GROUP STATUS ACK. Not in the Group
                               requested. The DATA field returns
                               the value contained in the REQUEST


x x x x x x C1 C0        3  B  CONFIGURE MODULES (this HC )
                               C0 = AUTOACK 'EXTENDED' MESS
                               C1 = AUTOACK 'STANDARD' MESS
                               Automatic ACK for messages that
                               alter O/P state of unit. Bit's 2-7
                               reserved for future.


G1 G0 0 B/D x x x x      3  C  Group Bright or Dim. The Group
                               address is absolute.
                               B/D = 1 for Bright, 0 for Dim


G1 G0 1 B/D S3 S2 S1 S0  3  C  Group Bright or Dim. The Group
```

address is relative to the GROUP

                                    REF. S3S2S1S0

NOTE on GROUP BRIGHT/DIM & GROUP OFF

This message causes the output state of a Dimmer to Brighten or Dim for as
long as the message is received, so long as the HC and GROUP ADDRESS (ABS. or
REL.) match the unit HC and it is within that Group. The Output Level defined
for the unit within that Group is unaffected.

Similarly, GROUP OFF will turn off any unit in the specified Group, but won't
affect the output level set for the unit for that Group.

TYPE = 4 Extended Secure Addressing

This field enables all Standard and Extended Type 3 X-10 message functions
but with an additional 8 bit security address in the DATA BYTE of the
message. For a unit to respond requires at least a HC and SECURE ADDRESS
match.

          DATA   TYPE/CMD
A7 A6 A5 A4 A3 A2 A1 A0   4   0   Unit is 'addressed' if there is a
                                    'HC' 'ADDR' 'DC' match
                                    (**HC EXT DC ADDR 40**)

A7 A6 A5 A4 A3 A2 A1 A0   4   1   Unit is 'addressed' if there is a
                                    'HC''ADDR' match
                                    (**HC EXT xx ADDR 41**)

A7 A6 A5 A4 A3 A2 A1 A0   4   2   Execute 'Standard' X-10 functions
                                    All Off, All Lights On, if there is a
                                    'HC''ADDR' match. Execute On, Off,
                                    Bright, Dim, if the unit is
                                    additionally 'addressed'.
                                    (**HC EXT FN ADDR 42**)

The Function is contained in the Unit Code nibble of the message and is the
same number as defined in 'Standard' messages.

D7 D6 D5 D4 D3 D2 D1 D0   4   3   Execute 'Extended Type 3' functions
                                    if there is a HC match and the unit

is additionally 'addressed'.
(**HC EXT FN DATA 43**)

The DATA BYTE is the Group Address as defined for TYPE 3 Messages. The TYPE 3 Function is defined in the Unit Code nibble of the message. The rules for the 'Addressed' Status follow the rules for Standard Adressing - a unit becomes 'Addressed' as a result of a Type 40 or 41 message and remains so until the next 40/41 message following a Type 42/43 message. The 'addressed' status is also reset if the is a HC match but secure address mismatch in a Type 4 message (BUT NOT 43).

DATA	TYPE	CMD	
A7 A6 A5 A4 A3 A2 A1 A0	4	4	Execute 'Unit Code' 'On' if there is a HC and SECURE ADDRESS match. (**HC EXT DC ADDR 44**)
A7 A6 A5 A4 A3 A2 A1 A0	4	5	Execute 'Unit Code' 'Off' if there is a HC and SECURE ADDRESS match. (**HC EXT DC ADDR 45**)

SECURE ADDRESS ACQUISITION (MODULES WITH SECURE ADDRESS CAPABILITY)
If there is no current secure address in the unit, it will acquire the address in the DATA BYTE if the first TYPE 40/41/42 or TYPE 5X message it sees, so long as there is a HC match. Once it has acquired a secure address, it will not respond to 'Standard' or 'Type 3 Extended' messages. The unit may be set back to a 'non secure address state' by applying power to the unit with the MAXDIM key held pressed.

TYPE = 5 Extended Secure Addressing for Groups

DATA	TYPE	CMD	
A7 A6 A5 A4 A3 A2 A1 A0	5	0	Execute Group 0 (relative to the Group Ref. in the Unit Code nibble) (**HC EXT GRPREF ADDR 50**)
A7 A6 A5 A4 A3 A2 A1 A0	5	1	Execute Group 1 (relative to the Group Ref. In the Unit Code nibble) (**HC EXT GRPREF ADDR 51**)

```
A7 A6 A5 A4 A3 A2 A1 A0        5  2   Execute Group 2 (relative to the
                                       Group Ref. In the Unit Code nibble)
                                       (HC EXT GRPREF ADDR 52)


A7 A6 A5 A4 A3 A2 A1 A0        5  3   Execute Group 3 (relative to the
                                       Group ref. in the Unit Code nibble)
                                       (HC EXT GRPREF ADDR 53)


A7 A6 A5 A4 A3 A2 A1 A0        5  4   Turn 'Off' all units in Group 0 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 54)


A7 A6 A5 A4 A3 A2 A1 A0        5  5   Turn 'Off' all units in Group 1 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 55)


A7 A6 A5 A4 A3 A2 A1 A0        5  6   Turn 'Off' all units in Group 2 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 56)



        DATA                TYPE/CMD
A7 A6 A5 A4 A3 A2 A1 A0        5  7   Turn 'Off' all units in Group 3 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 57)


A7 A6 A5 A4 A3 A2 A1 A0        5  8   Brighten all units in Group 0 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 58)


A7 A6 A5 A4 A3 A2 A1 A0        5  9   Brighten all units in Group 1 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 59)


A7 A6 A5 A4 A3 A2 A1 A0        5  A   Brighten all units in Group 2 (rel.
                                       to Group Ref. in Unit Code nibble)
                                       (HC EXT GRPREF ADDR 5A)
```

```
A7 A6 A5 A4 A3 A2 A1 A0        5  B  Brighten all units in Group 3 (rel.
                                     to Group Ref. in Unit Code nibble)
                                     (HC EXT GRPREF ADDR 5B)


A7 A6 A5 A4 A3 A2 A1 A0        5  C  Dim all units in Group 0 (rel. to
                                     to Group Ref. in Unit Code nibble)
                                     (HC EXT GRPREF ADDR 5C)


A7 A6 A5 A4 A3 A2 A1 A0        5  D  Dim all units in Group 1 (rel. to
                                     to Group Ref. in Unit Code nibble)
                                     (HC EXT GRPREF ADDR 5D)


A7 A6 A5 A4 A3 A2 A1 A0        5  E  Dim all units in Group 2 (rel. to
                                     to Group Ref. in Unit Code nibble)
                                     (HC EXT GRPREF ADDR 5E)


A7 A6 A5 A4 A3 A2 A1 A0        5  F  Dim all units in Group 3 (rel. to
                                     to Group Ref. in Unit Code nibble)
                                     (HC EXT GRPREF ADDR 5F)
```

NOTE ON GROUP BRIGHT/DIM FOR Leviton 6400 CONTROLLERS IN SECURE ADDRESS MODE
The Command 58 - 5F is derived from the last Group Execute key that was
pressed. The Group Reference is, in fact, the Unit Code of the Controller.


```
LIFESTYLE CODES        L4 L2 L1
                        0  0  0  Wake
                        0  0  1  Leave
                        0  1  0  Return
                        0  1  1  Sleep
                        1  0  0  Evening
                        1  0  1  Vacation
                        1  1  0  Special 1
                        1  1  1  Special 2
```

AMBIENT LIGHT DATA

```
I2 I1 P32 P16 P8 P4 P2 P1

0  0   D   D   D   D   D   D   Range 0-630 in steps of 10

0  1   D   D   D   D   D   D   Range 0-6300 in steps of 100

1  0   D   D   D   D   D   D   Range 0-63000 in steps of 1000

1  1   D   D   D   D   D   D   Range 0-630000 in steps of 10000
```

If the Data is divided by two it will approximate to LUX values.

TEMPERATURE DATA

```
(+/-)T64 T32 T16 T8 T4 T2 T1   Range 0 - 127 in integer values.

                               (+/-) = '1' for negative integers.

                               Units are Deg. Celsius.
```

NOTE : The Ambient Light/Temperature Sensor is capable of reading from -28 to +50 deg. Celsius.

ACCESS PROTOCOL

With Extended Code systems, the amount and nature of the messages that are being used requires that Transmitters avoid message collisions where possible, and that, when a collision does occur, it can be detected and the conflict resolved. In order to do this, the following access protocol should be adopted. All messages are assumed to have equal priority.

When a transmitter has a message it wishes to transmit, it must wait for access to the power line for either 8, 9, or 10 half power line cycles - during which the line must have been continuously clear of data '1' bits. If a '1' bit is detected, it must restart its access timing and wait for another 8, 9, or 10 cycles. After line access has been achieved, the transmitter must check the line during the transmission of a '0' bit (no carrier) to see that no other transmitter is transmitting. If a collision occurs, the transmitter must abort its transmission immediately and again go though the line access procedure. The choice of 8, 9, or 10 half cycles is chosen randomly for each line access attempt.

NOTES

1. Messages with a TYPE = 0010 are reserved for Security