Standard and Extended X10 Code Protocol

Bit Encoding

Data is accepted bit by bit as the presence or absence of 120Khz carrier occurring after the positive or negative mains zero crossing. The acceptance window begins approximately 250 usecs. and ends approximately 900 usecs. after a zero crossing. In this window 48 or more cycle 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 and complement form.

Standard Message Format

```
Powerline 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 mains cycle after the Function bit.
X10 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 X10 modules. Details of the Extended code bytes is 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 Powerline Cycles

2	6	11	15	23	31
1110	HC/HC	EXT./EXT.	DC/DC	DATA/DATA	COMMAND/COMMAND
Start	House	Extended	Unit	Data Byte	Command Byte
Code	Code	Code	Code		
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. (0 = closed, 25=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.

```
          DATA                   TYPE  /COMMAND
x  x  x  x  x  x  x  x       0 0 0 0 0 0 1 0 1 Open     all     shutters.
                                               Ignore   Housecode   and
                                               Unitcode fields.
                                               Disable Sun Protection.
L4 L2 L1  D  D  D  D  D      0 0 0 0 0 0 1 1 1 Include this unit in  the
                                               Lifestyle mode L.  D  is
                                               the degree of opening.
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
                                               Unitcode.  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
                                               on codewheels. Drive UP
                                               for 1 sec. if a 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.
```

```
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
```

```
T1 T0 B16B8 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' determines the dim level (63 levels from H'3F' to 1)
  'B'FIELD = H'3F' means 'ON'@ FULL BRIGHT immediately.
  'B'FIELD = H'01'to H'3E' means brighten gradually from the current
            level to the new level. If previously OFF the unit comes
            ON at FULL DIM before brightening.
  'T'FIELD = the time over which the change takes place.
  For 'T'=0,t=3.7s ;for 'T'=1,t=30s ;for 'T'=2,t=1min; for'T'=3,t=5min

```
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.
```

```
         DATA              TYPE/CMD
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
x  x  0  1  x  x  x  x      3  7  REQ.OUTPUT STATUS (this HC,DC)
                                 Req.FROM Module after PowerUp
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 B16 B8 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 B16 B8 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 put 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 X10 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' X10  functions
                                 All  Off, All  L.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
Addressing – 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  Put '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  Put '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  Put '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  Put '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 A 6400 CONTROLLER IN SECURE ADDRESS MODE
The Command 58 – 5F is derived from the last Group Execute key that
was pressed on the Scene Controller prior to pressing the BR/DIM key.
The Group Reference is 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 powerline for either 8, 9, or 10 half mains cycles -
during which the line must have been continuously clear of data '1'
bits. If a '1'bit is detected, it must restart it's 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