PRELIMINARY

CH80215 Wireless Networking Modules

DESCRIPTION

The Cermetek CH80215 family of wireless modules serves as a low cost building block for efficient wireless mesh networks. The CH80215 complies with the IEEE 802.15.4 wireless networking standard. The 802.15.4 standard is the industry accepted standard for wireless sensor networks.

Cermetek designed the CH80215 for easy integration. Wireless network control and configuration are accomplished with simple ASCII text strings. CH80215 modules cover just 1.35 square inches to permit convenient placement within the system. This small package includes the antenna so no bulky external antenna is needed.

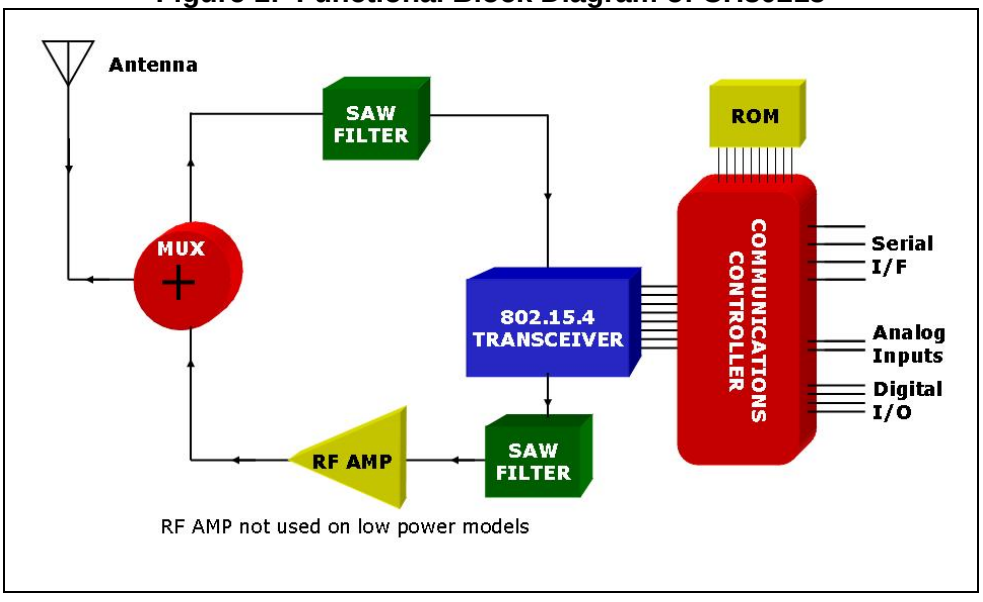
For battery powered applications Endpoint nodes include numerous power saving features. These include a Power down mode which draws a maximum of 20 microamps. Cermetek also allows the user to limit power consumption by adjusting output power. The CH80215 offers a choice of two output levels, 0 dBm and 20 dBm. Power level on the 20 dBm units can be lowered to adapt to applications which do not need full output power at all nodes.

The CH80215 receive sensitivity of -91 dBm insures maximum range even through obstructions. Cermetek testing showed a typical range of 100 feet through moderate obstructions, three walls in our testing, at 0 dBm transmit power. That range extended to 350 feet when output power increased to 20 dBm.

FEATURES

- Small Size: 1.35 inches by 1.00 inches
- FCC Part 15 modular approval: (Pending)
- Network control and configuration using modem-like AT Commands
- IEEE 802.15.4 compliant transceivers use the globally available 2.4 GHz ISM frequency band
- RoHS Compliant
- 3.3 volt operation
- Nodes include multiple power saving modes including Sleep and RF Power Down
- On board chip antenna
- Typical Receive Sensitivity -91 dBm
- Obstructed Range: 100 feet at 0 dBm transmit level; 350 feet at 20 dBm transmit level
- Direct connection for up to 6 sensors including 2 analog inputs with 10-bit analog to digital converter.
- Patented SensorOnAir permits reading sensor values or changing control outputs with a single command from the Network Coordinator
- Choice of Surface mount or through-hole modules
- Every module selectable as either Network Coordinator, Router, and End Point device
- Available Extended Operating temperature versions -40°C to +85°C

Figure 1: Functional Block Diagram of CH80215



BASIC OPERATIONS

Figure 1 shows a functional block drawing of the CH80215 transceiver module. The block diagram remains the same whether the node is configured as a Network Coordinator; Router, or Endpoint. The RF amplifier is removed for models with the maximum output power limited to 0 dBm. This helps reduce the overall power consumption of these models.

IEEE 802.15.4 OVERVIEW

The 802.15.4 wireless networking standard serves as a tool for building a variety of wireless sensor networks. These networks include Star, Tree and Mesh configurations. The standard refers to these as Wireless Personal Area Networks (PAN). The standard allows more than 65,000 addressable nodes in one network.

To create the Personal Area Networks 802.15.4 incorporates three types of nodes: Network Coordinator, Router, and Endpoints.

As the name implies the **Network Coordinator** manages the network. There can be only one Coordinator per network.

A **Router** is a full-featured 802.15.4 node that can relay messages from other nodes or serve at the network edge where the network interfaces with the real world. There can be many Routers in a network.

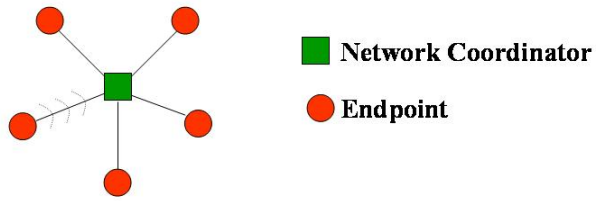
An **Endpoint** can be a full-function or reduced-function device used at the network edge. It cannot relay messages from other nodes. Because of its specialized function at the network edge, the Endpoint can utilize special techniques to reduce power consumption and be suitable for battery powered operation.

802.15.4 uses Direct Sequence Spread Spectrum (DSSS) modulation to optimize use of the 2.4 GHz ISM (Industrial, Scientific and Medicine) frequency band. DSSS spreads the transmit power across the complete frequency band. This allows maximum signal power without exceeding limits for out of band energy.

STAR NETWORK

A Star network offers the most basic multipoint network. The Network Coordinator in a Star network talks directly with all of the Endpoints. No Routers are used to relay data. A Star network is simpler to manage and has fewer issues with latency; however, the range of the network is limited to the range of the individual nodes. Figure 2 shows a typical Star network.

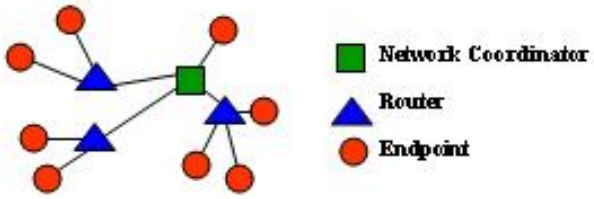
Figure 2: Star Network



TREE NETWORK

The Tree network (Figure 3) resembles a group of Star Networks linked together. In a Tree Network, clusters of Endpoints tie into a Router rather than connecting directly to the Network Coordinator. This extends the range of the network while maintaining just one path from each Endpoint to the Network Coordinator

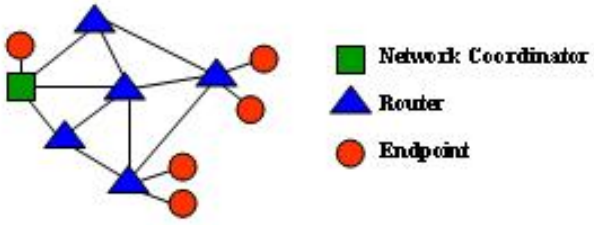
Figure 3: Tree Network



Mesh Network

A Mesh network (Figure 4) is the most complicated and most versatile network. It provides multiple data paths from the Endpoints to the Network Coordinator. This redundancy increases the complexity of the network and can introduce latency issues; however, it enhances reliability because the loss of a Router does not block the flow of data.

Figure 4: Mesh Network



ENDPOINT POWER CONSERVATION TOOLS

Cermetek has implemented a number of Power conservation tools into the CH80215 to serve Endpoint devices. These allow the radio to be shutdown to reduce power consumption thereby making applications requiring battery powered nodes practical. These tools cannot be incorporated into the Router and Network Coordinator nodes because those modules must always be available to communicate. Table 2 below illustrates the power savings for each mode.

The various power saving modes are selected with the AT#Pn command. The value of "n" selects the power saving mode as shown below

AT#P0; All power saving modes are disabled.

AT#P1; Sleep Mode is selected.

AT#P2; RF Power Down Mode is selected.

AT#P3; RF Monitor Mode is selected.

Sleep Mode

In Sleep Mode all circuits in the CH80215 are powered down to reduce power consumption of the CH80215 to 40 micro-amps. While in sleep mode, the transceiver cannot respond to AT commands or to incoming RF communications requests. The transceiver can be awakened from Sleep Mode by momentarily activating the /Reset signal.

RF Power-Down Mode

In the RF Power-Down Mode all the RF circuitry (including the power amplifier and Saw filters) are powered down. The communications controller remains active to permit configuration changes. Because the RF circuitry is shut off, the transceiver cannot respond to an RF communications request in the RF Power Down mode. The CH80215 can be returned to normal operating mode by monetarily activating the /Reset pin or by initiating a connection with the AT commands.

RF Monitor Mode

In the RF Monitor Mode the CH80215 sits in Sleep mode for a prescribed period of time set by the value of register S95. When the timer expires, the CH80215 wakes and checks for incoming RF communications request and/or any requests from the system host. The transceiver services any requests found and then returns to Sleep mode. The timer defined by register S95 sets the waking interval from 1 to 60 seconds long. The power savings achieved in the RF monitor mode will vary with the length of the waking interval.

Table1: CH80215 Power Consumption in Various Modes

Mode	Model	Minimum	Typical	Maximum	Units	Notes
Transmission	Low power		40	50	mA	Transmit level 0 dBm
	High power		75	85	mA	Transmit level 20 dBm
Reception	All		40	50	mA	
Idle	All		30		mA	
Sleep	All		0.045		mA	
RF Power Down	All		3		mA	No I/O active
RF Monitor (2-second Interval)	Low Power		5		mA	Average power
	High Power		7		mA	Average Power
RF Monitor (60-second Interval)	Low Power		2		mA	Average Power
	High Power		2		mA	Average Power

CH80215 SENSOR ATTACHMENT

The CH80215 has six I/O lines for connecting sensors. This includes two lines, ADC0 and ADC1 that can serve as either analog or digital inputs. The remaining four lines, DIO0, DIO1, DIO2, and DIO3, can function as either a digital input or digital output. Operation of these I/O pins is defined using register S97.

SensorOnAir

Cermetek holds a patent for a technique for reading remote sensors and changing remote control lines with a single command issued to the Network Coordinator. We call this feature SensorOnAir. The sensor inputs can also be read and control lines can be set by a command from a local host.

The AT#I command is used to remotely read sensor inputs or control remote output lines. The three forms of the command used for this purpose are detailed below.

AT#IxxxAn? This command allows any full-featured node to read the value of analog input "n" at address xxx. The response shows the value of the 10-bit Analog to Digital Converter from 0 to 1023.

AT#IxxxDn? This command allows any full-featured node to read the value of digital input "n" at address xxx. The response provided is either a 0 or 1.

AT#IxxxDn=z This command allows any full-featured node to set the value of Digital Output n at address xxx to value z. Z is either a 0 (low) or 1 (high)

The commands to read and control the I/O lines from the local host are similar to the SensorOnAir commands. AT&I is used in place of AT#I. The local commands are listed below.

AT&IAn? This command allows the local host to read the value of analog input "n". The response shows the value of the 10-bit Analog to Digital Converter from 0 to 1023.

AT&IDn? This command allows the local host to read the value of digital input "n". The response provided is either a 0 or 1.

AT&IDn=z This command allows the local host to set the value of Digital Output n. Z is either a 0 (low) or 1 (high)

CH80215 AT COMMANDS

The CH80215 is controlled and configured through the use of AT commands similar to those used on dial-up modems. AT commands permit control of the CH80215 with simple ASCII text strings. The CH80215 accepts commands at data rates from 1200 bits per second to 230,400 bits per second. The command data rate is set by register S23. The default command data rate is 19,200 bits per second.

AT Command Format

AT commands follow a standard format. A command prefix "AT" identifies the text string as a command. The "A" and the "T" may be either upper or lower case but the case must be the same for both characters. Each command is terminated with a carriage return. Commands are executed only after the carriage return character is received.

Multiple commands may be strung together in a single command line. The "AT" prefix may be followed by up to 48 characters. If more than 48 characters are placed into one command string the CH80215 will issue the ERROR" result code and none of the commands will be executed. If properly entered, the commands are executed in the sequence in which they appear in the command string.

Many commands include a parameter to select the function. If the parameter is omitted from the command string, the CH80215 assumes that the parameter value is 0.

The CH80215 normally issues a result code after each action. Result codes may be provided as complete words or numeric codes. The user also has the option of disabling result codes. When numeric result codes are selected, each result code ends with a carriage return character. When full word result codes are chosen, both a linefeed and a carriage return character are inserted before and after the result code. Result codes are listed in Table 3.

A character sequence has been defined to permit the CH80215 to abort an active wireless link without permitting the wireless link to be accidentally disconnected. Receipt of three consecutive tilde characters "~~~" will cause the CH80215 to immediately drop the active wireless link.

Registers

AT commands include a number of registers which are used to store configuration parameters. To read the present value of any register, enter the command "ATSn=?", where n is the register number. To change the value of register n enter the command ATSn=x, where n is the register number and x is the new value of register n.

AT Commands

Below is a list of the AT commands used for the CH80215. An asterisk by a parameter indicates the default state.

Dxxx - Establish a wireless link with the node at address xxx

En - Echo characters in command mode
- n = 0 No character echo
- n = 1* Echo received characters

In - Product information display
- n = 0* Display product code
- n = 1 Display code revision and date

Qn - Result Code display
- n = 0* Display result codes
- n = 1 Do not display result codes

Sn= - Set value of register n

Sn? - Read value of register n

Vn - Select response format
- n = 0 Select numeric responses
- n = 1* Select full word responses

Z - Execute a soft reset within the CH80215

&F - Reload factory default configuration

&IAn - Read current value of local analog input
- n = 0 Read analog input 0
- n = 1 Read analog input 1

&IDn - Read current value of local digital input
- n = 0 Read digital input 0
- n = 1 Read digital input 1
- n = 2 Read digital input 2
- n = 3 Read digital input 3

&IDn=z Set the value of local digital output n. A logic low is set with z equal to 0; a logic high is set with z equal to 1.
- n = 0 Read digital input 0
- n = 1 Read digital input 1
- n = 2 Read digital input 2
- n = 3 Read digital input 3

&Sn - Select data security
- n = 0 No secure wireless data transfer.
- n = 1 * Selects secure wireless data transfer

&V - Display active device configuration

&Wn - Store current configuration into non-volatile memory
- n = 0 Store in user profile 0 *
- n = 1 Store in user profile 1

&Yn - Reload profile "n" on power-up or reset
- n = 0 Reload profile 0 *
- n = 1 Reload profile 1

\Bn - Set the character format for ASCII commands. When a parity bit is selected, the type of parity is defined by the \P command
- n = 1 Seven data bits, no parity, one stop bit
- n = 2 Seven data bits, one parity bit, one stop bit
- n = 3 * Eight data bits, no parity, one stop bit
- n = 5 Eight data bits, one parity bit, one stop bit

\Pn - Selects the type of parity to be used when a parity bit is defined by the \B command
- n = 0 * Even parity selected
- n = 1 Odd parity selected
- n = 2 Mark Parity selected

\Q - Selects the type of flow control to be used between the host terminal equipment and the CH80215.
- n = 0 No flow control
- n = 1 * Hardware flow control (/RTS and /CTS signals control data flow)
- n = 2 Software flow control (XON and XOFF characters in the data stream control data flow)

\T - Selects serial interface speed
- n = 6 9600 bits per second
- n = 9 * 19,200 bits per second
- n = 10 38,400 bits per second
- n = 11 57,600 bits per second
- n = 12 115,200 bits per second
- n = 13 230,400 bits per second

#E - This command is valid only for Endpoint and Router versions of the CH80215. This command causes the node to join an existing network.

#F - This command is valid only for Network Coordinator versions of the CH80215. This command causes the Network Coordinator to build a new network.

#IxxxxAn? - This command allows the Network Coordinator to read the current value of analog input “n” at address xxxx.
- n = 0 Read analog input 0
- n = 1 Read analog input 1

#IxxxxDn? - This command allows the Network Coordinator to read the current value of local digital input “n”.
- n = 0 Read digital input 0
- n = 1 Read digital input 1
- n = 2 Read digital input 2
- n = 3 Read digital input 3

#IxxxxDn=z - This command allows the Network Coordinator to set the value of local digital output “n” to value z. Setting “z” equal to 0 sets a logic low; setting “z” equal to 1 selects a logic high.
- n = 0 Set digital input 0
- n = 1 Set digital input 1
- n = 2 Set digital input 2
- n = 3 Set digital input 3

#K? - Read security key value

#K=n - This command sets the value of the security key. The value is in Hex format. The key may be up to 16 bytes long. If a key of less than 16 bytes is entered, zeros will automatically be inserted into the unfilled spaces.

#Mn - Defines the type of node the module will operate as.
- n = 0 Reduced Function Device serving as an Endpoint
- n = 1 Full Function Device serving as an Endpoint
- n = 2 * Node to serve as a Router
- n = 3 Node to serve as Network Coordinator

#Pn - Selects power saving mode for Endpoint operation while the CH80215 is idle.
- n = 0 * No power saving mode active
- n = 1 Go to sleep mode when idle
- n = 2 Go to RF Power Down mode when idle
- n = 3 Select RF Monitor mode when idle

ASCII Character Chart

Table 2 below shows the decimal equivalent for all valid ASCII characters used in the AT commands. Several registers use these decimal values for storing character definitions.

Table 2: Decimal Equivalents of ASCII Characters

ASCII Character	Decimal Value
Nul	000
SOH	001
STX	002
ETX	003
EOT	004
ENQ	005
ACK	006
BEL	007
BS	008
HT	009
LF	010
VT	011
FF	012
CR	013
SO	014
SI	015
DLE	016
DC1	017
DC2	018
DC3	019
DC4	020
NAK	021
SYN	022
ETB	023
CAN	024
EM	025
SUB	026
ESC	027
FS	028
GS	029
RS	030
US	031
Space	032
!	033
“	034
#	035
$	036
%	037
&	038
‘	039
(	040
)	041
*	042

ASCII Character	Decimal Value
+	043
,	044
-	045
.	046
/	047
0	048
1	049
2	050
3	051
4	052
5	053
6	054
7	055
8	056
9	057
:	058
;	059
<	060
=	061
>	062
?	063
@	064
A	065
B	066
C	067
D	068
E	069
F	070
G	071
H	072
I	073
J	074
K	075
L	076
M	077
N	078
O	079
P	080
Q	081
R	082
S	083
T	084
U	085

ASCII Character	Decimal Value
V	086
W	087
X	088
Y	089
Z	090
[	091
\	092
]	093
^	094
_	095
`	096
a	097
b	098
c	099
d	100
e	101
f	102
g	103
h	104
i	105
j	106
k	107
l	108
m	109
n	110
o	111
p	112
q	113
r	114
s	115
t	116
u	117
v	118
w	119
x	120
y	121
z	122
{	123
|	124
}	125
~	126
	127

Registers

Registers within the CH80215 store critical configuration parameters. Each of the registers is defined below.

S2 Exit Character: S2 determines the ASCII character that will be used to exit RF data mode and enter command mode. Values of 000 to 127 define valid ASCII characters.

Range: 0 to 127
Units: ASCII Character Definition
Default: 126 (~)

S3 Command Line Termination Character: S3 sets the character used to terminate a command line.

Range: 0 to 127
Units: ASCII Character Definition
Default: 13 (carriage return)

S4 Line Feed Character: S4 defines the character to be use as the linefeed character in modem responses.

Range: 0 to 127
Units: ASCII Character Definition
Default: 13 (carriage return)

S5 Backspace Character: S5 defines the character to be use as the backspace character to edit command strings.

Range: 0 to 127
Units: ASCII Character Definition
Default: 008 (backspace)

S7 Connect Time: S7 determines how long the CH80215 will attempt to establish a link.

Range: 0 to 60
Units: seconds
Default: 010

S12 Guard Timer: S12 sets the guard timer before and after the exit character. If any data bits are received within the guard timer the exit character will be handled as normal data.

Range: 0 to 255
Units: 50 millisecond increments
Default: 050 (20 milliseconds)

S23 Serial Interface Speed: S23 sets the speed of the serial interface. Values are as shown below.

1 = 1200 bits per second
2 = 2400 bits per second
3 = 4800 bits per second
4 = 9600 bits per second
5 = 14,400 bits per second
6 = * 19,200 bits per second
7 = 28,800 bits per second
8 = 38,400 bits per second
9 = 57,600 bits per second
10 = 115,200 bits per second
11 = 230,400 bits per second

S95 RF Monitor Interval: S95 determines the interval at which the CH80215 awakens in the RF Monitor mode to check for an RF signal.

Range: 1 to 60
Units: seconds
Default: 2 (wake after 2 seconds of sleep)

S96 Digital Output Level: S96 sets the output level of any I/O lines defined by register S97 as an output. If the I/O is defined as an input this register is ignored.

Bit 0-3 Not used
Bit 4 0 = DIO3 is an output low
1 = DIO3 is an output high
Bit 5 0 = DIO2 is an output low
1 = DIO2 is an output high
Bit 6 0 = DIO1 is an output low
1 = DIO1 is an output high
Bit 7 0 = DIO0 is an output low
1 = DIO0 is an output high

S97I/O Configuration: S97 is a bit-mapped register storing the definition of the local digital I/O lines.

Bit 0-3 Not used
Bit 4 0 = DIO3 defined as an output
1 = DIO3 defined as an input
Bit 5 0 = DIO2 defined as an output
1 = DIO2 defined as an input
Bit 6 0 = DIO1 defined as an output
1 = DIO1 defined as an input
Bit 7 0 = DIO0 defined as an output
1 = DIO0 defined as an input

S98 Transmit Level Control: S98 sets the transmitter output level on CH80215 models with a 20 dBm maximum transmit level.

0 * = 20 dBm (100 mW)
1 = 10 dBm (10 mW)
2 = 0 dBm (1 mW)
3 = -10 dBm (0.1 mW)

S99 Set RSSI Threshold: S99 sets the threshold for reporting the transceivers Receive Signal Strength Indication.

S104 64-bit IEEE Address: S104 is a read-only register which contains the IEEE address. The address is displayed in Hex format.

S105 Personal Area Network (PAN) Identification: S105 assigns the Pan Identification Number for the transceiver. The CH80215 can only communicate with other nodes sharing the same PAN identification Number.

Range: 0000 to FFFF
Units: Hex Address

S106 2.4 GHZ Channel Selection: S106 is a bit-mapped register that allows the user to select which of the IEEE 802.15.4 channels the transceiver will use. The default value of this register is 7FFF.

Bit 0 - 2405 MHz
Bit 1 - 2410 MHz
Bit 2 - 2415 MHz
Bit 3 - 2420 MHz
Bit 4 - 2425 MHz
Bit 5 - 2430 MHz
Bit 6 - 2435 MHz
Bit 7 - 2440 MHz
Bit 8 - 2445 MHz
Bit 9 - 2450 MHz
Bit 10 - 2455 MHz
Bit 11 - 2460 MHz
Bit 12 - 2465 MHz
Bit 13 - 2470 MHz
Bit 14 - 2475 MHz
Bit 15 - 2480 MHz

S107 16-Bit Node Address: S107 stores the address of the node in the PAN.

Range: 0000 to FFFF
Units: Hex Address

Table 3: CH80215 Result Codes

Numeric Responses	Full Word Responses	Description
0	OK	Command line was successfully executed.
1	CONNECT RF	The transceiver has joined a network
2	JOIN?	A request has been received to join the network or cluster.
3	ORPHANED	The network has been lost.
4	ERROR	An error has occurred in the command line.
6	REQUEST REJECTED	Your request to join the PAN has been rejected.
7	DEVICE NOT FOUND	No device was found at the requested address.
9	TIMEOUT	The requested activity was aborted due to expiration of a system timer.

DEFAULT STATUS, PERFORMANCE, AND SPECIFICATIONS

Command Summary: Tables 4 and 5 below summarize the CH80215 commands and registers including the Default Configuration Profile installed by Cermetek Microelectronics, Incorporated, prior to delivery. Immediate action commands do not have a stored value.

Table 4: CH80215 Command Summary

Register	Function	Selections	Saved in NVRAM	Factory Defaults
D	Establish Wireless Network	Target Address		
E	Escape Character	0 = No character echo 1 = Echo characters	*	1
I	Product Identification	0 = Product Code 1 = Date Code and Revision		
Q	Result Codes	0 = Result Codes Displayed 1 =1 Do Not Display Result Codes	*	0
S	Set Register Value	Register Dependent		
V	Type of Response	0 = Numeric Responses 1 = Full Word Responses	*	1
Z	Soft Reset			
&IAn?	Read Local Analog Inputs	A0 = Read ADC0 A1 = Read ADC1		
&Dn?	Read Local Digital Inputs	D0 = Read Input DIO0 D1 = Read Input DIO1 D2 = Read Input DIO2 D3 = Read Input DIO3		
&Dn=z	Set Local Digital Outputs	D0=0 – Set Output DIO0 Low D0=1 – Set Output DIO0 High D1=0 – Set Output DI10 Low D1=1 – Set Output DI10 High D2=0 – Set Output DI20 Low D2=1 – Set Output DI20 High D3=0 – Set Output DI30 Low D3=1 – Set Output DI30 High		
&S	Secure Data	0 = Data Not Secure 1 = Data Secure	*	1
&V	Display Active Configuration			
&W	Store Current Configuration	0 = Store as Profile 0 1 = Store as Profile 1	*	0
&Y	Profile on Reset/power-up	0 = Restore Profile 0 1 = Restore Profile 1	*	0
\B	Character Format	1 = Seven data bits, no parity, one stop bit 2 = Seven data bits, parity bit, one stop bit 3 = Eight data bits, no parity, one stop bit 5 = Eight data bits, parity bit, one stop bit	*	3

Table 4: CH80215 Command Summary (continued)

Register	Function	Selections	Saved in NVRAM	Factory Defaults
\P	Parity Selection	0 = Even Parity 1 = Odd Parity 2 = Mark Parity	*	0
\Q	Flow Control	0 = No Flow Control 1 = RTS/CTS Flow Control 2 = XON/XOFF Flow Control	*	1
\T	DTE interface Speed	6 = 9600 bits per second 9 = 19,200 bits per second 10 = 38,400 bits per second 11 = 57,600 bits per second 12 = 115,200 bits per second 13 = 230,400 bits per second	*	7FFF
#E	Join Active Network			
#F	Build new Network			
#IxxxxA	Read Analog Input at Node xxxx	0 = Read ADCO 1 = Read ADC1		
#IxxxxD	Read Digital Input at Node xxxx	0 = Read DIO0 1 = Read DIO1 2 = Read DIO2 3 = Read DIOI3		
#IxxxxDn=z	Set Digital Output at Node xxxx	D0=0 – Set Output DIO0 Low D0=1 – Set Output DIO0 High D1=0 – Set Output DI10 Low D1=1 – Set Output DI10 High D2=0 – Set Output DI20 Low D2=1 – Set Output DI20 High D3=0 – Set Output DI30 Low D3=1 – Set Output DI30 High		
#M	Define Node Type	0 = Endpoint, Reduced Function Device 1 = Endpoint, Full Function Device 2 = Router 3 = Network Coordinator	*	2
#P	Low Power Operation	0 = Idle Mode 1 = Sleep Mode 2 = RF Power Down Mode 3 = RF Monitor Mode	*	0

Table 5: CH80215 S-Register Summary

Register	Function	Range	Units	Saved	Factory Defaults
S0	Automatically Join Network	0-1		*	001
S2	Escape Character	0-255	ASCII	*	126
S3	Carriage Return Character	0-127	ASCII		013
S4	Line Feed Character	0-127	ASCII		010
S5	Backspace Character	0-255	ASCII		008
S7	Connect Time	0-60	seconds	*	010
S12	Escape Guard Timer	0-255	0.02 seconds	*	050
S23	Serial Interface Speed	1-11	bits per second		006
S95	RF Monitor Interval	1-60	seconds	*	002
S96	Digital Output Level		Bit-mapped		000
S97	I/O Configuration		Bit-mapped		000
S98	Transmit Level Control	0-3	dBm		000
S99	RSSI Threshold				048
S104	64-bit IEEE Address (read only)	0-FFFFFFFFFFFFFFFF	Bit-mapped		
S105	Personal Area Network ID	0-FFFF	Bit-mapped	*	
S106	80215.4 Channel Selection	0-FFFF	Bit-mapped	*	7FFF
S107	16-bit Node Address	0-FFFF	Bit-mapped	*	

NOTES:
1. Parameters indicated with a (*) in the Saved column may be stored in User Profile n=0, 1 by executing the appropriate &Wn command.
2. A stored Profile is a subset of allowed parameters and is comprised of those parameters displayed with the **&V** command.
3. Restore Firmware Default values using &F command

Serial Interface Lines

The CH80215 supports a full EIA-232E/V.24 serial interface. The signal levels of the interface are TTL rather than EIA-232E level compatible, which allows direct connection of the CH80215 to the host UART without the need for external line drivers and receivers. See Table 8 for a complete pin description. The CH80215 is controlled by sending it serial commands over TXD and its status determined by monitoring the serial status messages returned on RXD. DTR is optionally used to reset, terminate calls or return CH80215 to command mode.

All other serial interface lines may be utilized for the convenience of a particular application. They are not required by the CH80215 but may be selected by the user's initialization string. Unused outputs (from modem) should be left unconnected. Unused inputs should be set to the proper logic level. See Table 8.

FCC PART 15 REGULATIONS

Mounting the CH80215 in Your Assembly

The CH80215 must be mounted horizontally on your printed circuit board to maintain proper orientation of the transceiver. The CH80215 may not be co-located with any other antenna or transmitter.

Antenna

The CH80215 is certified for compliance to FCC Part 15 rules only using the on board chip antenna. Use of any other antenna invalidates the FCC conveyed compliance and requires the end application employing the CH80215 to seek FCC Part 15 approval.

FCC Part 15 Certification (Pending)

Certification of the CH80215 per FCC Part 15 rules for integration into OEM products is pending. This certification is your assurance that the CH80215 will not cause harmful interference.

Labeling Requirements

FCC rules require the Original Equipment Manufacturer using the CH80215 to place an appropriate label on the outside of the finished equipment. The label must be clearly visible and include the information shown below.

Contains Transmitter Module
FCC ID: DWE-CH80215

WARNING:

This device complies with Part 15 of the FCC Rules. Its operation is subject to the following conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any received interference including interference that may cause undesired operation.

Limitations

The CH80215 is registered under FCC Part 15 Rules. To utilize this registration on your OEM System you must follow the applications circuit provided in this data sheet and use the listed antenna. Any changes or modifications to the recommended circuit must be approved by Cermetek. Failure to seek Cermetek approval for modifications could void certification of the end product.

Warning: RF Exposure

The CH80215 is approved for mobile, base station applications. A minimum separation of 20 centimeters should be maintained between the antenna and the equipment operator. To ensure compliance, operation at distances closer than those defined is not recommended.

The Warning message below must be included in the user Manual for the end product.

To comply with FCC RF exposure requirements for mobile transmitting devices, this transmitter should only be used or installed at locations where there is at least 20 cm separation distance between the antenna and all persons.

FCC Notifications

The CH80215 generates radio frequency energy. It must be installed according to the manufacturer's guidelines stated in this data sheet or it has the potential to cause interference with other radio devices. Testing has been performed to assure conformance to the FCC Part 15 rules for intentional and unintentional radiators.

No further EMI compliance testing of the *transmitter* is required as long as the 20 cm separation and co-location requirements are observed. Each new use of the module will, however, need to be scanned for unintentional radiation from digital clocks, etc.

All necessary calibration has been performed at the time of manufacture. Any modification of the device after it leaves the factory is a violation of FCC rules and invalidates the conveyed FCC approval.

Handling and Assembly Recommendations

The CH80215 contains static-sensitive components and should only be handled by personnel and in areas that are properly protected against static discharge. The recommended mounting technique the CH80215 to a PCB is described below.

CH80215 Solder Instructions:

Because of its Hybrid construction, the CH80215 is subject to damage if over-exposed to heat during solder operations. Following the soldering instructions below will ensure that the process of soldering the module to the board does not damage the unit.

Absolute Maximum Temperature	250° C
Maximum Time at 235° C	15 Seconds
Maximum Time in reflow zone (217° C)	90 Seconds
Maximum Preheat Dwell Time	180 Seconds

Figure 5: Maximum Recommended Solder Profile

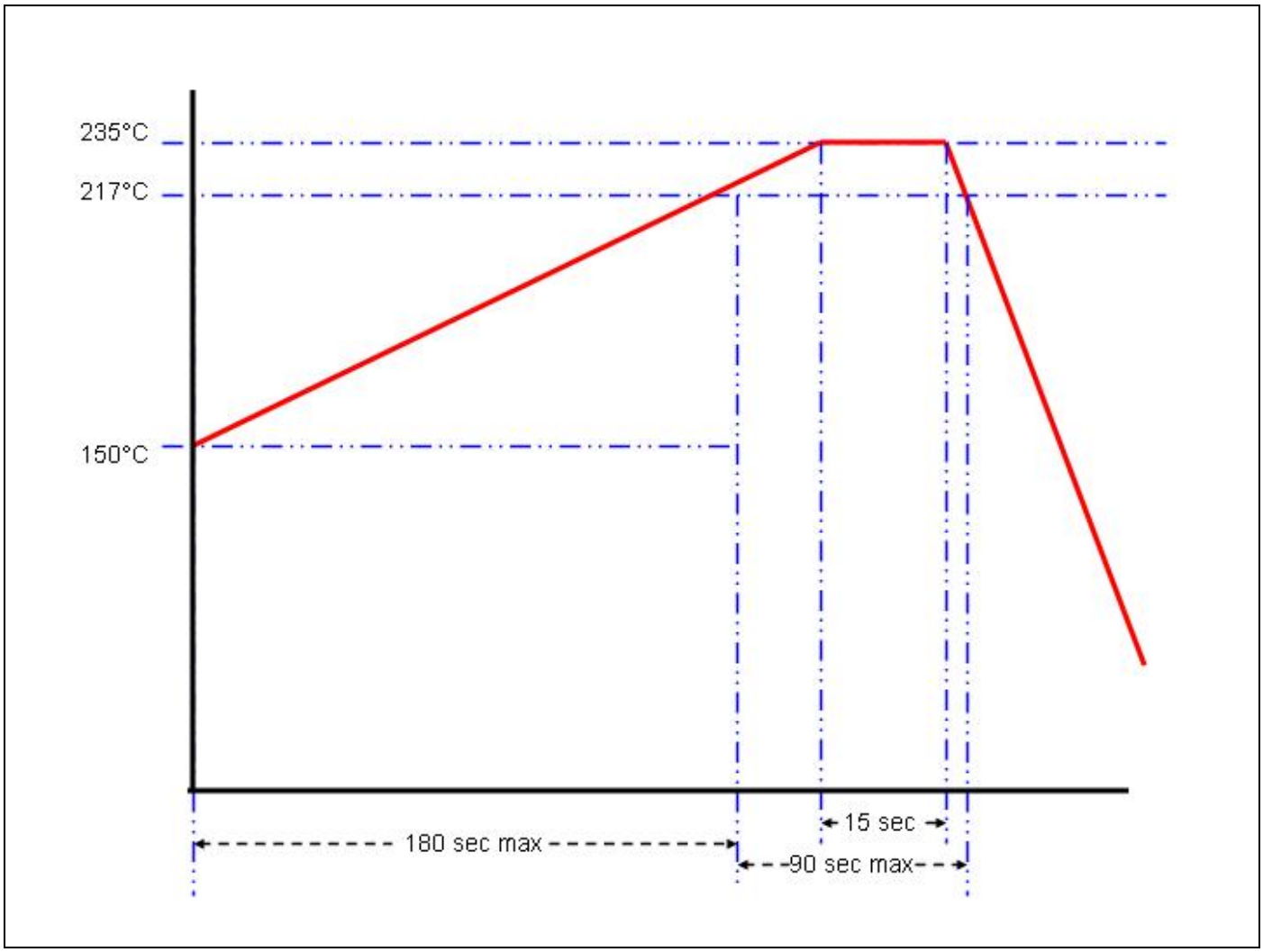


Table 6: CH80215 Electrical Specifications

Parameter	Notes	Min.	Typ.	Max.	Units
V_{CC}	Supply Voltage- Noise less than 50mV	2.7	3.3	3.6	V
Output Power	High Power Products (User Programmable)	-10		20	dBm
	Low Power Products		0	0	dBm
Receive Sensitivity	All Models	-91			dBm
Obstructed Range	Transmit power 0 dBm; (through 3 walls)		100		Feet
	Transmit Power 20 dBm; (through 3 walls)		350		Feet
Antenna Gain	On board Chip antenna		0		dB
Voh	VCC equal to 3.3 Volts	2.25			V
Vol	VCC equal to 3.3 Volts			0.75	V
Vih	VCC equal to 3.3 Volts	2.25			V
Vil	VCC equal to 3.3 Volts			0.75	V
ADC Input	10-bit Analog to Digital Converter	0		VCC	Volts
Test conditions: Temp = 0°C to 70°F					

Table 7: CH80215 Absolute Maximum Ratings

Parameter	Notes	Minimum	Maximum	Units
VCC		2.7	3.6	Volts
Storage Temperature		-55	100	Degrees Celsius
Operating temperature	Extended temperature parts available	0	70	Degrees Celsius

Table 8: CH80215 Pin Functions

PACKAGE CONNECTION TABLE			
PIN NO.	**FUNCTION**	**PIN NO.**	**FUNCTION**
1	VCC	8	DIO3
2	/RTS	9	DIO2
3	/CTS	10	DIO1
4	/RXD	11	DIO0
5	/TXD	12	ADC1
6	/RESET	13	ADC0
7	GND	14	GND

CH80215 PIN DESCRIPTIONS

Pin # Description

1 VCC; VCC provides 3.3 Volt power to the transceiver

2 /RTS; Request to Send is an active low input to the CH80215. With hardware flow control activated, the host equipment uses Request to Send to control the flow of data from the modem on the /RXD line. The host deactivates /RTS when its buffers near capacity to prevent the loss of data. Data flow from the CH80215 resumes when /RTS is reactivated.

3 /CTS; Clear to Send is an active low output from the CH80215. With hardware flow control activated, the transceiver uses Clear to Send to signal the host that the input buffers cannot accept more data. The CH80215 activates /CTS to signal the host to resume the flow of data to the transceiver on /TXD.

4 /RXD; Received Data is an active low output from the CH80215. Data received over the RF link passes to the host via /RXD.

5 /TXD; Transmit data is an active low input to the CH80215. Data placed on /TXD by the host system will be transmitted over the RF link.

6 /RESET; Reset is an active low input to the CH80215. Activating Reset restarts the CH80215 hardware and firmware.

7 GND; Ground provides a signal ground for the CH80215.

Pin # Description

8 DIO3; DIO3 is one of four digital control lines connected directly to the CH80215 communications controller. DIO3 may be programmed as either a digital input or as a digital output.

9 DIO2; DIO2 is one of four digital control lines connected directly to the CH80215 communications controller. DIO2 may be programmed as either a digital input or as a digital output.

10 DIO1; DIO1 is one of four digital control lines connected directly to the CH80215 communications controller. DIO1 may be programmed as either a digital input or as a digital output.

11 DIO0; DIO0 is one of four digital control lines connected directly to the CH80215 communications controller. DIO0 may be programmed as either a digital input or as a digital output.

12 ADC1; ADC1 is one of two analog inputs connected to an internal 10-bit analog to digital converter. ADC1 may also be programmed as a digital input if no analog inputs are required.

13 ADC0; ADC0 is one of two analog inputs connected to an internal 10-bit analog to digital converter. ADC0 may also be programmed as a digital input if no analog inputs are required.

14 GND; Ground provides a signal ground for the CH80215.

Figure 6: CH80215 Mechanical Dimensions, Surface Mount Versions

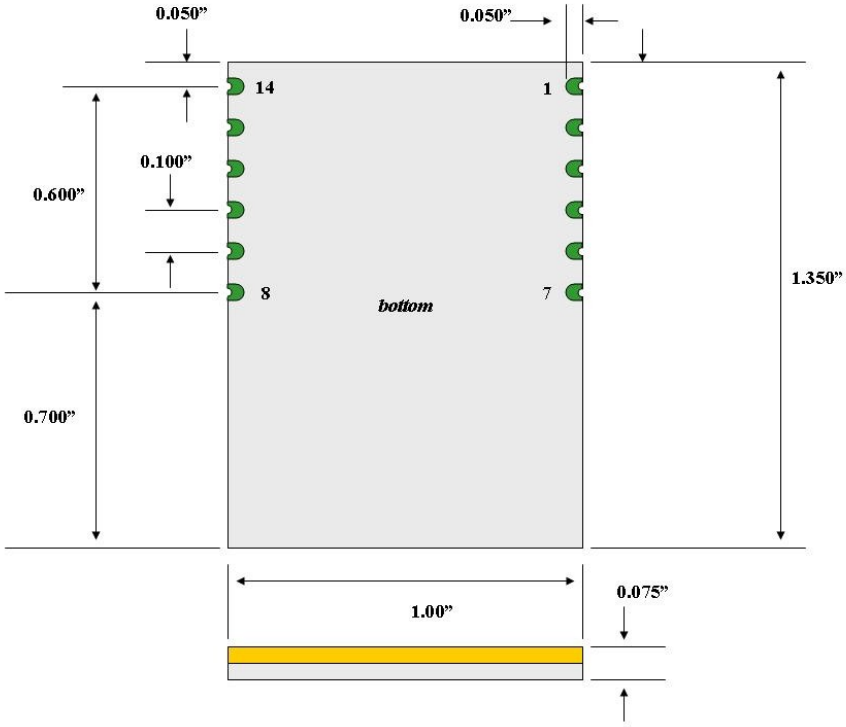
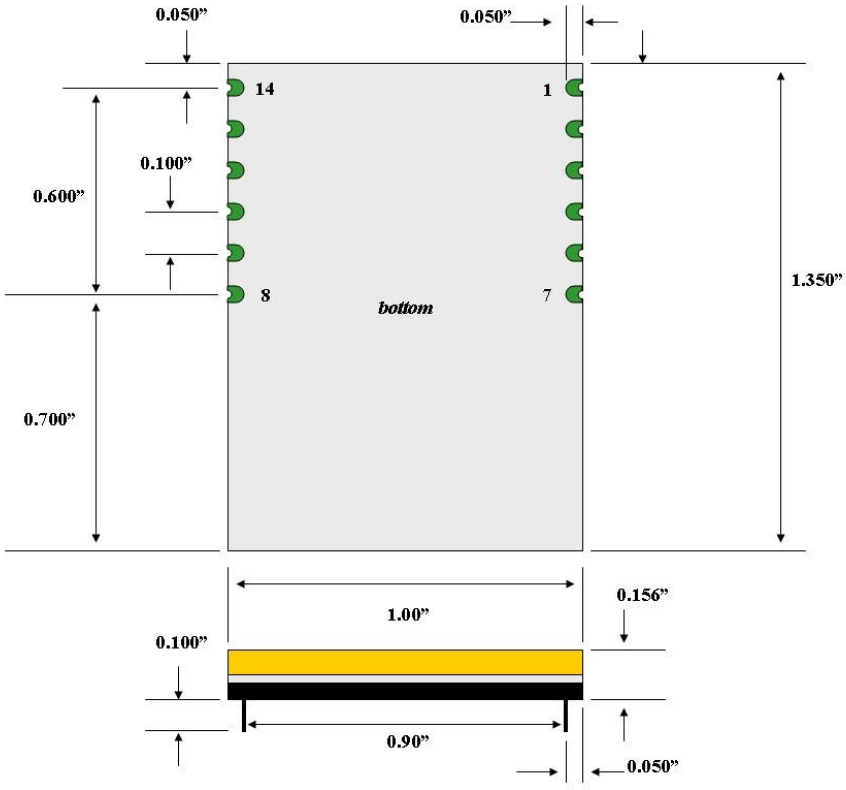


Figure 7: CH80215 Mechanical Dimensions, Through-Hole Versions



Model Numbers

Cermetek offers a variety of CH80215 models. The variations include Node type, output power, and the type of lead attachment. These choices provide the user with flexibility in building his network and in assembling his systems. The variations are listed below.

Table 9: CH80215 Model Numbers

Model	Summary of Features
CH80215-S00	Cermetek IEEE 802.15.4, Surface-mount module, Maximum output 0 dBm
CH80215-S20	Cermetek IEEE 802.15.4, Surface-mount module, Maximum output 20 dBm
CH80215-T00	Cermetek IEEE 802.15.4, Thru-hole module, Maximum output 0 dBm
CH80215-T20	Cermetek IEEE 802.15.4, Thru-hole module, Maximum output 20 dBm
CH80215-S00 ET	Cermetek IEEE 802.15.4, Surface-mount module, Maximum output 0 dBm, -40°C to +85° Operation
CH80215-S20 ET	Cermetek IEEE 802.15.4, Surface-mount module, Maximum output 20 dBm, -40°C to +85° Operation
CH80215-T00 ET	Cermetek IEEE 802.15.4, Thru-hole module, Maximum output 0 dBm, -40°C to +85° Operation
CH80215-T20 ET	Cermetek IEEE 802.15.4, Thru-hole module, Maximum output 20 dBm, -40°C to +85° Operation

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