BACnet CCM
WRV-CCMBAC &WDY-CCMBAC
MS/TP (RS 485) Protocol

Contents

Change History

Revision	Comments
1.0	Original Release
1.1	Revised section 3.4 and added BV6 and BV7

1 Purpose

This document describes the BACnet communications protocol for the Douglas Lighting Controls (DLC) BACnet CCM Controller (WRV-CCMBAC & WDY-CCMBAC)). This product provides a software-implemented network interface between BACnet client devices and CCM-BAC monitoring points. Once the module is configured, the CCM-BAC controller is a native BACnet controller device with MS/TP capabilities.

The CCM-BAC communicates with other BACnet devices and maintain proactive status of various real-time measurements. Information is published for use by BACnet devices and a limited number of parameters can be changed by BACnet client devices and conveyed to the controller. The CCM controller is used in the following products: WRV-CCMBAC & WDY-CCMBAC.

2 Operational Overview

This section provides a high level operational overview in the following sections:

- Daylight Harvesting / Zoning
- The Commissioning Process
- Timing Considerations
- Operating Level

Refer to the other sections of this document for more detailed information.

3 Daylight Harvesting / Zoning

To support Daylight Harvesting (DH), this protocol supports the CCM addressing ballasts in three different Zones – Zone-A, Zone-B, and Zone-C. Ballasts addressed prior to DH are all in Zone-A. The BACnet objects relating to setting the dim level include:

- Desired Power Level
- Fade Rate or Time
- Scene Index
- Fade Index.

Operations not related to dimming are addressed to Zone-A. In particular, relay-on and relay-off commands are only valid for Zone-A. The CCM uses an additional zone called Zone-T to send commands to commission ballasts. Note that some versions of the CCM only support Zone-A.

3.1.1 Circuit Control Module (CCM) Functionality

The CCM-BAC CCM functionality is similar to the operation of the existing Bacnet and MODBUS units and includes the following functions:

1. Control the power of the ballasts from a Minimum to a Maximum level.
2. Turn power on/off using the relay CCM's internal relay.
3. Ability to gradually change the output power to a new level based on either a rate or a time interval.
4. Support indirect control of power levels and fade rates/times using Scenes and Fade tables.
5. Measurement of circuit Voltage, Current, Power and processor Temperature.
6. Ability to read and write Configuration Data.

7. Ability to modify default behavior using Binary Value options.

3.1.2 Circuit Control Module Configuration with Binary Value Options

The Binary Value (BV's) Objects are used to modify the default operation of the CCM as follows:

1. BV0: Use Fade Time – If set to 0 then the fade rate is used to slew to the new desired power level, and if set to zero then the fade time is used to slew to the new desired power. The relationship is: Fade Rate = |Current Power – New Power| / Fade Time
2. BV1: Zero Not Off – The default operation of the CCM is to interpret a commanded level of 0% to Zone A as a command to turn off circuit power using the internal relay. However if BV1 is set to 1 then a commanded level of 0% is ignored for Zone A and the relay state is controlled by object BV100 (Relay Output).
3. BV2: Relay output Power-On – This value is use to set the power-on state of the relay; 1 for On (power to circuit / default) and 0 for Off (relay is open).
4. BV3: Exclude Levels – Setting to 1 will cause certain level to be excluded. Only use if issued related to false locking of ballast levels is encountered. The following level requests will be modified as listed:
   4.1. 81% --> 80%
   4.2. 87% --> 86%
   4.3. 88% --> 89%
   4.4. 94% -->93%
5. BV4: Alternate Reset – Warning: USE WITH CARE! Writing to this variable will cause the CCM to do a processor reset.
6. BV5: Alarm Status – Read as 1 if an alarm condition is set. The reason for the alarm is specified in MSI1. Write either 0 or 1 to BV5 to clear the alarm condition. However, if the alarm condition persists, then the value will immediately be set back to 1 by the CCM firmware.
7. BV6-BV7: Reserved for future use
8. BV100: Relay Output – This variable is used to open (0) or close (1) the relay contacts if BV1 =1; otherwise this variable is ignored

3.2 The Commissioning Process

During the Commissioning Process, the MAC Address, Device ID, Baud rate, and Heartbeat timeout are stored in non-volatile (Flash) memory in the CCM.

Douglas Lighting provides a handheld Commissioning Tool; the CCM-BAC-PRG, that will allows users to configure the module.

A system integrator may alternately use BACnet commands to set the values of the objects in section 4.

3.2.1 Node ID Commissioning

All Douglas Lighting CCMs are factory programmed with MAC (base) address set to 0. This base address is added to the MAC address set by the DIP switches to set the MAC address of the CCM. For hardware that does not contain switches, the MAC address is set by the desired MAC Address object. When a customer places an order for a Panel containing CCMs, the MAC Addresses are custom programmed into the CCMs according to the sales order, or with default MAC Addresses according to the location of the CCM within the Panel.

3.3 Timing Considerations

3.3.1 Processor Watch-Dog Timer

The CCM contains a Watch Dog Timer which must be reset every 256ms by the CCM, or the CCM processor will be Reset. This timer prevents the code from hanging due to software bugs or unexpected conditions. The Alarm-State and Red LED are set if the Watch-Dog Timer is not reset. The BACnet controller has no control over this timing value.

3.3.1.1 Heartbeat Timeout

The BACnet controller must send a command to the RS485 bus every N seconds (usually 90 sec), or the CCMs will command the ballast to go to the Default Operating-Level. The system ignores a Heartbeat-Timeout if the timeout value is zero. Receipt of any valid message will reset the Heartbeat-Timeout timer, e.g. a NOP command broadcast to all nodes.

3.3.1.2 Power Cycling

Since the CCM does not retain its current Desired Power Levels, e following a loss of AC power, it will be necessary to re-send the current Desired Power Levels or Scene Index after a power loss.

3.4 Operating Level

An Operating-Level command in the range of 0-100% (1% steps) may be sent to the CCM. For the WDY-CCMBAC, operating level is translated as a command for ballast input power, and is internally restricted to a low of 34%. For the WRV-CCMBAC, operating level is translated as a command for light output and has no such restriction. For both systems, the absolute low end operation is determined by ballast capabilities – please refer to the ballast cut sheets for this information. Additionally, the CCM relay will be opened when an operating-level of 0 is commanded to Zone-A, resulting in a power interruption to the ballast loads. Both CCM types support three Zones (A, B, and C), however all status and data such as temperature, voltage, and current are associated with Zone-A.

3.4.1 Fade-Rate

This value is the delay in seconds between reductions or increases in operating levels applying to all transitions. Since there are 100 operating- levels, it is the time it takes to fade (1/100) or 1.0% of full scale. For example, if the fade rate is 10 and the users change the operating level from 100% to 50%, then the time to fade is 10 x 50 = 500 seconds. A Fade-Rate of 0 indicates that the Operating-Level should be immediately set. A Fade-Rate of 127 (0x7F) indicates that the CCM should use the Default programmed Fade-Rate for that node.

Note: It may take an additional 20 to 30 seconds for the lamp to respond to a change in level due to the inherent "lag" in communications between the CCM and the ballast.

3.4.2 Fade Time

With the appropriate Configuration Data State-bit set, the user can specify the Fade Time instead of the fade rate. The Fade Time is the time it will take to achieve the next commanded level. This time is only approximate as the CCM converts the Fade Time into an equivalent Fade Rate that is used internally in the CCM to fade to the desired level. The maximum Fade Time is 127 seconds. Use the Fade-Rate if longer time delays are required.

3.5 Relay State

0 – "Yellow," meaning Red and Green, LED is ON and Relay contacts are open

1 – Green LED is on and Relay contacts are closed, and the lights have power

3.6 LED States

There is a single bi-color LED visible on the CCM: The colors provided are Red, Green, and Yellow. The use of each LED color is as follows:

3.6.1 Red LED

When lit this indicates an Alarm or Fault condition. The LED will blink the associated Error-Code when the Alarm Status bit is set. The Red LED also illuminates upon a Reset or Power-On of the CCM processor. The Red LED turns off after receipt of a valid command. This LED will blink at a 1/4 second rate to indicate an alarm condition with a pause of 1 second between blinks. The number of blinks indicates the Error-Code. The Red LED is also on during CCM programming over an RS485 link.

3.6.2 Green LED

Indicates that the CCM has power and is operating normally and that the relay contacts are closed and the lamps are lit. This LED may blink as a diagnostic aid to help locate the CCM in a panel.

3.6.3 Yellow LED

Indicates that power is present, but the CCM Relay contacts are open and that the ballasts are not receiving A/C power. The indicator is a bi-color Red/Green LED with both colors illuminated. (Yellow = Red + Green).

3.6.4 Alarm States

An alarm condition indicates that an internal error has occurred. This alarm will also be set following initial power-up of the CCM slave. The Red LED will blink an Error Code whenever there is an Alarm condition. If there are no internal errors, the alarm clears with any subsequent valid command received. If the alarm bit does not clear following an Operating-level change command, it may indicate a hardware failure.
Monitoring of the alarm state will allow the HOST to recognize that an individual CCM has lost power. Since the CCM does not retain its current Operating-level state following a loss of AC power, it will be necessary to re-send the current Operating-level or scene recall state.

3.6.5 CCM Error Codes

The Error reported in MSI1 gives additional information about the Alarm State.
They correspond to a Red LED that blinks differently according to the Alarm States, except for an Error Code Value of one that displays a Solid Red LED.

Values:

0	NO_ERR
1	POWER_ON or WDT RESET (Solid RED – does not blink)
2	HEART_BEAT_TIMEOUT
3	OVER_TEMPERATURE
4	ERASE_ERROR
5	DATA_OVERRUN
6	BAD_RELAY_EVENT
7	BAD_COMMAND
8	BAD_TIMER_UNITS
9	WRITE_ERROR
10	MISSING ZERO CROSSING
11	LOW_VOLTAGE_DETECT_RESET,
12	SERIAL_NUMBER_PROGRAMMING_FAULT
13	PROGRAM_CHECKSUM_ERROR
14	FACTORY_CHECKSUM_ERROR
15	CONFIG_CHECKSUM_ERROR

3.7 Processor Temperature

This optional value may be present if supported by the microprocessor used in the CCM. The processor temperature reading returns the internal core temperature of the embedded microcontroller inside the CCM unit.

3.8 Configuration Parameters

The CCM has a limited amount of local FLASH memory used to retain parameters between power cycles without the need for reloading these parameters by the BACnet controller. This data is stored in “Write Once” FLASH memory. The configuration data is mapped into individual BACnet objects.

The following values are stored as Configuration Data (with recommended default values):

- Node ID (uninitialized value is 0xFF)
- Min Commissioned Operating-Level (1 byte – default is 50%)
- Max Commissioned Operating-Level (1 byte – default is 100%)
- Default Fade-Rate (1 byte – default is 10; 0-127 seconds / 1% change)
- Default Power Level (default is 80%)
- Default Relay State on power-up (default is 1 = closed contacts)
- Heartbeat timeout in seconds (default is 90 seconds)
- Operating-Level Scene array (16 bytes)
- Fade-Rate Scene array (8 bytes)
- Other data use by program internally

3.8.1 Minimum Commissioned Operating-Level

The Min-Commissioned Operating-Level specifies the minimum commanded operating-level. This value is normally set during the commissioning process. If a commanded level is less than this value, then it is set to the Minimum Commissioned Operating Level. This value is specified by the Max_Pres_Value property of the Desired Power Level objects.

3.8.2 Maximum Commissioned Operating-Level

The Max-Commissioned Operating-Level specifies the maximum commanded operating-level. This value is normally set during the commissioning process. If a commanded level is greater than this value, then it is set to the Maximum Commissioned Operating Level. This value is specified by the Min_Pres_Value property of the Desired Power Level objects.

3.8.3 Default Fade Rate

After a CCM processor reset, the ballasts are set to the Default Fade Rate at the Default Power Level.

3.8.4 Default Power Level

After a CCM processor reset, the ballasts are set to the Default Power Level at the Default Fade Rate.

3.8.5 Default Relay State

The Default Relay State is normally set to 1 (On) to specify closed contacts or power applied to the lamp circuits. This is the state of the Relay during power-up of the CCM.

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3.9 Physical Layer

The physical layer of the communication link is RS-485 with the following specifications.

Baud Rate:	38400 Bits per second
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

RS232 Signaling is also supported, but this requires the use of an external signal converter to convert RS232 signals to RS485 signals. RS232 Signaling may need to use hardware flow-control to work properly with the external signal converter. Any CCM slaves connect together with straight-through RJ45 network cables. See Appendix 6.1 for more information.

Baud Rates supported are 9600, 19200, 38400, 57600, 76800 and 115200 baud

3.9.1 Vendor ID

The vendorID is 559. The Device Instances defaults to 559000. When WriteProperty service requests using the wildcard Device instance are received, the Device Object_Identifier may be written with a new device instance which is retained in FLASHmemory. Inter-character Delay

3.9.2 BIBB Support

The CCM-BAC generally behaves as a B-ASC type profile server. The following specific BIBBs are supported per their relevant definitions in Annex K to BACnet:

DS-RP-B, DS-WP-B, DS-RPM-B, DM-DDB-B, DM-DOB-B, DM-DCC-B.

3.9.3 Alarms

Although the CCM-BAC supports the ability to indicate various alarm conditions through value changes in properties of several of its objects, it does NOT generate BACnet Event Notifications.

4 Objects Supported

The CCM-BAC supports 176 BACnet standard objects that represent the controller itself. Properties are **R**eadonly, **W**ritable in RAM, or Writeable in **F**lash. Writeable properties are also readable.

DEx	Object_Identifier	default to DE559000	F
	Object_Name	Up to 64 characters	F
	Object_Type	DEVICE	R
	System_Status	OPERATIONAL or NON_OPERATIONAL	R
	Vendor_Name	"Douglas Lighting Controls Inc."	R
	Vendor_Identifier	559	R
	Model_Name	"WRV-CCMBAC or WDY-CCMBAC"	R
	Firmware_Revision	"aa|bb|cc|dd" SN, Fmw, Hdw, Boot ver	R
	Application_Software_Version	"1.00"	R
	Description	Up to 64 characters	F
	Protocol_Version	1	R
	Protocol_Revision	12	R
	Protocol_Services_Supported	{ readProperty, writeProperty, readPropertyMultiple, deviceCommunicationControl, who-Has, who-Is, i-Am, unconfirmedCOVNotification, reinitializeDevice, atomicReadFile, atomicWriteFile }	R
	Protocol_Object_Types_Supported	{ AnalogInput, AnalogOutput, AnalogValue, BinaryValue, Device, MultistateInput, MultistateValue, Positive Integer Value }	R
	Object_List DEx, AI1, AI2, AI3, AI4, AI100, AI200, AI300, AO100, AO200, AO300, AV0, AV1, AV2, AV3, AV4, AV5, AV100, AV101, AV102, AV1100, AV1101, AV1102, AV1103, AV1104, AV1105, AV1106, AV1107, AV1108, AV1109, AV1110, AV1111, AV1112, AV1113, AV1114, AV1115, AV1116, AV1117, AV1118, AV1119, AV1120, AV1121, AV1122, AV1123, AV1124, AV1125, AV1126, AV1127, AV1128, AV2100, AV2101, AV2102, AV2103, AV2104, AV2105, AV2106, AV2107, AV2108, AV2109, AV2110, AV2111, AV2112, AV2113, AV2114, AV200, AV201, AV202, AV1200, AV1201, AV1202, AV1203, AV1204, AV1205, AV1206, AV1207, AV1208, AV1209, AV1210, AV1211, AV1212, AV1213, AV1214, AV1215, AV1216, AV1217, AV1218, AV1219, AV1220,		R

	AV1221, AV1222, AV1223, AV1224, AV1225, AV1226, AV1227, AV1228, AV2200, AV2201, AV2202, AV2203, AV2204, AV2205, AV2206, AV2207, AV2208, AV2209, AV2210, AV2211, AV2212, AV2213, AV2214, AV300, AV301, AV302, AV1300, AV1301, AV1302, AV1303, AV1304, AV1305, AV1306, AV1307, AV1308, AV1309, AV1310, AV1311, AV1312, AV1313, AV1314, AV1315, AV1316, AV1317, AV1318, AV1319, AV1320, AV1321, AV1322, AV1323, AV1324, AV1325, AV1326, AV1327, AV1328, AV2300, AV2301, AV2302, AV2303, AV2304, AV2305, AV2306, AV2307, AV2308, AV2309, AV2310, AV2311, AV2312, AV2313, AV2314, BV0, BV1, BV2, BV3, BV4, BV5, BV6, BV7, BV100, FI1, FI2, MSI1, MSV1, PIV1		
	Max_APDU_Length_Accepted	480	R
	Segmentation_Supported	NONE	R
	APDU_Timeout	3000 default	R
	Number_Of_APDU_Retries	1 default	R
	Device_Address_Binding	always empty	R
	Database_Revision	X	R
objid	name	notes	R/W
AI1	Actual Power Level	measured feedback	R
AI2	Temperature	Internal processor temp	R
AI3	Voltage	measured load voltage	R
AI4	Current	measured load current	R
AI100	Current Power Level A	0..100	R
AI200	Current Power Level B	0..100	R
AI300	Current Power Level C	0..100	R
AO100	Desired Power Level A	Dimmer setpoint (commandable)	W
AO200	Desired Power Level B	dimmer setpoint (commandable)	W
AO300	Desired Power Level C	dimmer setpoint (commandable)	W
AV0	DesiredMACAddress	0..127	F
AV1	DesiredBaudrate	9600, 19200…	F
AV2	Heartbeat Time	90 seconds, 0=off	F
AV3	Reserved	For Future Use Only.	F
AV4	Reserved	For Future Use Only.	F
AV5	Reserved	For Future Use Only.	F
AV100	Fade Rate A	0..127	F
AV101	Fade Time A	0..127	F
AV102	Scene Index A	dimmer setpoint	W
AV103	Fade Index A	dimmer setpoint	W
AV11xx	Scene[xx] A where xx=0..28	0..100	F
AV21xx	Fade[xx] A where xx=0..14	0 to 127	F
AV200	Fade Rate B	0..127	F
AV201	Fade Time B	0..127	F
AV202	Scene Index B	dimmer setpoint	W
AV203	Fade Index B	dimmer setpoint	W
AV12xx	Scene[xx] B where xx=0..28	0..100	F
AV22xx	Fade[xx] B where xx=0..14	0 to 127	F
AV300	Fade Rate C	0..127	F

AV301	Fade Time C	0..127	F
AV302	Scene Index C	dimmer setpoint	W
AV303	Fade Index C	dimmer setpoint	W
AV13xx	Scene[xx] C where xx=0..28	0..100	F
AV23xx	Fade[xx] C where xx=0..14	0 to 127	F
BV0	UseFadeTime	0=fade rate, 1=fade time	F
BV1	ZeroNotOff		F
BV2	Relay Output Power-On	power-on state for BV100	F
BV3	ExcludeLevels		F
BV4	Alternate Reset	write 1 to reset	W
BV5	Alarm Status / Reset	1 if in alarm; set to 0 or 1 to clear alarm	W
BV6	LogDimming	1 for demandflex DS ballasts.	F
BV7	QuickDim	0	F
BV100	Relay Output	alternate command relay on/off	W
FI1	Configuration Data Block	binary up/download image of parameters	R
FI2	FactoryData		R
FI3	BACnetData		R
MSI1	Error	enumerated error code and text	R
MSV1	LED	1=off, 2=on, 3=blink	W
PIV1	SupervisoryDevice	0..4194303	F

4.1.1 AI Properties Supported

Object_Identifier	dword	R
Object_Name	string	F
Object_Type	dword	R
Present_Value	real	R
Description	string	F
Device_Type	string	R
Status_Flags	bitstring	R
Event_State	dword	R
Reliability	dword	R
Update_Interval	dword	R
Units	dword	R
Min_Pres_Value	real	F
Max_Pres_Value	real	F
Resolution	real	R

4.1.2 AV Properties Supported

Object_Identifier	dword	R
Object_Name	string	F
Object_Type	dword	R
Present_Value	real	W

Description	string	F
Status_Flags	bitstring	R
Event_State	dword	R
Reliability	dword	R
Units	dword	R

4.1.3 AO Properties Supported

Object_Identifier	dword	R
Object_Name	string	F
Object_Type	dword	R
Present_Value	real	W
Description	string	F
Device_Type	string	R
Status_Flags	bitstring	R
Event_State	dword	R
Reliability	dword	R
Units	dword	R
Min_Pres_Value	real	F
Max_Pres_Value	real	F
Resolution	real	R
Relinquish_Default	real	F
Priority_Array	real	R

4.1.4 BV Properties Supported

Object_Identifier	dword	R		
Object_Name	string	F		
Object_Type	dword	R		
Present_Value	real	W		
Description	string	F		
Status_Flags	bitstring	R		
Event_State	dword	R		
Reliability	dword	R		
Inactive_Text	string	F		
Active_Text	string	F		

4.1.5 FI Properties Supported

Object_Identifier	dword	R		
Object_Name	string	F		
Object_Type	dword	R		
Description	string	R		
File_Type	string	R		
File_Size	dword	R		
Modification_Date		datetime	R	
Archive	bool	W		
Read_Only	bool	R		
File_Access_Method		dword	R	always STREAM_ACCESS

4.1.6 MSI Properties Supported

Object_Identifier	dword	R	
Object_Name	string	F	
Object_Type	dword	R	
Present_Value	dword	R	
Description	string	F	
Device_Type	string	R	
Status_Flags	bitstring	R	
Event_State	dword	R	
Reliability	dword	R	
Number_Of_States		dword	R
State_Text	string	R	

4.1.7 MSV Properties Supported

Object_Identifier	dword	R	
Object_Name	string	F	
Object_Type	dword	R	
Present_Value	dword	W	
Description	string	F	
Device_Type	string	R	
Status_Flags	bitstring	R	
Event_State	dword	R	
Reliability	dword	R	
Number_Of_States		dword	R
State_Text	string	R	

4.1.8 Non-Volatile Storage

The CCM-BAC supports storage of various parameters in Flash memory. When these properties of BACnet objects are written using WriteProperty service, the CCM-BAC performs the necessary procedure to write the new values to Flash locations in-situ when appropriate. In general properties marked as W in the object table are updated in RAM and properties marked F are written to Flash any time a new value is received.

4.1.9 Commandability

The AO100, AO200, and AO300 objects are commandable.

4.1.10 Segmentation

The CCM-BAC does not provide this functionality.

4.1.11 Configuration

The CCM-BAC is completely configurable by writing to properties of standard objects.

4.1.12 Cloning

CCM-BAC supports two file objects that can be used/imported to another CCM-BAC as an aide to commissioning.

4.1.13 Default Power Level, MinCommissioned Level, MaxCommissioned Level

The AO100, AO200 and AO300 objects represent Desired Power Levels A, B and C. The standard properties Relinquish_Default (representing Default Power Level), Min_Pres_Value (representing MinCommissioned Level) and Max_Pres_Value (representing MaxCommissioned Level) are used to store these parameters.

4.1.14 Heartbeat

CCM-BAC requires periodic supervision. The AV2.Present_Value (Heartbeat Timer) specifies a number of seconds during which CCM-BAC must detect the presence of a supervisory controller. If no supervisory controller is detected in that time, then CCM-BAC revert to a default control setting .

There are two mechanisms that are equally suitable for resetting the supervision timer.

1. If a read or write request for any property is received it will reset the heartbeat timer.
2. An UnconfirmedCOVNotification with Subscriber Process Identifier of zero and an Initiating Device Identifier whose device instance is PIV1.Present_Value is received.

4.1.15 Setting the MAC address and Baud rate

Since not all CCM-BAC platforms include dipswitches for setting MS/TP MAC address, the following procedures are implemented to allow setting MAC address and baud rate.

CCM-BAC has a default MAC address of 0 (4 for units without DIP switches) and baud rate of 38400. Writing to the AV0.Present_Value object sets a new MAC address, initiate 5 seconds of non-communication, followed by a delayed restart, after which the new baud rate will take effect. Writing to AV1.Present_Value will set a new baud rate. In practice the baud rate should be written first followed by MAC address. Once established, the MAC address or baud rate can then be changed by addressing the current configuration.

5 Factory Default Values

	Object	Douglas Versions	ULT Versions
DEx	Object_Identifier	559000	559000
	Object_Name	CCM-BACCM	CCM-BACCM
	Object_Type	Device	Device
	System_Status	Operational	Operational
	Vendor_Name	Douglas Lighting Controls	Douglas Lighting Controls Inc.
	Vendor_Identifier	559	559
	Model_Name	WRV-CCMBAC	DY-CCMBAC
	Firmware_Revision	SN|FW ver|HW ver|BL ver	SN|FW ver|HW ver|BL ver
	Application_Software_Version	1.0	1.0
	Description	?	?
	Protocol_Version	1	1
	Protocol_Revision		
AO100	Relinquish_default Property	100.0	100.0
AO100	Min_present_value Property	5.0	34.0
AO100	Max_present_value Property	100.0	100.0
AO200	Desired Power Level B	5.0	34.0
AO200	Relinquish_default Property	100.0	100.0
AO200	Min_present_value Property	5.0	34.0
AO200	Max_present_value Property	100.0	100.0
AO300	Desired Power Level C	5.0	34.0
AO300	Relinquish_default Property	100.0	100.0
AO300	Min_present_value Property	5.0	34.0
AO300	Max_present_value Property	100.0	100.0
AV0	DesiredMACAddress	0.0	4.0
AV1	DesiredBaudrate	38400.00	38400.00
AV2	Heartbeat Time	0.0 (none)	0.0 (none)
AV3	Reserved	0	0

AV4	Reserved	0	0
AV5	Reserved	0	0
AV100	Fade Rate A	0.0	ULT Versions
AV101	Scene Index A	1.0	559000
AV102	Fade Index A	2.0	CCM-BACCM
AV103	Fade Time A	0.0	Device
AV11xx	Scene[xx] A where xx=0..28	90, 80, 70, 60, 50, 40, 100, 100, …	Operational
AV21xx	Fade[xx] A where xx=0..14	0, 1, 2, 0, 0, 0, 0, 0, …	Douglas Lighting Controls Inc.
AV200	Fade Rate B	0.000	559
AV201	Scene Index B	3.000	DY-CCMBAC
AV202	Fade Index B	4.000	SN|FW ver|HW ver|BL ver
AV203	Fade Time B	0.000	1.0
AV12xx	Scene[xx] B where xx=0..28	91, 81, 71, 61, 51, 100, 100, …	?
AV22xx	Fade[xx] B where xx=0..14	0, 1, 2, 3, 0, 0, 0, 0, …	1
AV300	Fade Rate C	0.000	
AV301	Scene Index C	5.000	100.0
AV302	Fade Index C	6.000	34.0
AV300	Fade Time C	0.000	100.0
AV13xx	Scene[xx] C where xx=0..28	92, 82, 72, 62, 52, 100, 100, …	34.0
AV23xx	Fade[xx] C where xx=0..14	0, 1, 2, 3, 4, 0, 0, 0, …	100.0
BV0	UseFadeTime	0	34.0
BV1	ZeroNotOff	0	100.0
BV2	Relay Output Power-On	1	34.0
BV3	ExcludeLevels	1	100.0
BV4	Alternate Reset	0	34.0
BV5	Alarm State / Reset	0	100.0
BV6	LogDimming	1	4.0
BV7	QuickDim	0	38400.00
BV100	Relay Output	0	0.0 (none)

.

5.1 Fade-Time

Set the UseFadeTime binary value to 1 to change the Fade-Rate field to a Fade-Time. Then the Fade-Rate for the Desired Power Level and Scene objects becomes the delay in tens of seconds between reductions or increases in Operating-Levels. For example, a Fade-Time of 2 will indicate a time of 20 seconds to change from the current operating level to the commanded operating level. Fade times will apply to all transitions – increasing & decreasing. A Fade-Time of 0 indicates that the Operating-Level should be immediately set. A Fade-Time of 127 indicates that the CCM should use the default programmed Fade-Time for that node. The CCM converts the Fade-Times into Fade-Rates that for internal use. Because of round-off errors in the above calculation, there may be a slight error between the commanded and actual Fade-Times.

5.2 Fade-Rate (0-126 sec)

Set the UseFadeTime binary value to 1 to change the Fade-Rate field to a Fade-Rate.
This value is the delay in seconds between reductions or increases in Operating-Levels. Fade rates will apply to all transitions – increasing & decreasing. Since there are 100 operating- levels, it is the time it takes to fade (1/100) or 1.0% of full scale. A Fade-Rate of 0 indicates that the Operating-Level should be immediately set. A Fade-Rate of 127 (0x7F) indicates that the CCM should use the default programmed Fade-Rate for that node.

The building management controller must map between the Percentage of full Operating-Level and the encoded value sent to the CCMs. It must also compute and set the Fade-Rate necessary to achieve the desired fade time. This will save the resources of the CCM.

Total Fade Time = Fate-Rate * (change in %) * (See Appendix 0 for a more extensive table.)

Fade-Rate (seconds/1.0%)	% Operating-Level change	Total Fade Time (min:sec)
0		0
1	10	10
1	20	20
1	30	30
1	40	40
1	50	50
10	10	1:40
10	20	3:20
10	30	5:00
10	40	6:40
10	50	6:20
127		Default Fade-Rate

5.3 Scene Arrays

This is a pair of byte-arrays of Operating-Levels and Fade-Rates, typically programmed into the CCM at commissioning. The Operating-level value in the Scene-Recall command will be used as an index to retrieve the stored operating-level value from the Operating-Level Scene-Array. Similarly, the Fade-Rate will cause a lookup of a new Fade-Rate in the Fade-Rate Scene-Array. The CCMs will then begin signaling the ballasts to go to the recalled Operating-Level, at a rate determined by the recalled Fade-Rate.

All members of a set of CCMs containing the same scene arrays will respond identically to a broadcast scene recall command. This allows lighting circuits to be “grouped” by giving their respective CCMs a unique scene array. Other groups of CCMs will respond with the operating-level values stored in their unique scene array. In this way, a single broadcast command can result in a number of different operating-levels for circuits in the system.
There are separate Scene-arrays provided for Zone-A, Zone-B, and Zone-C, so that the zones may change independently using the same scene index value.

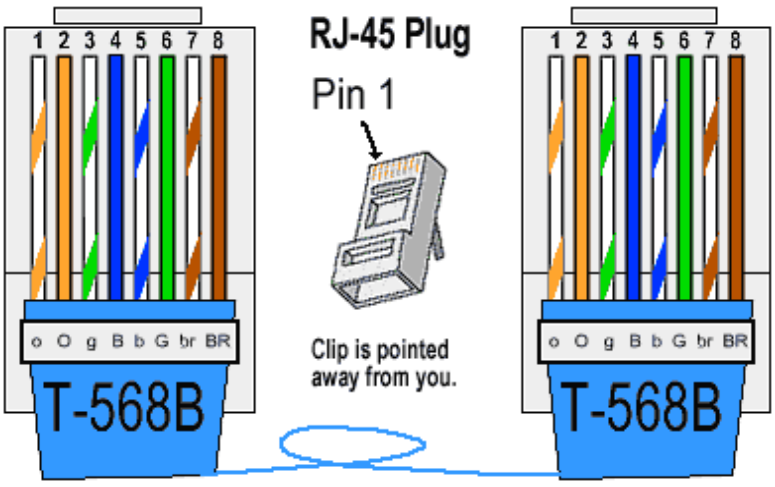
6 Appendices

6.1 RS-485 Cable wiring diagram

Signal Name	RJ-45 pin	Cat-5 wire color
Unused	1	White / Orange Stripe
Unused	2	Orange
Ground	3	Green / White Stripe
Data- / B	4	Blue
Data+ / A	5	While / Blue Stripe
Ground	6	Green
Reserved – Do Not Use	7	White / Brown Stripe
Reserved – Do Not Use	8	Brown

Pin-1 is on the right hand side when looking into the RJ45 connector.

Ethernet Cable



6.2 Serial Number

The serial number is set in the factory during programming of the microcontroller using the P&E Cyclone Pro Programmer, and the software utility serialize.exe. The SN is 11 bytes long and begins at memory location 0xFC14. An un-programmed SN read is a sequence of 0xFF characters. An **un-programmed** SN is field programmable as part of the commissioning process, using the Write Serial Number command.

6.3 Software and Hardware Version Numbers

MC20 version	Ballast version	Software Version (r is software revision)
WRV-CCMBAC	DR / DCL	90601019_r
WDY-CCMBAC	DR / DCL	90601021_r
CCM-BAC-CCM	DR / DCL	90601021_r

6.4 Fade Rate Table

Fade-Rate (seconds per 1.0%)	% Operating-Level change	Fade Seconds	Total Fade Time (min:sec)
0	0	0	0:00
1	5	5	0:05
1	10	10	0:10
1	15	15	0:15
1	20	20	0:20
1	25	25	0:25
1	30	30	0:30
1	35	35	0:35
1	40	40	0:40
1	45	45	0:45
1	50	50	0:50
2	5	10	0:10
2	10	20	0:20
2	15	30	0:30
2	20	40	0:40
2	25	50	0:50
2	30	60	1:00
2	35	70	1:10
2	40	80	1:20
2	45	90	1:30
2	50	100	1:40
3	5	15	0:15
3	10	30	0:30
3	15	45	0:46
3	20	60	1:00
3	25	75	1:15
3	30	90	1:30

Fade-Rate (seconds per 1.0%)	% Operating-Level change	Fade Seconds	Total Fade Time (min:sec)
3	35	105	1:45
3	40	120	2:00
3	45	135	2:15
3	50	150	2:30
4	5	20	0:20
4	10	40	0:40
4	15	60	1:00
4	20	80	1:20
4	25	100	1:40
4	30	120	2:00
4	35	140	2:20
4	40	160	2:40
4	45	180	3:00
4	50	200	3:20
5	5	25	:25
5	10	50	:50
5	15	75	1:15
5	20	100	1:40
5	25	125	2:05
5	30	150	2:30
5	35	175	2:55
5	40	200	3:20
5	45	225	3:45
5	50	250	4:10
10	5	50	0:50
10	10	100	1:40
10	15	150	2:30
10	20	200	3:30
10	25	250	4:10
10	30	300	5:00
10	35	350	5:50
10	40	400	6:40
10	45	450	7:30
10	50	500	8:20
15	5	125	2:05
15	10	150	2:30
15	15	225	3:45
15	20	300	5:00
15	25	375	6:15
15	30	450	7:30
15	35	525	8:45
15	40	600	10:00

Fade-Rate (seconds per 1.0%)	% Operating-Level change	Fade Seconds	Total Fade Time (min:sec)
15	45	675	11:15
15	50	750	12:30

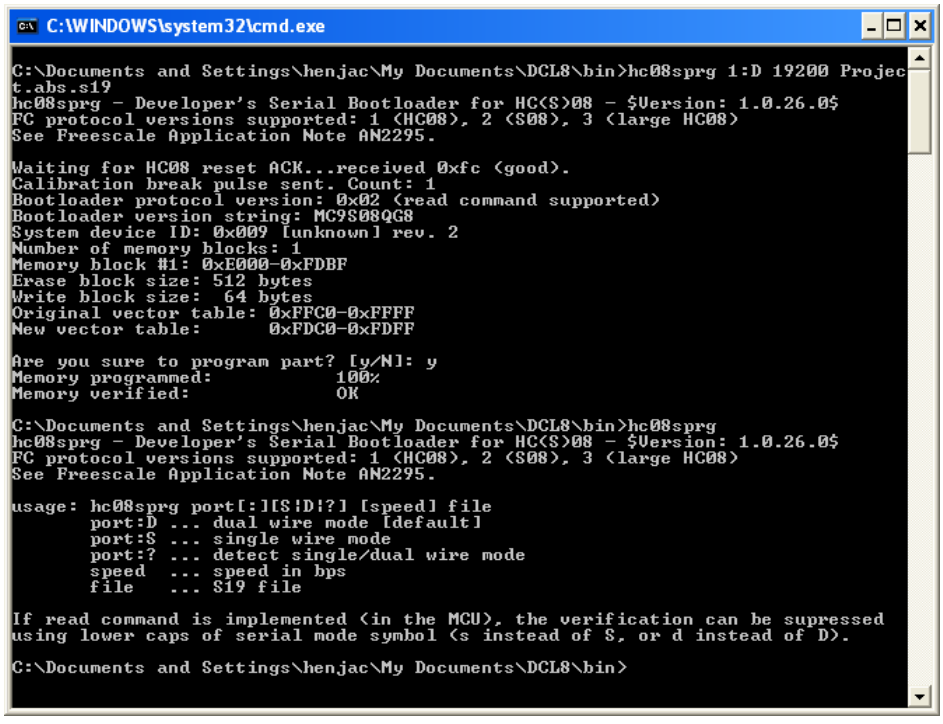
6.5 Device Re-Programming / Boot Loader Code

Users may re-program CCM Program Code via an RS-485 interface attached to a PC by using the Freescale-supplied boot loader program "hc0ssprg.exe." Refer to Freescale Application note AN2295 for details and source code. The MCU code described in AN2295 has been modified for the MC9S08QG8 MCU and for the RS-485 interface.
At startup from Power-On Reset (POR), the MCU transmits an $FC character at 19200 baud to indicate that it is available for re-programming. The programming device must respond with an $FC character to begin the programming sequence, otherwise the normal boot sequence in the MCU is performed. This device programming may occur during Factory Test or in the field using a laptop computer equipped with an RS-485 interface.

Note: The CCM code will not function after programming until the unit resets by cycling power, or by sending serial data to the unit. The unit will not see the first message since the code is not running at that time.

Note: A delay in bringing up multiple units may occur during power on because the $FC character is used as both a command and a reply character. Some units may read the $FC character sent by other units as a response to their $FC command, and wait for programming data. The unit will timeout since programming data will not be forthcoming. The BACnet controller should wait several seconds after initial power-on for all units to become operational.

6.5.1 Example Programming Session



7 Glossary

A/D or ADC Analog to digital converter - This hardware device converts an analog voltage to a digital value.

Circuit Controller Module (CCM) - An individual DCL control unit attached to a branch circuit and capable of controlling DCL ballasts connected to it.

Commissioning - The process of setting up a DCL controlled lighting system. This will include programming each CCM slave with a Node ID, Max Commissioned, and Scene matrix, which may be done either during panel assembly or in the field.

DCL - Demand Control Lighting

DCL bus - This is a multi drop, half-duplex, RS485 communication bus used for sending and receiving information to individual CCM slaves.

LSB - Least Significant Byte**.**

Lsb - least significant bit.

MCU Micro Control Unit – This is the microprocessor on the CCM slave board.

MSB Most Significant Byte**.**

msb most significant bit.

Operating Level - A numeric value between 0-100, used to command the CCM slave to set the operating state of the ballasts attached to it. A value of 0x00 corresponds to 0% brightness and causing the relay in the CCM slave to open. A value of 100 will correspond to the maximum operating level programmed into the CCM slave. Values between 0 and 100 translate linearly to a corresponding ballast input power level range from 0%-100%. The actual minimum ballast input power level achieved will be a function of ballast model, and the actual maximum ballast input power level achieved will be limited to the maximum level programmed into the CCM slave at commissioning.

Maximum Commissioned Operating Level - A value programmed into each CCM slave setting an upper limit to how bright the individual ballasts on the circuit operate in a non-override command mode. In the absence of a communication pulse from the BACnet controller, the CCM slave will cause all ballasts on the circuit to operate at this level.

Minimum Commissioned Operating Level - A value programmed into each CCM slave setting a lower limit to how bright the individual ballasts on the circuit can operate.

POR Power On Reset – Initial condition of the microprocessor in the CCM slave after power on.

Scene - A number corresponding to an index in an array of operating levels programmed into the CCM slave at commissioning. The CCM slave enters a particular programmed scene when it receives a message to do so. Users can program different scene-arrays of operating values into different groups of CCM slaves. In this way, a single broadcast command to all CCM slaves can enter a Scene, resulting in different operating levels for different groups of CCM slaves.

8 Protocol Implementation Conformance Statement

Date:	April 6, 2012
Vendor Name:	Douglas Lighting Controls
Product Name:	DCL-BACCCM™
Product Model Number:	DCL-BACCCM
Product Version:	1.00
BACnet Protocol Revision:	Revision 12

Product Description:
CCM-BAC is a multi-fixture 3 channel lighting controller. TheCCM-BAC provides dimmable lighting control, preset and scene control for three channels of lighting. The CCM-BAC provides integration with other BACnet systems and devices using BACnet MS/TP.

BACnet Standardized Device Profile (Annex L):
BACnet Application Specific Controller (B-ASC)

BACnet Interoperability Building Blocks Supported (Annex K):

Data Sharing	Supported
Data Sharing-ReadProperty-B (DS-RP-B)	☑
Data Sharing-ReadPropertyMultiple-B (DS-RPM-B)	☑
Data Sharing-WriteProperty-B (DS-WP-B)	☑
Device Management	
Device Management-Dynamic Device Binding-B (DM-DDB-B)	☑
Device Management-Dynamic Object Binding-B (DM-DOB-B)	☑
Device Management-Device Communication Control-B (DM-DCC-B)	☑
Device Management-Reinitialize Device-B (DM-RD-B)	☑

Segmentation Capability:
Segmentation is not supported

Data Link Layer Options:

☑ MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 57600, 76800, 115200

Device Address Binding:

Is static device binding supported?	☐ Yes	☑ No

Networking Options:
None

Character Sets Supported:

☑ UTF-8

Standard Object Types Supported:
No object types may be created or deleted.

Object-Type	Writable Properties	Optional Properties	Range
Analog Input		Update_Interval Min_Pres_Value Max_Pres_Value Resolution	
Analog Output	Present_Value Min_Pres_Value Max_Pres_Value Relinquish_Default	Update_Interval Min_Pres_Value Max_Pres_Value Resolution	0 to 100%
Analog Value	Present_Value		varied
Binary Value	Present_Value	Inactive_Text Active_Text	
Device	Object_Identifier Object_Name Max_Master Max_Info_Frames		
File	Archive		
Multi-state Input		State_Text	
Multi-state Value	Present_Value	State_Text	1 to 3
Positive Integer Value	Present_Value		0 to 4194303

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