Last Revised: 18th Dec 2007
7-May-03 Update 10-Oct-03
Update 23-May-05 add 0% charge rate and 250 VAC Dropout for ac disconnect for EMS support
Update 28 March 2006 for new fault codes and new VAC dropout values
Update Oct 06 for sending VACin and VAC output and new fault codes:
RELAY_FAULT
CHARGER_FAULT
Update Nov 06 for new battery sizes and new TCO FAULT
Update Jan 23-07 added EOF (0xFF) value and third party notes.
Update Apr-23-07 added (Ox91) CB3 open fault
Update Aug-13-07 corrected VAC dropout values
Updated Jan-08-08 Added Custom battery charge info that RC send to INV
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Software definition of comm system:

This is a definition of the "TCS" (Temp Comm Sys) for the "Charger"
part of the Magnum Energy Inverter/Charger/Remote pair.
TCS-C is the "Charger/Inverter" end.
TCS-R is the "Remote" end.

OVERVIEW:

This implementation works as:
"Charger/Inverter" is the MASTER of communications, and will
transmit its data once every 100ms. During this time
TCS-C will:
1. Enable the RS-485 transmit driver
2. (internally) disable the Receiver (RE)
3. Reset the RECEIVE DATA POINTER
4. Reset the TRANSMIT DATA POINTER, and transmit
16 bytes of data.

At the "end" of the transmission:
1. Disable the RS-485 transmit driver
2. (internally) ENABLE the Receiver (RE)

On reception of bytes (from the Remote):
1. Store data sequentially
2. advance the RECEIVE DATA POINTER
3. after the 16th byte,
(internally) disable the Receiver (RE).
(repeat)

"Remote" is the SLAVE and responds to messages by transmitting
its own message 10ms after the MASTER's message ends.

TCS-R operates in the following manner:
1. Receives bytes of data, storing to ram,
advancing the RAM_POINTER, and RESETTING
the Rx_CLOCK (2ms step) to ZERO.
When Rx_CLOCK reaches 5 (10ms) do:
1. (internally) disable Receiver (RE),
2. enable the RS-485 transmit driver
3. reset the TRANSMIT DATA POINTER
4. reset the RECEIVE DATA POINTER
5. trigger the TRANSMITTER
6. Every fourth send extends data transmission with AGS or BMK settings

When the transmitter is complete:
1. disable Transmitter
2. disable the RS-485 transmit driver
3. (internally) enable the Receiver (RE)

When AGS clock reaches 10ms, or BMK clock reaches 14ms:
1. "Remote" receives bytes of data, storing to ram
Note: AGS and BMK do not communicate on every cycle, only twice per second
(repeat)

Hardware definition of comm system:

This is a simple communications systems, where the physical
link is RS-485, which is defined as:
true 2 wire only
5V differential,
half-duplex,
multi-drop up to 32 connected transceivers.

<u>RJ-11 wiring on inverter is (from top to bottom) :</u>
1 = "B" RS485 comm
2 = +14
3= GND
4 = "A" RS485 comm

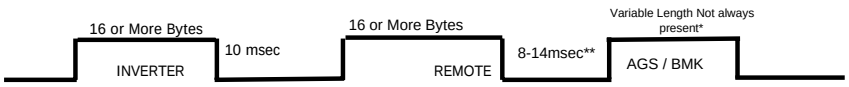
Comm rate	19.2Kbps
Each bit time	~ 50us
Each byte	
Time each packet is sent	about every 100 msecs

<u>Communications from inverter and remote:</u>
Every 100 msecs, the inverter sends a packet of 16 bytes, one right after the other,
whether remote is connected or not.

If remote is connected it will receive the 16 byte packet and then after a short delay will begin
sending a 16 byte packet back to the inverter.

Packet Sequence and Dead Times:

Scope picture of comm string:



Notes:

* Variable 8-14 ms, depend on the device. AGS = 10ms, BMK = 14ms

** 3rd device (AGS/BMK) communicate only twice per second so not present in every communication cycle.

Inverter Packet (data from the Inverter/Charger)

Byte order	Data name	bits	value assignments	Value sent to remote remote (hex)	variable name	Comments
0	Mode	8	EQMODE	0x01	gMode	// unit is eq'ing with ac
			FLOATMODE	0x02		// unit is float charging w/ac
			ABSORBMODE	0x04		// unit is charging in absorb w/ ac
			BULKMODE	0x08		// unit is charging in bulk mode with ac applied
			BATSAVERMODE	0x09		// unit is charge mode but no charge current since bat is full
			CHARGEMODE	0x10		// unit is in charge mode, no ac applied
			SLEEPMODE	0x20		// inverter off, charger off waiting for user input
			CHARGEROFF	0x00		// note that 0 = off as well as 20 = "Off"
			INVERTMODE	0x40		// inverter on (charger on or off)
			SEARCHMODE	0x80		// searching for load (charger on or off)
1	Fault	8	No Fault on inverter	0x00		
			STUCKRELAY	0x01	gFault	// not used
			DC_OVERLOAD	0x02		// DC bridge overload fault
			AC_OVERLOAD	0x03		// AC output overload fault
			DEAD BAT	0x04		// charging a dead battery
			BACKFEED	0x05		// leave a space for a future fault
			FUTURE1	0x06		
			FUTURE2	0x07		
			LOWBAT	0x08		// low bat cutout
			HIGHBAT	0x09		// high bat cutout
			HIGHACVOLTS	0x0A		// high ac output voltage
			BAD_BRIDGE	0x10		// Remote displays = Internal Fault 1 = bad fet bridge
			NTC_FAULT	0x12		// Remote displays = Internal Fault 2 = fets too hot (>20C step)
			FET_OVERLOAD	0x13		// Remote displays = Fet Overload = FETS too hot too fast (6C over 4 sec)
			INTERNAL_FAULT4	0x14		// Not used
			STACKER_MODE_FAULT	0x16		// Stacker fault, both units not in same mode, problem with "other" inverter
			STACKER_CLK_PH_FAULT	0x18		// Stacker sync clocks are not in phase
			STACKER_NO_CLK_FAULT	0x17		// Stacker does not detect other stackers sync clock
			STACKER_PH_LOSS_FAUL	0x19		// Stacker AC output voltage is not properly phased
			OVERTEMP	0x20		// overtemp shutdown
			RELAY_FAULT	0x21		// Transfer relay is not closed in chg mode
			CHARGER_FAULT	0x22		// Bridge fault in chg mode = max PWM, no ac amps, Vbat < FloatV
			HIBATEMP	0x81		// high battery temp
			OPEN_SELCO_TCO	0x90		// open transformer TCO temperature cutout
			CB3 OPEN FAULT	0x91		// open input 30 amp AC Breaker CB3
	Factory Use Only		EOF	0xFF		//End Of File
2,3	DC volts	16*	0-64K		gVDC	0-64K = 0 - 6400.0V or 1 count/ 0.1V (real range = 0-100.0V)
4,5	DC amps	16*	0-64K		gADC	0-500 amps DC
~~6,7 (was)~~	~~Ac amps NOT IMPLEMI~~	~~16*~~	~~0-64K~~		~~gAAC~~	~~NOT Implemented~~
6	AC volts output	8			*gVAC_RMS*	*0-150 Volts ac RMS* Rev 3.0 and more
7	AC volts input	8			*gVACin*	*0-255 Volts ac peak* Rev 3.0 and more
8	Inverter LED	8			gLEDS_Inv	IF = 0, then INV LED is off else INV Led on remote ON
9	Charger LED	8			gLEDS_Chg	IF = 0, then CHG LED is off else CHG Led on remote ON
10	Inverter Version	8	0 to 256		Version	i.e. 10 = 1.0 NON-ZERO MANDATORY FOR REMOTE
11	Battery temp	8			gTbatt	0-150 = 0-150 deg C
12	Transformer temp	8			gTransf	0-150 = 0-150 deg C
13	FET temp	8			gTFET	0-150 = 0-150 deg C
14	Inverter Model	8			gModel_Number	

Model	Dec	Hex
MM612-AE	7	0x07
MM1212	8	0x08
MMS1012	9	0x10
MM1012E	10	0x09
ME1512	15	0x0F
ME2012	20	0x14
ME2512	25	0x19
ME3112	30	0x1E
MS2012	35	0x23
MS2X12E	40	0x28
MS2812	45	0x2D
RD1x24E	53	0x35
MM1524	54	0x36
RD1824	55	0x37
RD2624E	59	0x3B
MM1x24E	60	0x3C
RD2824	63	0x3F
RD4024E	69	0x45
RD3924	74	0x4A
MS3x24E	90	0x5A
MS4024	105	0x69
MS4448	111	0x6F

15	Dummy byte for future use		0

* = NOTE that for all 16 bit variables, they are sent in two bytes, the high byte sent first. So for DC volts, high byte is sent in third position (byte 2) and low byte is sent in fourth position or byte 3.

Remote Packet (data from the remote)

Byte order	Data name	bits	value assignments	variable name	Remote display	Value sent to inverter (decimal)			Comments
0	Inverter ON/OFF	8		InvertSwitch		BIT0	ON = 1 OFF = 0	ALL OFF	is default
	Charger ON/OFF		(same byte as inverter on/off)	ChargeSwitch		BIT1	ON = 1 OFF = 0	BIT = 1 is a momentary	
	FUTURE USE		(same byte as inverter on/off)	FUTURE USE		BIT2	ON = 1 OFF = 0	(1 sec) condition	
	EQ Mode		(same byte as inverter on/off)	EQMode		BIT3	ON = 1 OFF = 0		
1	Search watts	8		Searchsense	Defeat		0		
					5W	(default)	5		
					10W		10		
					15W		15		
					20,30,50W		20,30,50 etc		
2	Battery size	8		BatSize	10Ah = 1 Count				
					Inverter Accepts increments of 20 from 20-160				
					400Ah	(default)	40	ME-RC	
					200Ah	(default)	40	MM-RC / MM-R 3.6	
3	Battery Type	8		BatType	Gel		2		
					Flooded	(default)	4		
					AGM		8		
					AGM2		10		
			If custom, then battery type is now absoption voltage		Custom		1xx		
3	Absoption voltage	8	** Only if battery type is > 100 !!! **		12.0 - 16.0 12v base		146	See #11 Float for explaination	
4	Charger Amps	8		ChgAmps	0%		0	"New for EMS"	no charge
					10%		10		
					20%		20		
					30%		30		
					40%		40		
					50%		50		
					60%		60		
					70%		70		
					80%	(default)	80		
					90%		90		
					100%		100		
5	AC shore amps	8		ShoreAmps	5AAC		5		
					15A		15		
					20A		20		
					30A	(default)	30		
					50A		50		
6	Remote version	8		Version	1.0		10	ME-RC	
					1.1		11	MM-R & MM-RC (3.5-3.6)	
					1.2 etc		12	ME-RB > 8.0	
7	Ambient temp	8		Tambient	0-150 = 0-150 deg C				
8	Auto Genstart	8		AGS	BIT0	ON = 1 OFF = 0	0ff = default		
					BIT 1	ENABLE = 1 NOT ENABLED = 0			
					BIT 2	TEST = 1 , Default to 0			
9	LBCO	8		LBCO	9VDC		90		
					10V	(default)	100		
					11V		110		
					18V		90		
					20V		100		
					22V		110		
								HEX	
10	VAC cut out voltage	8		VDROPOUT	60VAC		110	6E	
					65V		122	7A	
					70V		135	87	
					75V		145	91	
					80V	(default)	155	9B	
					85V		165	A5	
					90V		175	AF	
					95V		182	B6	
					100V		190	BE	
					"EMS over-ride- open relay"		255	"New for EMS"	disconnect from ac input
11	Float Voltage	8			12.0v - 16.0v	(default)	132		
					Setting 13.0 on a 24 volt system would result in 26.0 float voltage				
					Setting 13.0 on a 48 volt system would result in 52.0 float voltage				
12	EQ Voltage	8	Not implemented		0 - 2.0 v				
					Voltage set point above bulk setting				
13	Dummy byte for future use								
14	Real time clock hours	8		gHrs					
15	Real time clock mins	8		gMins					
*	**Byte 3 (Custom battery) & 11 ONLY WORK ON MS SERIES INVERTERS V3.4 AND GREATER**								

Bytes 16-20 were Added for AGS in ME-RC Rev 1.5 and Greater

16	Gen run time	8		h.m, 0-255, 25 would be two and half hours
17	Start Temp	8		Fahrenheit
18	Start VDC	8		all voltages are 12v based (0.0 to 25.5)
19	Quiet time hours	8		0 - Off 1 - 9pm-7am 2 - 9pm-8am 3 - 9pm-9am 4 - 10pm-8am 5 - 11pm-8am
20	0xA0 - AGS address	8	Footer	Remote will always send twenty-one bytes. We can use bytes 14 though 19 to talk to other devices. The last byte will tell which device that the remote wants to talk to (shunt, hub, ect).

BMK Footer was added in ME-RC Rev 2.0 and Greater

16	Program Batt Effecienc	8		
17	Resets	8		0 = normal 1 = Reset Vmin 2 = Reset Vmax 3 = Reset AmpH Trip 4 = Reset KAH_ResetCount
18	Battery size	8		10Ah = 1 Count minimum 200Ah
19	Dummy byte for future use			
20	0x80 - BMK address	8	Footer	Remote will always send twenty bytes. We can use bytes 14 though 19 to talk to other devices. The last byte will tell which device that the remote wants to talk to (shunt, hub, ect).

AGS Packet (data from the AGS) ***Only AGS Ver 3.5 or higher***

Byte order	Data name	bits	value assignments	Value sent		Comments
0	New Protocol header	0xA1		0xA1 means AGS		Device ID
1	Status	8				00 - Not valid (No Comm on remote) 01 - Off (not enabled) 02 - Ready (enabled) 03 - Manual Run (gen manually started) 04 - AC In (inverter is in charge mode) 05 - In quiet time (hours) 06 - Started in test 07 - Started on temperature 08 - Started on voltage 09 - Error in test 0A - Start error on temp 0B - Start error on voltage
2	Revision	8	35 to 256		Version	i.e. 10 = 1.0 Started TX at 3.5 i.e. 11 = 1.1
3	Temperature	8	33 to 104			In degrees Fahrenheit (33-104F)
4	Gen Runtime	8				Gen running for h.m, so 2.5 would be two and half hours
5	VDC of AGS	8				xx.x VDC (Scaled to 12V numbers)

AGS TX every 0.5 seconds with a deadtime of 8msec after a ME-RC revision 1.5 or more

BMK Packet (data from the BMK)

Byte order	Data name	bits	value assignments		Value sent		Comments
0	New Protocol header		0x8S		S = String Type		8 means ME-BMK
1	State of Charge	8					0-100 - 0 - 100% or 1 count / 1% (255 = Think'n)
2,3	DC volts	16	0-64K				0-64K = 0 - 640.00V or 1 count/ 0.01V (real range = 0-70.00V)
4,5	DC amps	16	0-64K				0-64K = -3.2K to 3.2KAmps or 1 count/ 0.1A (real range +-1000A)
6,7	Min Volts	16	0-64K			gVDC	0-64K = 0 - 640.00V or 1 count/ 0.01V (real range = 0-70.00V)
8,9	Max Volts	16	0-64K			gVDC	0-64K = 0 - 640.00V or 1 count/ 0.01V (real range = 0-70.00V)
10,11	AmpH in/out	16		65536			0-64K = -32K to 32KAmpH or 1 count/ 1AmpH
14,15	AmpH Trip	16					0-64k = 0 to 6.4kAmpH or 1 count/ 0.1AmpH
12,13	Cumulative AmpH out of Battery	16					0-64k = 0 to 6.4MAmpH or 1 count/ 100AmpH
16,17	Number of Discharge Cycles	16					0-64k , 1 count / 1Discharge Cycle
18	Software Ver	8	0 to 256			Version	

BMK TX every 0.5 seconds with a deadtime of 14msec after a ME-RC revision 2.0 or more

Notes for Third Party Developments

If your company is considering building a product to connect to the Magnum Network:

1. Please contact Engineering Department at Magnum for approval.
2. No power is available for third party devices on the network.
3. You should design your product so that it looks like a "wire" to the network. This is so that the timing of the data is not affected adversely and so that the devices on the network will operate properly. Also, when your product is off or not operational, it will not affect existing communication on the network.
4. Magnum Energy Inc has rights to change/alter the protocol with or without notice to third parties