0.4 RMYoung Model 9101 Prop / Vane Anemometer
Quick Reference

Sections Include:

0.4.1 Description:

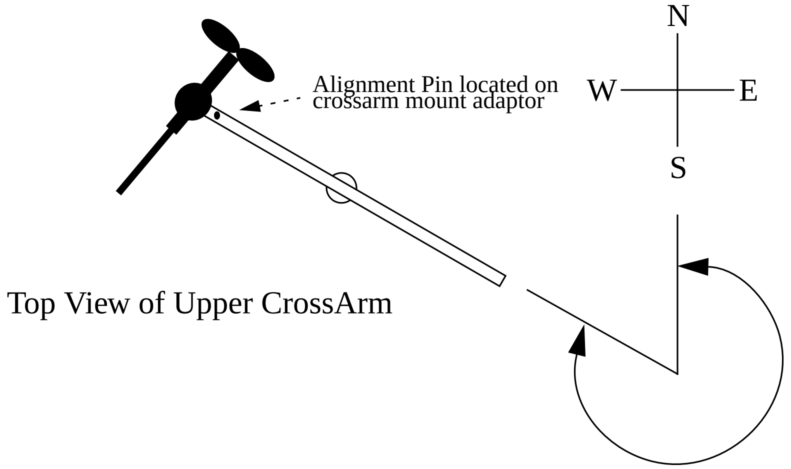
R.M. Young prop-vane with microprocessor circuitry and digital wind direction encoder. Output of unit is by NCAR serial sensor bus.

Conversions: *RPM * .0049 = m/s*
RPS * .2940 = m/s
Ie. 1 m/s = 204 RPM or 3.4 RPS

0.4.2 Installation:

The sensor is normally installed on the top crossarm of a PAM mast. A black plastic collar is provided with the R.M.Young sensor which is keyed to allow adjustment of north for the sensor. For a standard PAM installation, the key should be aligned with the pin on the aluminum elbow so that the prop-vane is aligned with the PAM cross-arm. A compass is used to determine the orientation of the cross-arm which is then corrected in the EVE configuration or in the sensor itself using the 'BD' command via EVE entersys/talk (refer to figure 1). The 9-pin AMP sensor bus cable in the crossarm should be attached to the mating recepticle on the prop-vane mounting elbow before sliding the elbow into the cross-arm. The main sbus cable in the mast must be connected to the crossarm before assembly.

Figure 1) Determining Boom Alignment for Prop/Vane Anemometer



Example Boom Alignment Command:

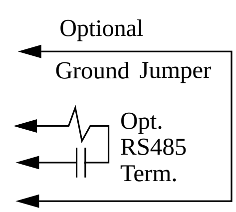
BD300

Use Compass or Theadolite to determine Azimuth from North (shown ~= 300 degrees)

0.4.3 *Connector Wiring:*

Between the aluminum mounting elbow and the RMY screw terminal’s

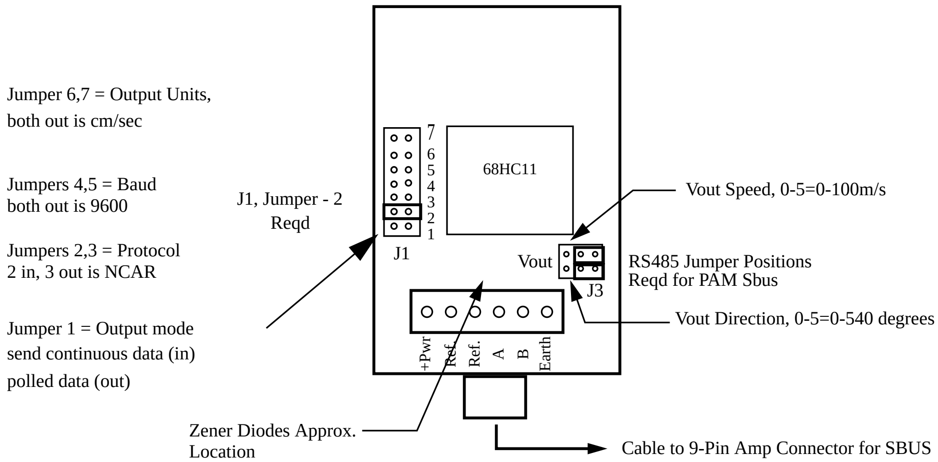
Signal	9pin Amp connector	R.M.Y
======	==============	======
+12V	8	+PWR
ground	7	Pwr REF
		REF
RS-485+	5	A
RS-485-	9	B
earth ground	none	EARTH



Board Jumpers:

There are two sets of jumpers on the R.M. Young circuit board. These jumpers configure the sensor for the NCAR sensor bus operation. J1 should have a jumper installed at position 2 (from the bottom). J3 should have two jumpers installed, between the two middle and right pins. One jumper for the top row, and one jumper for the bottom row.

RMYoung PC Board



0.4.4 RS485 Issues and Problems:

Line Termination: Depending upon the length of the SBUS cable, a 120 ohm terminating resistor can be placed on the R.M.Y. sensor between pins “A” and “B” to reduce noise. In practise on a standard PAMIII installation, this termination has not been used, however for longer cable lengths this may be advisable. **Note Dec-‘98**: Using only a 120-ohm resistor was found to cause problems during tests of GAME’s long SBUS configuration deployed in Thailand. During the tests, the termination required addition of a 500pF capacitor with the 120-ohm resistor for the bus to work. This is similar to the termination used on the NCAR hygrothermometer and EVE RS232/485 converter. The capacitor reduces power requirements and is a low-pass filter. The LTC485 chip used in the RMY should be able to drive only the resistor but the Maxim 487 chips apparently cannot.

March-2002: Line Protection / Zener Diode / Driver Problems: While checking out sensors before going into the field, a problem was discovered with one sensor which was *causing loss of SBUS data from other sensors on the bus*. The problem was one of the 6V zeners used on the RS485 A/B lines, the A signal was being clipped at ~2V. The data system was still receiving messages from this particular 9101 but other sensors on the bus were dropping out when it was attached. When we removed it, or used a different 9101 everything worked fine. After removing its zener(s), it also worked fine. Apparently a surge on the line or age caused them to become marginal. The zeners were removed from all NCAR 9101 sensors to avoid this tricky problem in the future. They do not provide substantial protection for the lines because they have less energy dissipation capacity than standard TVS devices.

RMY recommended keeping the zeners in because they do not see this type of failure very often. They also suggested replacing the RS485 chip (LTC485) in our older sensors with a different version which can handle more energy than the zener/old-chip can (LT1785). The old sensors have a socket for this chip so replacing it is very easy and is the best solution. Unfortunately, the newer RMY sensors do not have this chip in a socket. This makes it difficult to replace because of the protective coating on the board and where it is located, etc. I tried this on one of our newer sensors and it took a long time and I had to be very careful to remove the 2 zener diodes and the old chip, but it did work.

Old Zener:	Microsemi 1N5233, 6V, 500mW power dissipation, located between connector and HC11.
RS485 Chip	LT1785AIN8-ND (Digikey Part #), ext-temp.

0.4.5 Analog with Serial Output:

It is possible to monitor the analog output signals as well as the serial messages (sbus format or otherwise) of the RMY simultaneously. Only 1 of the analog signals is available at the terminal strip, however both analog signals can be monitored on the RMY PC board at jumper pad J3 in the left position next to the jumpers as shown above. Another limitation according to RMY is that the 'RMYT' test protocol may not work. Setting the boom azimuth angle (command BD=xxx where xxx is the boom pointing bias angle) also changes the 'zero point' for the analog direction output so that it continues to track the values reported in the serial message output.

The RMY manual describes the analog direction output as being 0-5VDC = 0-540 degrees azimuth. A verification test of this capability while monitoring both the analog output voltage and the serial output message of two separate sensors indicated that there is a calibration gain difference which must be accounted for. Both sensors were operated at 0 m/s 'wind-speed' and both had RMY software version 2.05. One was sampled by hand comparing the serial output direction while monitoring the voltage output. The other was placed on a scaled machinist's table with better than 1-degree resolution and accuracy. As expected, the serial output of the sensor always agreed with the table to within 1-degree. However both sensor's analog readings when scaled using gain factor 540/5 were off by the same amount, which was as much as 20-degrees error at full-scale. The corrected sensor analog output readings both agreed to within 1-degree of the table and/or sbus message by using the gain factor of 540/5.207. Without additional testing it is unclear whether this is a gain calibration issue specific to individual sensors (and we just happened to grab 2 which had the same gain) or it is a systematic issue. Each sensor should be tested individually before assuming either gain factor.

The RMY manual describes the analog speed output as being 0-5VDC for 0-100m/s speed. A wind tunnel comparison test for one sensor between its analog output versus the wind tunnel speed from 0 - 15m/s indicated that the analog output reading agreed to within .2 m/s or better of the tunnel using the gain factor of 100/5. However, given the precaution mentioned above about the direction, it must be noted that the speed difference began at ~-.1 and rose to ~+.2 near 15 m/s, hinting that there may be a gain issue for speed readings as well.

A final note is that care should be taken, as with any analog signal transmission, to use good shielding and grounding practices especially for long cable lengths to minimize the influence of noise.

0.4.6 Grounding and Static Charge:

Static electricity can cause sensor noise and/or lockup if it doesn't have connection to a good earth ground. This is more problematic in cold/dry conditions. The earth ground also helps provide protection from damage due to lightning. In the past, the sensor's 68HC11 processor has been vulnerable to static charge and subsequently to lock up. RMYoung attempted to circumvent this problem by utilizing the processor's built-in watchdog timer in their software. This may or may not work in all cases and care should be taken to make sure that the sensor is properly grounded to avoid these problems. This usually involves connecting the earth ground in the sensor's junction box to the tower/infrastructure.

RMYoung upgraded the 9101 in December 1997 to help reduce static discharge problems. The upgraded model uses conductive carbon fiber material parts on the mount. The older version used a non-conductive PVC type material which can be identified by looking where the housing slides over the mounting post 'T' piece. If the 'T' is white with a black base then it is an older model. The newer model is all black.

Connection to earth ground is usually accomplished via an unpainted metal (non-galvanized) mounting structure. If the crossarm and tower are low-resistance, conductive materials and are properly grounded, the RMY's black carbon-fiber housing is internally connected to this ground path. This is true for both newer and older models. Measurement of the resistance between the RMY 'earth' terminal and the metal tower can be misleading. Even if voltmeter readings are 100-ohms or even a few hundred ohms, the sensor still has a good ground. The conductivity of the RMY housing is internal to the material so readings taken on the surface are non-representative. Additional resistance within the tower structure and the earth bond is a separate issue.

An alternative earth ground connection can be made if the mounting structure is non-conductive. Connection of a jumper wire to the RMY 'earth' terminal (don't be confused by the RMY manual's reference to 'spare' in the grounding section) and the true ground is preferred. In practise with PAMIII, a jumper wire has been placed between 'earth' and 'pwr ref.' This provides a path to earth through the power ground wire to the PAMIII electronics box and it's bond to earth ground. Because typical PAMIII installations are on a 10-m tower, this 'double-ground' via the tower mount and the power return is not a problem. However this creates a potential ground-loop problem for some installations such as GAME's Thailand installation where the sensor is mounted on a 100-m tower and the PAMIII electronics is on the ground, 40-m from the tower. This double ground has the potential to disrupt communications, but should not prevent the sensor from operating or expose it to increased risk of damage from static/lightning.

0.4.7 RM Young 9101 Prop/Vane Sensor Bus Commands:

The R.M. Young prop-vane supports a subset of the full NCAR sensor bus. The following commands are supported:

BDxxx	Set Boom Direction Offset (Even degrees only)
CD	Continuous data output
FC	Use calibrated speed units
FR	Use raw speed pulse count
OD	Output Data
OS	Output status
PM	Polled mode
PO	Print operating parameters
SAxx	Set Address to xx, where xx is 00--ff
ZN	Set zero direction reference
calib	enters calibrate mode...see manual
ratexx	Set continuous output rate in xx * 32.77mS
propxxx	Set prop pitch to xxx in cm/rev
	NOTE: Normally Set to approximately 300
unitx	Set wind speed units to x where x is:

0	knots
1	miles per hour
2	km per hour
3	cm per sec
4	meters per sec

SBUS Address:

The address is set to “0x01” at the factory. This normally needs to be reset to address “0x12” before going into the field. Type command “SA12” while talking directly to the sensor.

0.4.8 EVE Configuration Commands:

EVE configuration commands needed to ingest the RMY sbus data are shown below. Note that the ‘DO: AVG WIND.SPD’ commands are normally not used by NCAR, but provide scalar speed and direction values if they are desired. NCAR typically archives only the averaged U and V components produced by the ‘ETAUAVG’ commands. See the EVE manual for more information on how to setup the SBUS port and to OUTPUT and archive the data.

```
SBUS: WIND /tyCo/3  0x12 1sec MAX_ERRORS=0
W: %f %d
SPD F
DIR I 1 0
:

DO: GETUAVG WIND.SPD WIND.DIR =Uavg
DO: GETVAVG WIND.SPD WIND.DIR =Vavg
DO: MAX WIND.SPD =max
DO: AVG WIND.SPD
DO: AVG WIND.DIR

MESG: WIND
Errors = %d\n\
Speed = %7.2f m/s   Dir = %7.1f deg  Uavg=%7.2f m/s  Vavg=%7.2f m/s\n\
MAX speed = %7.2f m/s\n
WIND/ERR
WIND.SPD
WIND.DIR
WIND.Uavg
WIND.Vavg
WIND.max
:
```

0.4.9 Problems / Trouble Shooting Hints:

1) SBUSdebug Message “Purging 16-Chars: &12W:...”.

This problem is caused by the sensor sending continuous data. It stills respond to sbus poll messages but also sends other data. This will cause problems on the bus and there will be some errors counted for both the 9101 and the others.

Solution: Remove Jumper 1 (see jumpers above), and set ‘PM’ software mode.

2) Bad observed wind direction.

Make sure collar on sensor mount is properly aligned. Verify cross-arm angle correction is entered into EVE or the sensor itself.

3) Bad windspeed.

Check propeller bearings. If they are noisy and/or stiff, they must be replaced. R.M. Young sells both grease filled and oil filled bearings. The grease filled are the standard bearing for the model 9101, but they should not be used if accurate wind speeds below 5 m/s are desired. NCAR uses the oil filled bearings only.

4) Bearings / Quick Test:

The bearings used in PAM are oil filled, RMY model 5363. If a bad bearing is suspected, a quick test can be performed by placing a paper-clip on the end of one prop blade. That blade when released from the 3:00 position should drop to the 6:00 position without difficulty. Perform the same test on each of the 4 blades to check the entire rotation. A similar test can be performed for the directional bearing by using a penny placed on the end of the tail when the sensor is positioned horizontally.

5) No communications to sensor:

The most likely cause is that the sensor is either jumpered incorrectly (see above) or has an incorrect sbus address. The address can be set using EVE talk as described below and sending the ‘SA’ command to the RMY.

See-Also the section on RS485 problems associated with a deteriorated zener diode. A thorough test involves examining the signals on the bus to verify their integrity.

Troubleshooting: Verify operation of sensor bus. Stop the data system using the EVE system console. Type “talk” and at the first menu select the proper port. At the next menu select sensor bus mode (S). At the next menu select check all possible sensor addresses (option 3). Do any other sensor bus sensors respond (the Trh sensor)?

NO) Check cabling, check power to sensor bus, check serial-option board in PAM electronics box.

YES) Check terminals at R.M.Y. sensor. Verify power and sensor bus connections with a volt meter.

The other possibility is that the sensor is responding to the wrong address. RMY by default is addressed to ‘01’ which is the same as the standard NCAR trh. If both attempt to reply to that address, you must disconnect the trh and reprogram the RMY using the ‘SA’ command.

Verify operation of the R.M.Y. sensor. The easiest method is to remove the trh sensor from the sensor bus so that the RMY is the only sensor on the bus. Otherwise, remove the RMY from the crossarm and connect it to the electronics box with a short (2m) sensor bus test cable. between the electronics box and a sensor bus sensor.

a) On the EVE system console use “talk” to try and communicate with the prop vane. Use option 3 from the main sensor bus talk menu to try and find the sensor’s address on the bus. It should usually be set to either 0x12 or 0x10.

b) If the address is not found, then stop the data collection on EVE and talk to the R.M.Y. sensor in normal mode using RS-485, 9600 baud, 8 data bits, and no parity. Hit the <ESC> key three times to place the sensor in interactive mode. Type “SA12” to set the sensor address to 0x12. If no response is received, then the problem is either:

- bad serial hardware or fuse in electronics box.
- bad cabling between R.M.Y. and elbow
- bad R.M.Young sensor

Bench test. Another test for communications can be performed in the lab using the RS232/485 converter box and the sbusterm software. Connect the RMY to the converter box, the converter box to a PC serial port and power the converter box with 12VDC via banana plug leads. The easiest initial check is to jumper the RMY for continuous data output ‘CD’ via jumper J1 - 1, put sbusterm into option 5, interactive and power on the sensor. If data messages are being displayed on the screen, you know the sensor is capable of sending data.

0.4.10 Limitations of the RMY using SBUSTERM software:

The SBUSterm software allows a PC to talk with a SBUS sensor via a RS232/RS485 converter module. Certain of the SBUS conventions are not recognized by the RMY.:

The R.M.Young 9101 prop vane: Does not fully support the sensor bus protocol.

- Software reset: The MR mode-reset command or ‘break’ key sequence does not work, therefore the sbusterm command option ‘3) Reset all sensors’ is ignored by the RMY.

- Interactive mode: It does not work in interactive mode even though the sensor will actually switch into what it thinks is interactive mode. This can be observed if you first talk to the sensor and command it to go into CD, continuous data. After that, during the sbusterm command option ‘5) interactive,’ characters will be displayed initially in the sbus protocol. If you enter the 3-esc characters, the sensor continues to send data but without the extra sbus protocol characters. Unfortunately, the RMY does not respond to interactive mode commands and you are forced to go back into its non-interactive mode (3 more esc characters) and then use the sbusterm talk option to try to get its attention and halt the continuous data output.

- The RMY also does not always respond to queries. This is particularly true when it is in continuous data mode. Data messages are transmitted roughly every 1-second and it will not recognize valid commands if they are sent to the sensor while the sensor is trying to output a data message. This is because it is only capable of half-duplex communication. Another failure to respond can occur because the RMY sometimes requires a short delay after the last time it has been accessed.

- The PH (print help), OS (output status), PO (print operating mode) command messages do not include the sensor id number prefixed to the message. This is not a strictly legal response and causes the sbusterm program to complain by printing an error message: “invalid address” even though the RMY thinks it responded properly.

- Change sensor address, sbusterm option 2, uses the official sbus method employing the sensor’s name and s/n. This doesn’t work with a RMYoung. Instead go into the talk mode option and issue a ‘SAxx’ command and that does work.

0.4.11 Calibration Procedure for the RMY 9101:

Unit must be in NCAR protocol

- Press the ESC button quickly three times to change the 09101 from bussed to interactive mode (the data seen on the screen will change from scrolling across to scrolling down one string at a time)

- Type "PM<Ent>" (quickly) to revert 09101 into polled mode (data will stop being sent)

- Type "calib" and enter - unit will begin internal calibration and send instructions to the screen (be ready to begin rotation of vane).

- Upon completion the "ratexx" may need to be set - xx being the delay between each output (02 ~ 1/16 sec, 30 ~ 1 sec)

- Type “PO” and enter to verify the settings.

- Type “OS’ and enter to verify the status (and sofware version).

- Type “propxxx’ and enter to change the prop - xxx being the prop pitch in mm/rev

- Type “ZN” and enter to set the zero point

- Type “SAaa” and enter to set the address of the sensor - where aa is the new hex address

- Type “CD” and enter upon completion, to change back into polled mode

Reset jumper settings and verify output

The following is a sample calibration sequence for the 9101 begun by typing the 'calib' command. When turning the encoder there is a timeout to the calibration and you should get at least 270-degrees around with the vane to get a good calibration. Normally 1.5 revolutions is about right. Also note that the sensor needs to have its 0-degree position set. The best method is to put the sensor on a PAM mounting collar then onto a crossarm and have the sensor's tail held by using the vane alignment bracket attached to the crossarm. This will ensure a good alignment with the boom and will help minimize later errors when shooting the boom angle and programming that offset into the sensor.

```
CALIBRATE AT ROOM TEMPERATURE (20-25C) ONLY!
PRESS ANY KEY TO BEGIN...

TURN ENCODER SLOWLY...
***************
********
***************
STORING RESULTS IN EEPROM...

POSITION VANE AT 0 DEGREES. PRESS ANY KEY TO SET REFERENCE...
CALIBRATION COMPLETE


PO
PIXEL COMPARE RATIOS:
046 046 049 050 052 052 052 058 060 061 062 063 066 068 069 071
074 076 078 079 082 085 087 089 087 094 096 097 097 100 100 100
100 100 100 099 099 100 100 098 098 097 097 095 095 093 092 091
091 089 088 086 085 085 082 079 081 078 075 073 072 071 069 065

        ADDR: 12
        PROP: 294
    BOOM DIR: 0
   UNIT CODE: 3 (0-KTS, 1-MPH, 2-KMPH, 3-M/S)
  RATE DELAY: 30 x 32.768 mS
  FLASH TIME: 04
R. M. YOUNG COMPANY
MODEL 09101 ENCODER VER 2.03a (c)1995-1999
13.6 VDC
WATCHDOG TIMER ENABLED.
```