RC Aircraft Telemetry Secrets

Do you love mysteries and secrets? I'm going to share some with you about what you can do with telemetry between your radio control transmitter and the receiver in your plane.

OK, perhaps they are not military grade secrets, but they are certainly things that I didn't know, and for some of them couldn't find the answers by searching online. Special thanks to Frederick at Lemon RX for personally answering several of my detailed questions, and for providing some receivers for testing.

Speaking of Lemon RX, I'm going to be using their telemetry stabilized receivers along with Spektrum receivers as examples of what can be done, together with my Radiomaster TX16s. The same general principles will apply to many other brands. Spektrum is seen in our club as a quality, but a bit pricey, brand of radio gear. As Lemon RX is DSMX compatible, and they are a readily available, low cost and dependable receiver, I think they are a good alternative. Radiomaster is in a similar category. While I had been using a Spektrum NX6 along with their receivers when I got back into the hobby after my 20 year pause, I needed to use more channels to do all the things that I wanted to do. As this was before Spektrum decided to let the cat out of the bag, letting us know that it was simply a firmware choice on their part that limited that radio to 6 + 1 channels, and I couldn't afford the NX10, I went searching. Initially I tried a Flysky ST8, and it worked, but had a lot of limitations, and it wasn't compatible with anything, not even its higher end Flysky brothers. The widespread use of Radiomaster by the FPV guys got my attention, and I haven't looked back. By the way, they didn't give me a radio. I bought it at retail price. For that matter, I bought my first Lemon RX receiver at retail price as well, following a similar search!

So, again, other brands will do similar things, and the basic principles will apply to all of them. However, note that each one may have different sets of information that they send back, and the same "label" may mean different things from one manufacturer to another.

In this article, and the associated YouTube video, we want to cover the following:

- What is telemetry?
- What information can telemetry give you?
- Do you need special equipment for telemetry?
- How do you set up telemetry with a Radiomaster TX16s and a Lemon RX receiver?
- How can telemetry help you sort out what happened when your plane crashes?

So, let's get right into it!

What is telemetry?

Every radio control system requires a signal to be sent from your transmitter to a receiver in the airplane. With DSMX that typically happens at least 91 times per second, cycling through 23 different frequencies, changing frequency every 22 ms. But that's for another video. What telemetry involves is the receiver sending information back to the transmitter. A bit like Apollo 11 sending back signals to the "Dish" at Parks, NSW.

Because the receiver is small and low powered, and its antennas are optimised for receiving signals, not transmitting them, telemetry will not have the same range as the control signals coming from your handheld transmitter. The better ones will provide enough strength on the telemetry signal to keep on receiving it through the entire flight. Others will only provide "fly by" capability where it simply updates the data whenever the plane is close enough to the transmitter.

The signals that are sent via telemetry have to do with what's going on in the plane, and that can be very helpful to know. So, let's look at that next.

What information can telemetry give you?

Spektrum gives you some excellent information about how well the control signal from the transmitter is being received by the receiver in the plane:

- Fades – when one of the receiver antennas fails to receive a complete packet of information
- Frame losses - when no antenna on the receiver provides a given packet of information
- Holds – where a signal is not received for a full second (45 frames of transmission)

In addition, depending on which receiver you get and whether you have a "Smart" technology Spektrum receiver, ESC and battery (all rather expensive), you may get:

- Receiver voltage
- Battery pack voltage
- Altitude
- Rate of climb ("Vario")
- Temperature of the chip in the receiver
- Temperature in another location
- Signal strength for the receiver receiving the control signal from the transmitter
- Motor RPM
- GPS position

And, there are probably additional ones also.

Lemon RX telemetry receivers will provide the following data via telemetry:

- Battery pack total voltage (A3)
- Receiver voltage (A2)
- Signal strength for the transmitter receiving the signal from the receiver (TRSS – scale of 0-31)
- RSSI signal strength for the receiver receiving the control signal from the transmitter (FdeA – scale of 0-100)
- Temperature of the chip in the receiver (Tmp2 – degrees C)
- Altitude (Alt – m)
- Rate of climb (VSpd – m/s)

It's a whole different kettle of fish, but a Radiomaster ELRS receiver will give you some great telemetry related to how well the signal is being received, and what level of power is being used to achieve that. Given that they are used for long distance applications, that is vital.

With Spektrum transmitters, the telemetry information can be seen on the screen during or immediately after the flight (until you change planes or turn off the transmitter). From the main screen normally used while flying you just scroll across to the telemetry screens, and you can see the totals that have accumulated to that point. Obviously, that is rather difficult when flying the plane, but it is possible. The main practical way to use it is to set up alarms or messages for the radio to give you of important things during the flight, then look at the telemetry screens at the time you cut the motor at the end of the flight to get an indication of whether you have some issues.

The Spektrum information will be available on the screens until you turn the transmitter off or change planes.

You can expect to have a good number of fades, perhaps even hundreds during a flight, but they are not a big issue when you have more than one antenna. Frame losses are a problem, but if you have, say, less than 20 during a flight, that should be acceptable. But if you have any holds at all, you need to see what's causing the problem. It might be antenna placement in the model, putting your hand over the transmitter antenna, or whatever else.

It is also possible on NX radios (and some of the later DX radios) to record a continuous log of telemetry values on an SD card. Values are cumulative, and it's not in a file type that can be read by normal spreadsheet software, but it can be converted into one. With a bit of manipulation using formulas, you can generate second by second actual values. You should also note that each flight that is recorded is added to the same file, so you need to make sure and download copies after every ten or so flights and then delete the original file so it doesn't get too big. The radio will then just create a new, empty one. They also have an iPhone app for viewing this data.

A transmitter, such as Radiomaster running EdgeTX can display the information you want on your main screen, and you might even have it shown as a bar graph, to make it clear at a glance whether things are OK. As with Spektrum, you can set alarms to sound, or a voice to speak, to warn you of something that is a problem. You can have it record data on the SD card at any time interval you specify. The data will be instantaneous values at each interval, not the running totals like what Spektrum gives you. The files are small, and lots of them fit on the card. Furthermore, there is an individual file for each flight with the name of the plane and a time stamp in the filename for each one. They are CSV files, which can be read in any spreadsheet app on your computer, such as Excel.

As far as the transmitters go, Spektrum is easy – some of it is already set up. You just need to look at it. If there are items missing you can have the radio search for them, and you do need to set up the flight logging. But, with Radiomaster and similar transmitters, you have many more options as to how you want it displayed. That, in turn, means that they need to be set up. But, typically, you do that once on a model template, then just use that template for adding new models. They are similar regarding searching for new telemetry items, triggering the logging and setting up spoken messages or alarms.

Do you need special equipment for telemetry?

A Lemon RX stabilized telemetry receiver has the basics all built in. You do have the option of selecting either a voltage probe or an 'energy meter.' The voltage probe can plug into the balance connector of the plane's battery to monitor its total voltage, or you can solder it in with

the red wire at the ESC connector that connects to the battery to have it in place permanently. Either way it is monitoring the total battery pack total voltage. The 'energy meter' just plugs into the ESC with the battery plugging into it. With it you get both voltage and current, and that allows the calculation of power being drawn, energy consumed, etc.

Our experience with Lemon RX receivers has shown that their telemetry works for nearly the entire range of the control signal. In our testing there were only a few short times where we lost telemetry with control of the aircraft being maintained.

Spektrum has receivers that provide either 'fly by' telemetry or telemetry throughout the flight. Their receivers will have some basic telemetry built in, but to get a more complete range of data, you need to use their 'Smart' receivers with 'Smart' ESCs and 'Smart' batteries. But, when you do that, you get far more data than what you can get with a Lemon RX receiver. Just add a significant multiplier to the cost! In addition, for things like the GPS, external temperature and RPM, you need to buy additional sensors.

It also is possible to set up a totally independent radio system, or use a controller to send back telemetry, but that's beyond the scope of this article.

How do you set up telemetry with a Radiomaster TX16s and a Lemon RX receiver?

First of all, set it up on model templates. It's good to have one for each sort of plane that you might have. So, have one with flaps and fixed gear, one with flaps and retracts, one with separate channels for the ailerons, etc. And, of course, in creating those, do the simplest one (no flaps, one aileron channel, fixed gear), and then copy it and modify the copy to create the next one, and so on.

Receiving all the data

Begin by creating a new model in your TX16s, then bind it to the transmitter. Keep it connected for the following. Press the "MDL" button then "Page<." Scroll left, then select "Delete all." This will clear the list of sensors that you do not have. Then select "Discover new." Give it 15 seconds or so to make sure it has located everything. Now, as you scroll to the right, you will see a list of all your telemetry items under "Sensors."

While you are on this screen, scroll back and find RSSI. This is where you can put in values for a low signal alarm. I have mine set at 37 for low alarm, and 33 for critical. You may want something different, but typically I find that it is announcing the warnings before the signals get that low.

You can now remove power from the receiver.

Displaying the data

Touch the "EDGE TX" icon in the upper left corner of the screen. Select "Screens Settings." Select the area of the screen that you want to edit along the top, or the "+" to add another screen. Select "Setup widgets." You can now select where you want the item of telemetry to show, select the widget that you want to use to display it, and then edit the color, etc. See our video, "Radiomaster TX16s Custom Screen Setup" for further details.

Recording the data

For this you need to press “SYS” and select the “Global Functions” icon. Press the “+” at the bottom. For the Trigger, choose what you want to trigger starting the flight log. I use the switch for arming the throttle. For “Function,” choose “SD Logs.” The “Interval” is how often you want the data recorded. I have selected 0.5s. Make sure the round button at “Enable” is on the right.

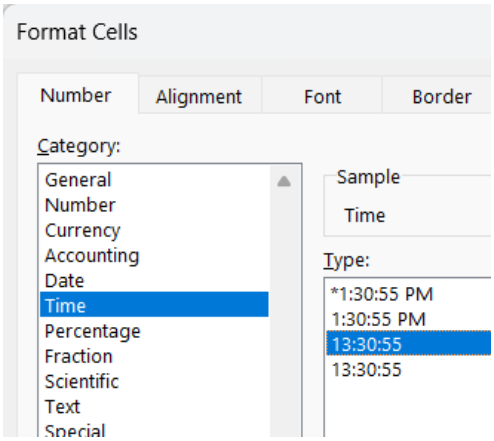
This will have it set up to record all your flights. You only need to do this once. You don’t need to do anything more each time you add a model.

Viewing the data

With the SYS menu showing, select “SD Card.” Select “Logs.” There you can see the list of logs that you have, and if you wanted to delete some that you don’t need, you could do it here. But this isn’t a good way to view the data.

The best way to view the data is to connect your transmitter to your computer, using the USB connection at the top, near the antenna. But before you plug that in, turn the transmitter on. When you have it connected, select “USB Storage (SD)” from the window that pops up. It will then display the folders from your SD card on your computer.

Open the “Logs” folder, and you will see a CSV file for each flight. You can either copy and paste them into a folder on your computer or open them directly from the transmitter. I do the latter, then I do a “Save As” to convert it to an Excel file and save it to the “Flight Logs” folder on my computer. Note that the “Time” column needs to be formatted as “time” for it to be correct. Select the column, right click on it, select “Format Cells,” Then “Time,” as you see here.



We will discuss more about this in the next section.

How can telemetry help you sort out what happened when your plane crashes?

This is always a challenge. Many RC pilots are quick to blame the radio for nearly any mishap. It does happen, but it's good to know if that is really the case.

Keep in mind that the guys spending many thousands of dollars on their RC aircraft don't even trust the most expensive transmitters and receivers to control their planes without several redundancies in the systems. So, for those of us down in the more down to earth realm, you can expect a glitch now and then.

Before you even start the analysis, write down what you remember about the crash. What were you doing, or trying to do? How was the airplane responding? What sort of airspeed did it have? Could you hear the motor going? About how long was it from when you first noticed a problem to when it crashed?

Some of these things may not be totally accurate but writing it down is helpful when you are trying to sort things out.

So, as described above, locate the flight log CSV file, and save it as an Excel file on your computer (or other proper spreadsheet file type). Format the time column as time.

Let's consider a log generated from a Lemon RX telemetry stabilized receiver on a Radiomaster TX16s transmitter.

Now, as you look at the data, TRSS is "telemetry received signal strength." It's the strength of the signal from the plane's telemetry as received by your transmitter on a scale of 0 to 31, where 31 is the best. The next column is FdeA. For some receivers that would be fades on antenna A, but for Lemon RX it is your TRSS signal strength on a scale of 0 to 100, where 100 would be the signal strength when the plane is right next to the transmitter. If things are working, those values should be going up and down at least slightly every second or so.

Before you worry too much about those numbers, we want to look for a time segment where all of the telemetry values are frozen, as shown at the right, highlighted in yellow.

That is an indication that at least the telemetry signal has been lost, and it's likely that the control signal has also been lost, given that the receiver is not the fly by variety. When Radiomaster stops receiving a signal, it simply freezes the values until new ones are received.

If you don't find a segment like that, then connection between the transmitter and receiver has been maintained throughout the flight.

Next, do your best to work out the time on the spreadsheet when the crash happened. That's easy if the control signal has been maintained. Just have a look at the altitude and see where it goes to something close to zero, or the height that it ended up in the tree. In my example, it wasn't quite so easy. I was thinking that I cut the throttle just before the crash. That happened at 9:34:55 so I highlighted the following row to indicate that the crash should be sometime after that.

Date	Time	TRSS	FdeA	A2(V)	A3(V)
22/01/2025	9:34:47	30	86	5	14.84
22/01/2025	9:34:48	27	80	5	14.76
22/01/2025	9:34:48	13	72	5.01	14.82
22/01/2025	9:34:49	22	71	4.99	14.76
22/01/2025	9:34:49	17	66	5	14.37
22/01/2025	9:34:50	30	93	5.01	14.66
22/01/2025	9:34:50	29	84	5	14.35
22/01/2025	9:34:51	28	75	5.01	14.66
22/01/2025	9:34:51	28	81	5.02	14.75
22/01/2025	9:34:52	30	83	5.03	14.59
22/01/2025	9:34:52	29	75	5	14.73
22/01/2025	9:34:53	29	75	5	14.73
22/01/2025	9:34:53	29	75	5	14.73
22/01/2025	9:34:54	29	75	5	14.73
22/01/2025	9:34:54	29	75	5	14.73
22/01/2025	9:34:55	29	75	5	14.73
22/01/2025	9:34:55	29	75	5	14.73
22/01/2025	9:34:56	29	75	5	14.73
22/01/2025	9:34:56	29	75	5	14.73
22/01/2025	9:34:57	29	75	5	14.73
22/01/2025	9:34:57	29	75	5	14.73

In my observations I noted that as I was turning onto the downwind leg of the pattern, I experienced a lot of what I figured was adverse yaw. Shortly after that, as the plane was banking slightly to the left, and with plenty of airspeed it stopped responding to controls and gently continued its left bank, flying into a tall tree. It maintained plenty of airspeed. I should also mention that the plane had been flying beautifully that day. This was the second flight, and I was working out what gain to use for the stabilization. By this time, I had turned its gain down to next to nothing, but stabilization was on.

So, I had a look at what was happening with the aileron and rudder. I didn't have any mixing programmed, and earlier I had noticed adverse yaw, so I was using the rudder with the ailerons in the turns. In the analysis, to help me visualize what was going on, I put in cell highlighting rules to color cells with left aileron or rudder red, and right, green. The lighter color indicates a minor movement of the stick.

To my embarrassment, I realised that I was making my adverse yaw worse going around that turn. I was using opposite rudder! Brain fade!

One last observation. In locating which tree the plane was in, I gave the throttle a blip a couple of times. I could hear the propeller spin, so the receiver was still connected to power and was functional following the crash.

	Ail hi=lft	Elev	Thr	Rud lo=lft
Time	CH1(us)	CH2(us)	CH3(us)	CH4(us)
9:34:40	1507	1466	1214	1500
9:34:40	1507	1473	1214	1500
9:34:41	1507	1448	1214	1500
9:34:41	1507	1434	1214	1500
9:34:42	1505	1448	1194	1500
9:34:42	1464	1473	1227	1520
9:34:43	1442	1466	1290	1537
9:34:43	1507	1409	1283	1568
9:34:44	1511	1438	1307	1574
9:34:44	1519	1446	1244	1579
9:34:45	1528	1451	1212	1571
9:34:45	1570	1445	1230	1551
9:34:46	1506	1459	1241	1561
9:34:46	1414	1447	1260	1555
9:34:47	1476	1418	1345	1545
9:34:47	1507	1334	1388	1551
9:34:48	1511	1357	1400	1549
9:34:48	1511	1421	1425	1541
9:34:49	1522	1424	1434	1542
9:34:49	1543	1410	1482	1541
9:34:50	1545	1413	1541	1530
9:34:50	1542	1447	1526	1500
9:34:51	1537	1470	1495	1500
9:34:51	1558	1456	1559	1500
9:34:52	1570	1447	1583	1500
9:34:52	1517	1450	1586	1500
9:34:53	1511	1444	1635	1500
9:34:53	1498	1433	1639	1500
9:34:54	1463	1439	1645	1500
9:34:54	1330	1474	1654	1500
9:34:55	1329	1482	1569	1500
9:34:55	1329	1518	988	1499
9:34:56	1329	1218	988	1501

Now, from the data on the previous page, you would note that the telemetry signal was lost at the second half of 9:34:52. At that time the aileron was slightly left (1517 with the trimmed center being 1507) and the rudder was neutral. Given that one second later I'm beginning to put in right aileron, and my observation was that it simply continued a gentle bank to the left, that's consistent with the receiver going into fail safe mode at that point in time. The throttle is cut, and the control surfaces hold their last position.

Looking at the altitude, it had been dropping during my side slip, but once the rudder was neutralized, and with about half throttle, the plane was climbing. With no telemetry from 9:34:52 it's not telling us what happened, but it ended up in a tree about 12 m above ground, and that is consistent with what we observed as well as the suggestion that the throttle was cut with the fail safe at 9:34:52.

This is a 3D plane with huge ailerons. Given that we have put in lots of right aileron, beginning at 9:34:53 and elevator from 9:34:56 without the plane responding, that is also consistent with what we are considering.

We do not know precisely when the plane hit the tree, but it is certain that it happened after the throttle cut at 9:34:56. I flicked off the stabilization at 9:35:00, and aileron and elevator sticks didn't go to neutral until 9:35:07 so it's likely that the plane hit the tree around the time that the telemetry was restored.

B	M	AM	AN	AO	AP
		Ail	Elev	Thr	Rud
		hi=lft			lo=lft
Time	Alt(m)	CH1(us)	CH2(us)	CH3(us)	CH4(us)
9:34:44	28	1511	1438	1307	1574
9:34:44	28.2	1519	1446	1244	1579
9:34:45	28.2	1528	1451	1212	1571
9:34:45	28.6	1570	1445	1230	1551
9:34:46	28.4	1506	1459	1241	1561
9:34:46	26.4	1414	1447	1260	1555
9:34:47	24.3	1476	1418	1345	1545
9:34:47	22.6	1507	1334	1388	1551
9:34:48	19.9	1511	1357	1400	1549
9:34:48	19.4	1511	1421	1425	1541
9:34:49	18.9	1522	1424	1434	1542
9:34:49	16.1	1543	1410	1482	1541
9:34:50	12.6	1545	1413	1541	1530
9:34:50	11.6	1542	1447	1526	1500
9:34:51	13.6	1537	1470	1495	1500
9:34:51	15.3	1558	1456	1559	1500
9:34:52	16.4	1570	1447	1583	1500
9:34:52	16.8	1517	1450	1586	1500
9:34:53	16.8	1511	1444	1635	1500
9:34:53	16.8	1498	1433	1639	1500
9:34:54	16.8	1463	1439	1645	1500
9:34:54	16.8	1330	1474	1654	1500
9:34:55	16.8	1329	1482	1569	1500
9:34:55	16.8	1329	1518	988	1499
9:34:56	16.8	1329	1218	988	1501

It's also worthy of noting that there was a big glitch in the altitude value, and the receiver voltage dropped at that point in time. For what it is worth, we saw a similar glitch in altitude in testing a variety of receivers when we were diagnosing a fault in our Radiomaster 4 in 1 module. We didn't see that when range testing with the Lemon RX.

Finally, note that the signal strength was very strong just before all of this happened.

9:35:03	29	75	5	14.73	31	16.8
9:35:03	29	75	5	14.73	31	16.8
9:35:04	29	75	5	14.73	31	16.8
9:35:04	29	75	5	14.73	31	16.8
9:35:05	24	75	5	14.73	31	16.8
9:35:05	24	75	5	14.73	31	16.8
9:35:06	24	75	5	14.73	31	16.8
9:35:06	17	52	2.93	14.72	31	16.8
9:35:07	17	47	2.99	14.73	31	-2.2
9:35:07	15	42	3.16	14.79	31	-3.1
9:35:08	15	42	3.16	14.79	31	-3.1
9:35:08	16	42	3.16	14.79	31	-3.1
9:35:09	17	42	3.06	14.73	31	-3.1
9:35:09	17	42	3.06	14.73	31	-3.1
9:35:10	15	42	3.06	14.73	31	-1545.2
9:35:10	21	50	2.94	14.7	31	0.4

Conclusion

A radio fault was the ultimate reason for the crash. That could have been a fault in the transmitter or receiver. Additionally, there is a remote possibility that it could have been an issue with interference. I can't imagine someone in the bush with a directional WiFi shooting me out of the sky, and the frequency hopping that modern transmitters use should mean that other transmitters at the club shouldn't have been a problem. Certainly, there is a lot of 2.4 GHz clutter around, but our transmitters are designed to work in spite of that.

What I will be doing at this time is doing some extensive bench testing with the same plane, receiver and transmitter, to see if I can replicate it. If I do, then I will swap in and out the ESC, receiver and transmitter, one at a time, to see if I can isolate which one, if any, is the problem.

Having said all that, if I had not done the sideslip going around the turn, I would have had a lot more altitude, and if lucky, might have regained control before the plane hit anything. It does pay to generally fly a couple of mistakes high!

I would appreciate your comments and ideas. View the video below, and provide your feedback there.

By the way, after having spend three or four days in the tree, including a rain storm with heavy winds, friends of mine at the club got the plane down for me. It suffered a lot of damage, partly from the impact, and partly from getting poked at with PVC pipes! Anyhow, it's now been repaired, and you can see what that was all about here: