2011

INTRODUCTION

360°RF has performed new measurements upon revised 433.92 MHz remote control transmitters and receivers, as shown to the right. These are used to control an actuating device, as shown below.

New equipment provided included the following:

- XYZ 285.1, PRC origin remote control transmitter and receiver
- XYZ 285.2, PRC origin remote control transmitter and receiver
- XYZ 285.3, PRC origin remote control transmitter and receiver

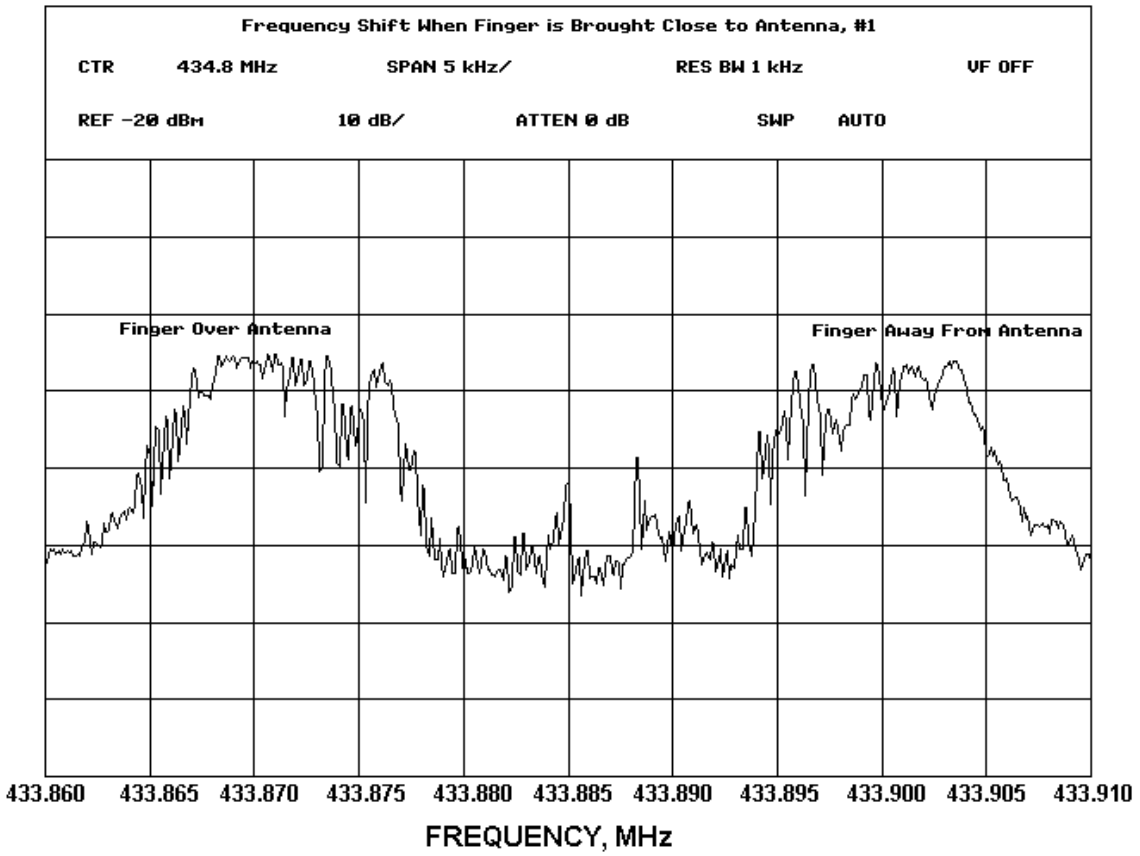
Measurements of Transmitters

360°RF first measured the operating frequency of the transmitters, obtaining the results shown in the following table (which also shows the measured frequency of the earlier transmitters). As we had observed of the PRC origin transmitters earlier, the frequency of the revised transmitters was extremely sensitive to how the remotes are held in a hand. All three revised transmitters were found to be operating within 30 kHz of the correct frequency when the remotes are grasped with fingers away from the transmitter antenna (which is at the far end of the bulge in the remote's case), much closer to the design frequency than the earlier PRC origin samples.

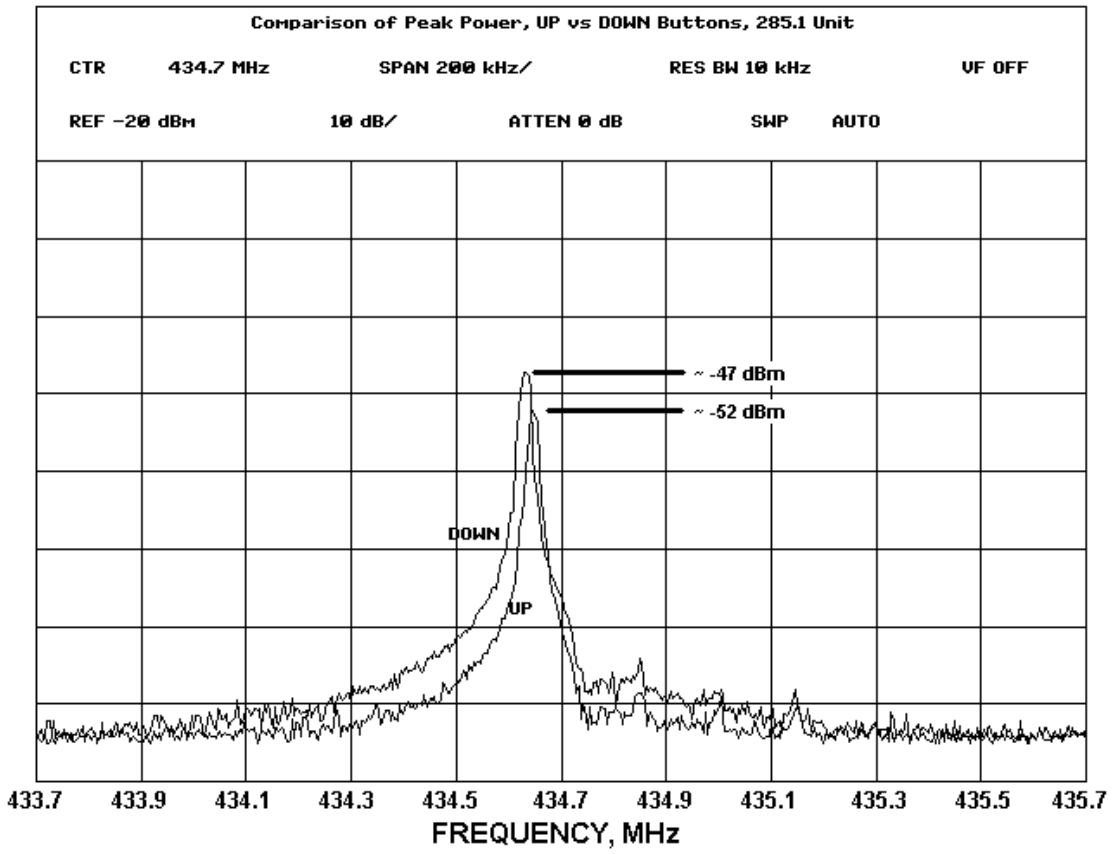
The effect of an off-frequency transmitter upon system range can be considerable, depending upon the bandwidth of the receiver. If the transmitter frequency is too far from the receiver frequency, range of the system can be greatly decreased. If the transmitter frequency is "pushed" out of the receiver's passband, the system can fail entirely. As mentioned in 360°RF's earlier report, engineers were unable to find a data sheet for the receiver IC inside the PRC origin receivers, so are unable to determine whether this is a real concern.

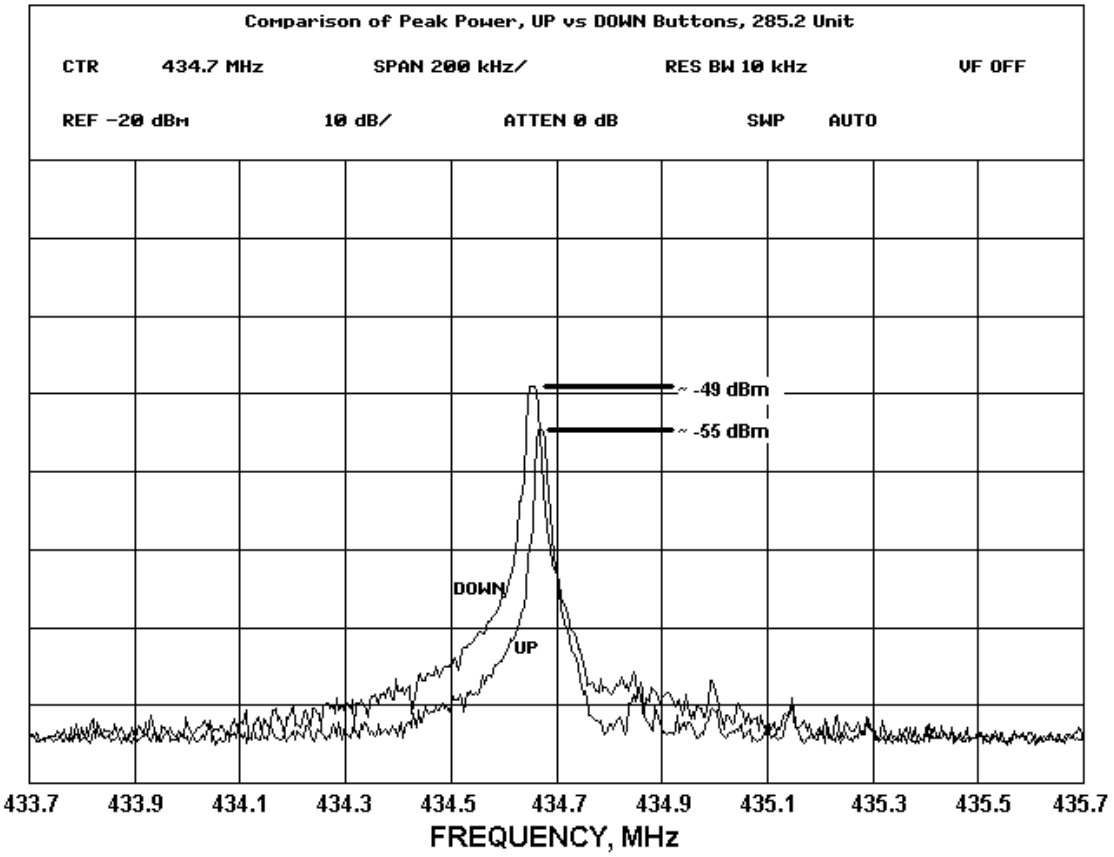
TX	Measured Frequency (MHz), DOWN Button Depressed	Measured Frequency (MHz), UP Button Depressed	Measured Frequency (MHz) with Finger Wrapped around top of Transmitter
279.1	433.855	433.855	433.826
279.18	433.828	433.833	433.768
279.20	433.852	433.852	433.798
281.1	433.920	433.920	433.920
281.2	433.920	433.920	433.920
281.3	433.920	433.920	433.920
285.1	433.907	433.918	433.868
285.2	433.941	433.951	433.927
285.3	433.926	433.938	433.910

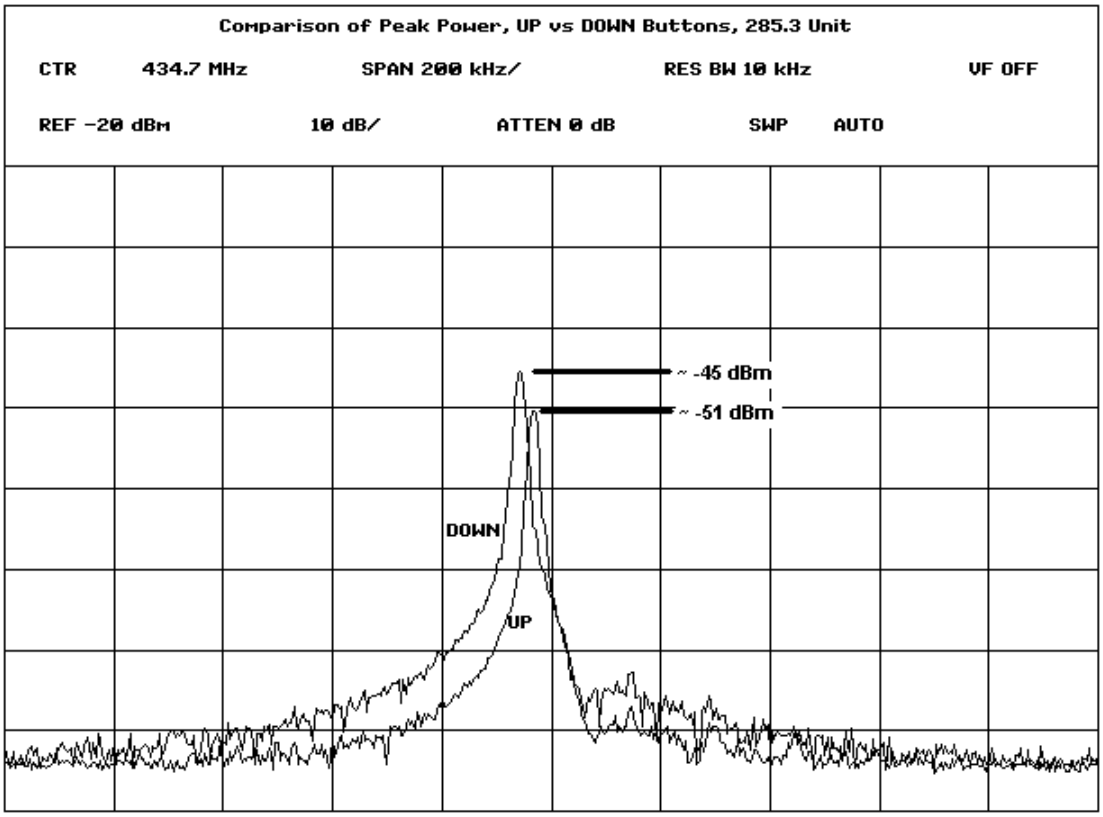
The frequency difference between the DOWN and UP pushbuttons was measured at 10 to 12 kHz (we did not perform that measurement on the earlier units). Note that when a finger is wrapped around the large end of the remotes (where the antenna is located), the frequency can shift lower by as much as 50 kHz; however, this is less shift away from the design frequency of 433.92 MHz than we observed during the first trials, which was as much as 65 kHz as can be seen from the preceding table. The following plot is typical of the frequency-pulling that was observed with the 285.1 unit.



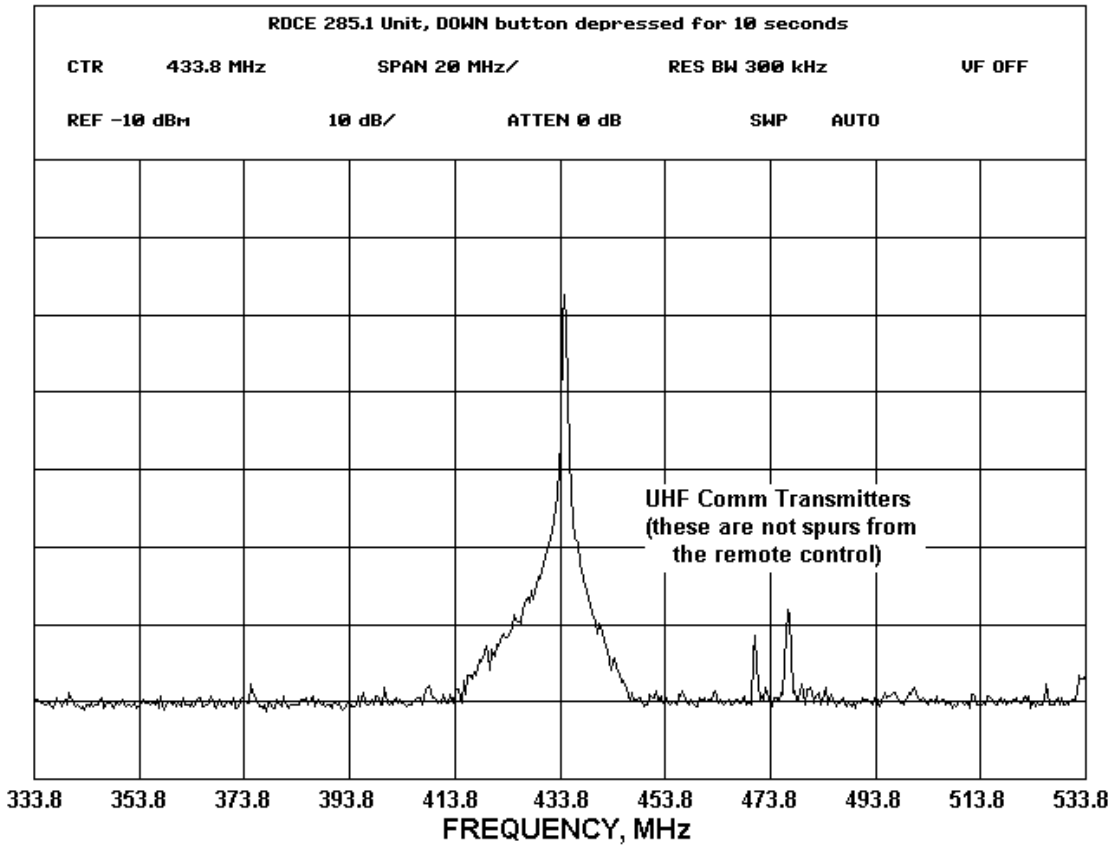
The following plots illustrate power level differences between the UP and DOWN pushbuttons on each revised unit. The slight frequency shift between the UP and DOWN pushbuttons can also be discerned, as noted above. The power levels on the following plots are not absolute; the distance from each transmitter to the spectrum analyzer antenna was set for an easily observable power level.

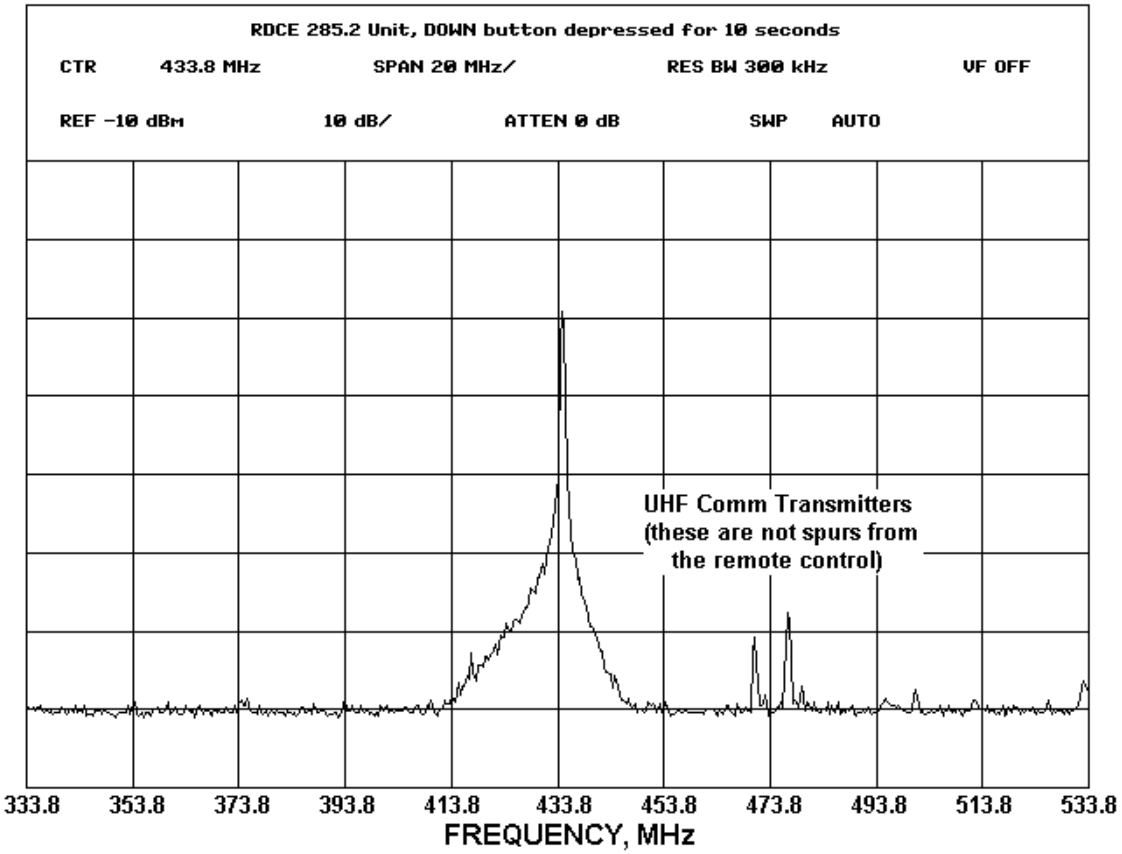

Comparison of Peak Power, UP vs DOWN Buttons, 285.1 Unit
CTR 434.7 MHz
SPAN 200 kHz/
RES BW 10 kHz
VF OFF
REF -20 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
~ -47 dBm
~ -52 dBm
DOWN
UP
433.7 433.9 434.1 434.3 434.5 434.7 434.9 435.1 435.3 435.5 435.7
FREQUENCY, MHz

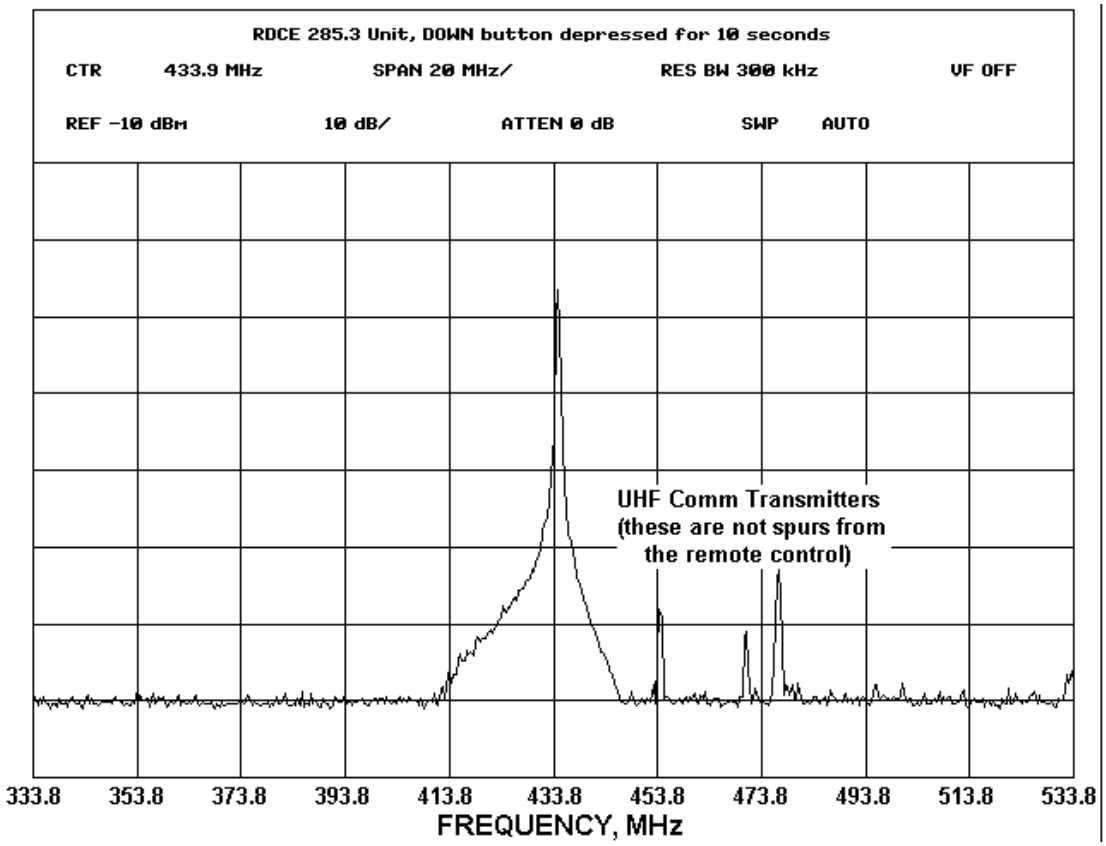

Comparison of Peak Power, UP vs DOWN Buttons, 285.2 Unit
CTR 434.7 MHz
SPAN 200 kHz/
RES BW 10 kHz
VF OFF
REF -20 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
~ -49 dBm
~ -55 dBm
DOWN
UP
433.7 433.9 434.1 434.3 434.5 434.7 434.9 435.1 435.3 435.5 435.7
FREQUENCY, MHz



Engineers did not find the new transmitters to be radiating any spurious emissions. The spectrum now appears about as “clean” as, and resembles, the US-made transmitters tested previously. The following plots show the spectral response of each transmitter. Again, the power levels are not absolute; each transmitter was placed so as to obtain a reasonable signal level for observation. The spurs seen in the 450 to 480 MHz region are signals from local UHF communications radios; a television transmitter can be seen at the extreme far right.


RDCE 285.1 Unit, DOWN button depressed for 10 seconds
CTR 433.8 MHz
SPAN 20 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
UHF Comm Transmitters
(these are not spurs from
the remote control)
333.8
353.8
373.8
393.8
413.8
433.8
453.8
473.8
493.8
513.8
533.8
FREQUENCY, MHz


RDCE 285.2 Unit, DOWN button depressed for 10 seconds
CTR 433.8 MHz
SPAN 20 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
UHF Comm Transmitters
(these are not spurs from
the remote control)
333.8
353.8
373.8
393.8
413.8
433.8
453.8
473.8
493.8
513.8
533.8
FREQUENCY, MHz



Engineers next measured the relative radiated output power of each transmitter by holding each transmitter in the hand on an antenna range, one meter from a receiving antenna connected to a spectrum analyzer. 360°RF recorded the displayed peak signal level from each transmitter as shown in the table below. Note that there is up to 10 dB difference in radiated power between the UP and DOWN buttons; this can cause the range to be further for the DOWN function by as much as double the range. In addition, for the PRC origin transmitters, engineers found that when held horizontal and facing perpendicular to the axis toward the receiver, the apparent radiated power increased another 10 dB. However, during actual range tests, this did not result in any significant increase in range, most likely due to the signal reflecting from the ground and other objects and the signal polarization then becoming mixed.

These levels are different from those previously reported because for these measurements, the transmitters were being held in the hand for direct real-world comparison.

TX	DOWN Signal Strength, dBm, Vertical	DOWN Signal Strength, dBm, Horizontal
285.1	-75	-40
285.2	-75	-40
285.3	-75	-40
279.1	-75	-45
279.18	-80	-50
279.20	-75	-45
281.1	-50	-40
281.2	-50	-40
281.3	-50	-40

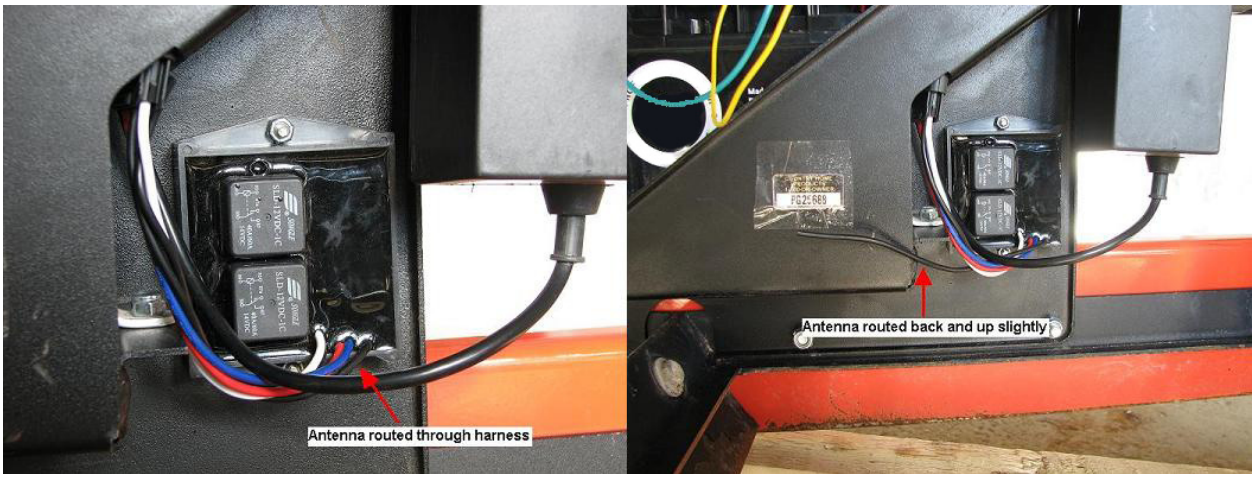
Note that the radiated signal level of the new PRC origin transmitters is now about the same as the earlier-measured US-made transmitters on horizontal polarization.

Measuring the actual range of the transmitters and receivers, with the receivers mounted on the actuating device, produced the following results. Engineers held the transmitters horizontal, and measured the range facing the grader then facing away from the grader. 360° noted that when held facing away from the grader, with the remote several inches from a human body, the range seemed to lengthen slightly but noticeably in most circumstances. 360° performed four tests with each transmitter with the antenna routed through the harness to adjudge repeatability.

Test #	TX	RX	Range, TX Facing Grader (feet)	Range, TX Facing Away (feet)	Comments
1	285.1	285.1	44	43	Antenna routed through harness
2	285.1	285.1	43	47	Antenna routed through harness
3	285.1	285.1	47	47	Antenna routed through harness
4	285.1	285.1	47	47	Antenna routed through harness
5 – 9	285.1	285.1	>225	>225	Antenna straight away from RX
10	285.2	285.2	83	89	Antenna routed through harness
11	285.2	285.2	87	89	Antenna routed through harness
12	285.2	285.2	87	90	Antenna routed through harness
13	285.2	285.2	87	92	Antenna routed through harness
14 – 18	285.2	285.2	>225	>225	Antenna straight away from RX
19	285.3	285.3	117	115	Antenna routed through harness
20	285.3	285.3	116	115	Antenna routed through harness
21	285.3	285.3	113	120	Antenna routed through harness
22	285.3	285.3	115	116	Antenna routed through harness
23 – 26	285.3	285.3	>225	>225	Antenna straight away from RX
27	285.2	285.2	189	>225	Antenna back and up slightly
28	285.1	285.1	132	175	Antenna back and up slightly
29	285.1	285.1	>225	>225	Remote held above head facing RX
30	285.3	285.3	165	202	Antenna back and up slightly

Even though the transmitter power now appears to be higher, on frequency, and with no spurious emissions, the range measured with the antenna routed through the receivers' wiring harnesses now appears to be somewhat less than our earlier measurements. However, we obtained much more consistent range measurements with these units than we did during our earlier measurements. With the receiver antenna routed straight away from the receiver, the range was in excess of 225 feet every time, which was not always the case with the earlier PRC origin units, which exceeded 225 feet several times, but not always.

360 Antenna also performed several range measurements with the receiver antenna wire routed back along the grader frame but clear of the wiring harness, and obtained intermediate ranges between that with the antenna in the harness, and protruding straight away from the harness (labeled above as "Antenna back and up slightly"). The photos below show the antenna wire routed through the harness, and routed back and up slightly but clear of the harness. For best range, we recommend that the user be directed to keep the antenna wire clear of the harness.

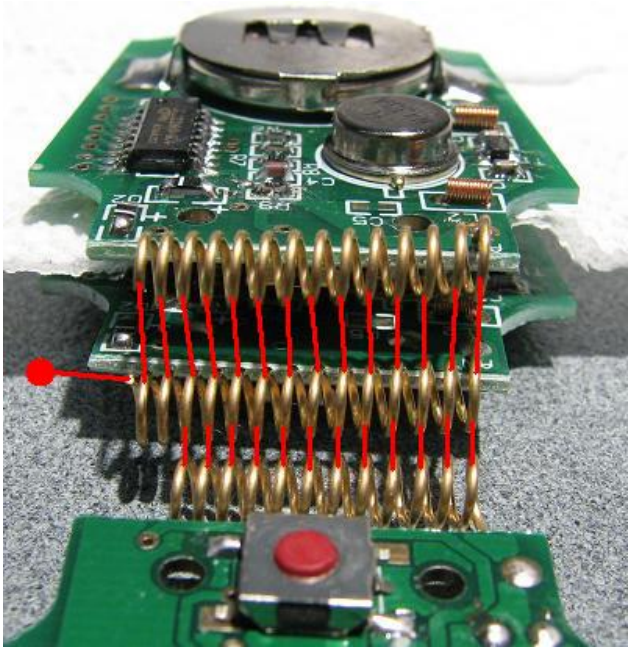


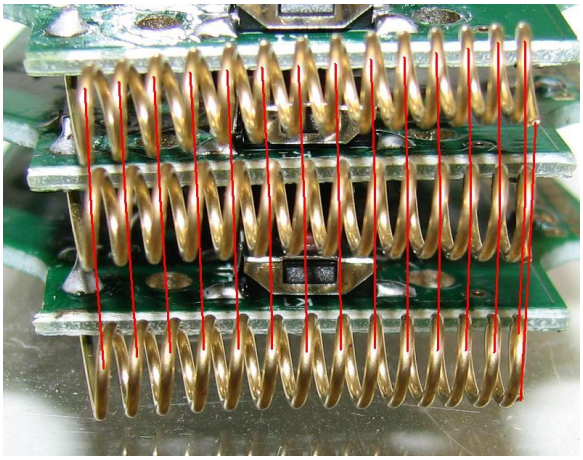
For comparison, the range measurements of the earlier six transmitters (horizontal only) are shown below.

Test #	TX	RX	Range, TX Held Horizontal (feet)	Comments
6	279.1	279.18	160	Antenna protruding straight away from receiver
15	279.1	279.18	158	Antenna protruding straight away from receiver
17	279.1	279.18	>225	Antenna protruding straight away from receiver
21	279.1	279.18	126	Antenna routed through harness
2	279.1	279.6	>225	Antenna protruding straight away from receiver
22	279.1	279.6	120	Antenna routed through harness
9	279.1	279.8	135	Antenna protruding straight away from receiver
10	279.1	279.8	202	Retest with New Battery, Antenna protruding straight away
7	279.18	279.18	159	Antenna protruding straight away from receiver
14	279.18	279.18	196	Retest, Antenna protruding straight away from receiver
18	279.18	279.18	>228	Antenna protruding straight away from receiver
20	279.18	279.18	120	Antenna routed through harness
3	279.18	279.6	>225	Antenna protruding straight away from receiver
23	279.18	279.6	101	Antenna routed through harness
8	279.18	279.8	184	Antenna protruding straight away from receiver
5	279.2	279.18	171	Antenna protruding straight away from receiver
11	279.2	279.18	212	Antenna protruding straight away from receiver
16	279.2	279.18	>228	Antenna protruding straight away from receiver
19	279.2	279.18	115	Antenna routed through harness
4	279.2	279.6	>225	Antenna protruding straight away from receiver
24	279.2	279.6	114	Antenna routed through harness
1	281.1	281.1	155	Antenna protruding straight away from receiver
26	281.1	281.1	133	Antenna routed through harness
13	281.2	281.2	117	Antenna protruding straight away from receiver
25	281.2	281.2	155	Antenna routed through harness
12	281.3	281.3	130	New Battery, Antenna protruding straight away
27	281.3	281.3	130	Antenna routed through harness

Internal Examination

During 360°RF's earlier inspection of the PRC origin transmitters, engineers had found that each transmitter had a different length antenna installed, as shown in the photo to the left, below. The photo to the right shows the antennas of the new transmitters, which now appear to be comprised of identical lengths. The red lines are intended to show the number of wire turns that compose each antenna. In the left photo, it is clear that each antenna is different, but the right photo shows that now, each antenna is the same. The revised transmitters otherwise appear to be physically identical to the earlier samples.





Other Comments and Observations

The turn-on and turn-off delay of about one second previously reported with the earlier PRC origin samples, both UP as well as DOWN, still exists and does not appear to have been reduced. The spectrum analyzer indicates that the transmitters are turning on instantaneously, so the delay appears to be in the receiver. In our earlier report, 360° commented that we believe the delay is due to 33 microfarad electrolytic capacitors connected in shunt with the base of the relay switching transistors in the receiver. To eliminate or at least reduce the delay, 360°RF suggests that the manufacturer reduce the value of those capacitors to 4.7 or 10 microfarad so as to reduce the turn-on and turn-off delays to a fraction of a second.

Engineers also noticed that each transmitter appears to work with each receiver, rather than being individually coded to a particular receiver. 360° did not perform tests using, for example, the 285.1 transmitter with the 285.2 receiver.

Conclusion

360°RF has compared three revised 433.92 MHz remote control receivers and transmitters, measuring the effective range and analyzing their performance. Findings indicate that the PRC origin samples now are somewhat more powerful and no longer have spurious emissions, but the range appears to be slightly less, although far more consistent than had been measured earlier. The delay in turn on of the Actuator by the receivers still exists and does not appear to have been shortened. 360°RF also found the PRC origin transmitters are still very sensitive to how they are held, or their proximity to nearby metal objects. Due to their circuit design, they are very easy to "push" off the desired operating frequency of 433.92 MHz, and perhaps out of the receivers' passband, reducing the effective range.

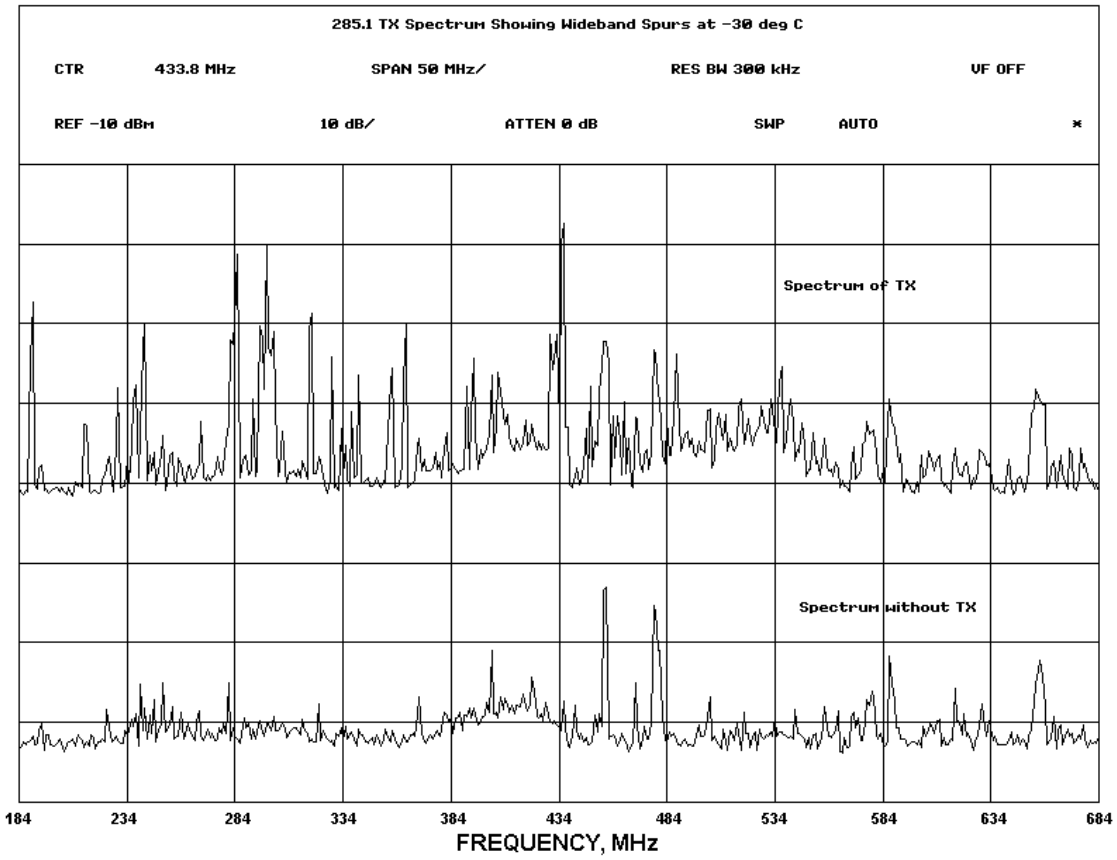
Comparison of Performance with Specifications and Requirements
360°RF performed several tests to confirm that the 285- series transmitters and receivers perform properly over a temperature range of -30°C to +70°C, and also over the desired operating voltages. In addition, engineers compared actuator specifications against the provided linear actuators.

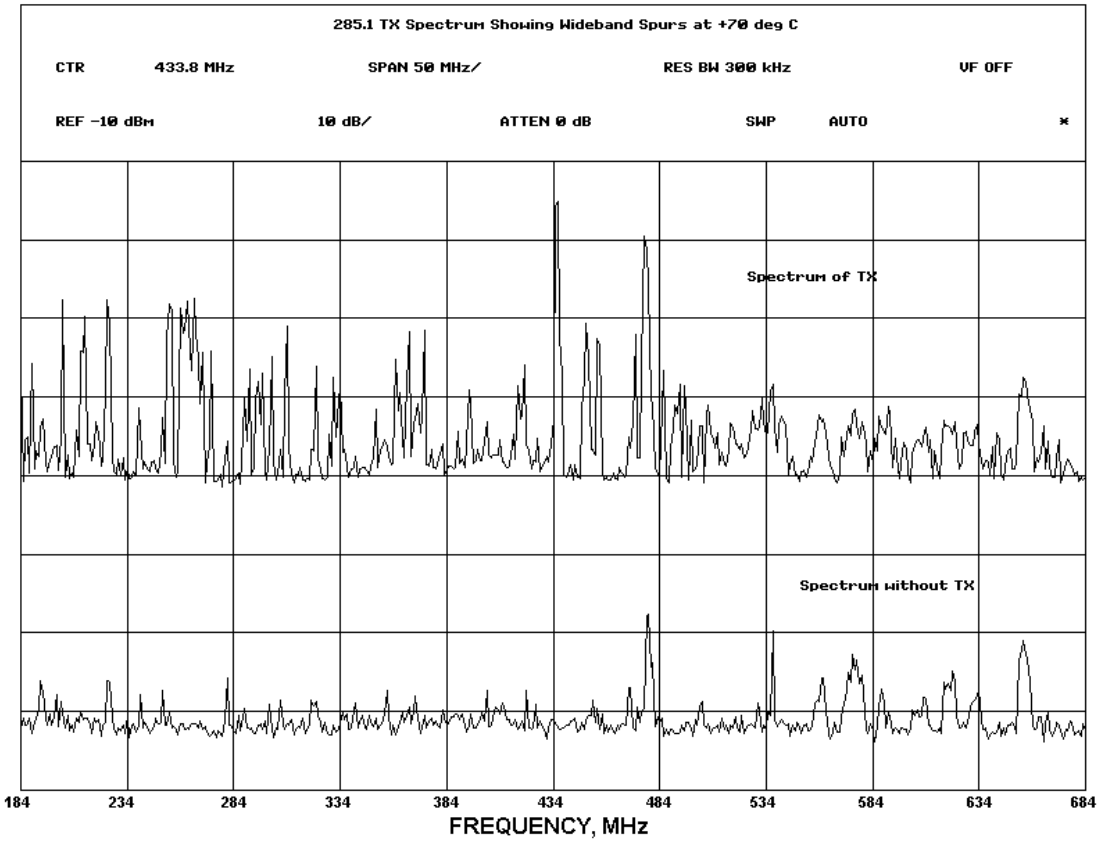
360° notes that the model actuator provided to us, a Model ABC, states on its label “Max. load: 1500N,” whereas the specification calls for a maximum loading of 2000N for the actuator. However, our research found an advertisement for this model that states “largest charge 6000N”. We do not know what is meant by “largest charge,” but suspect it means the same as “maximum loading”.

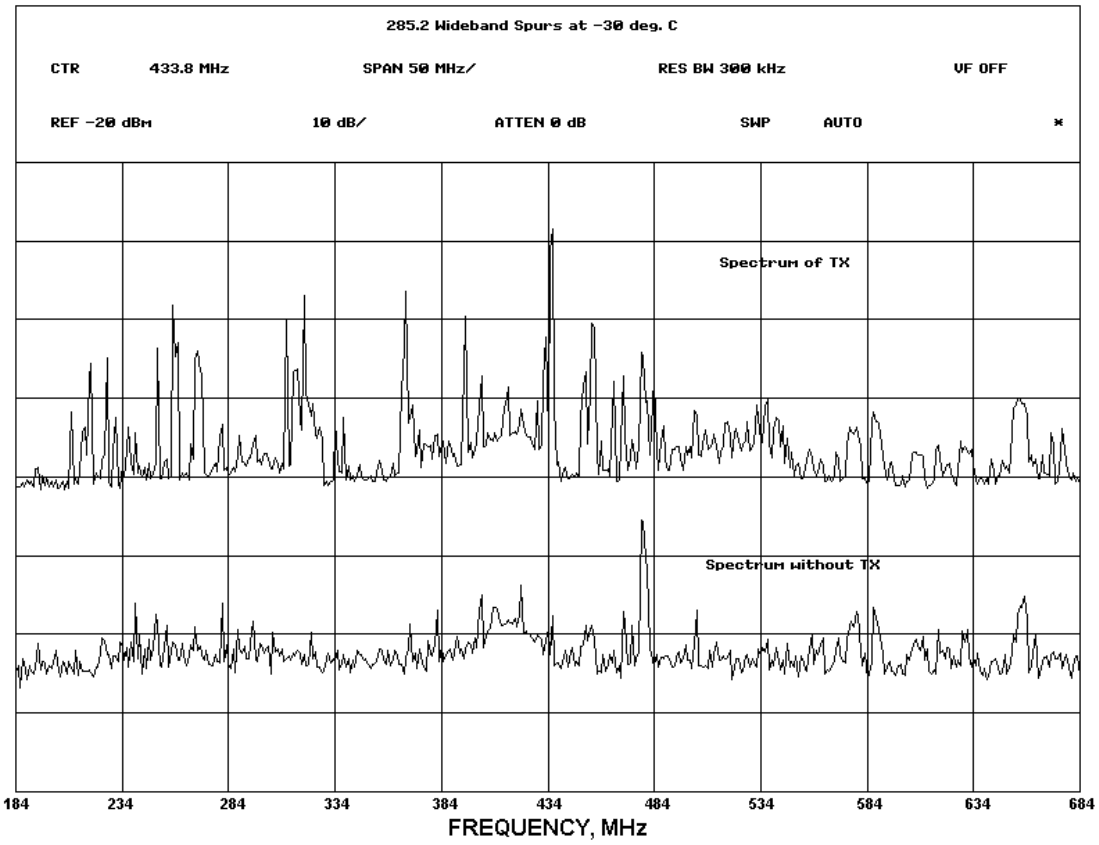
In addition, the same advertisement lists the “Environment temperature 5 - 40 degrees”, whereas the specification calls for -30°C to +70°C.

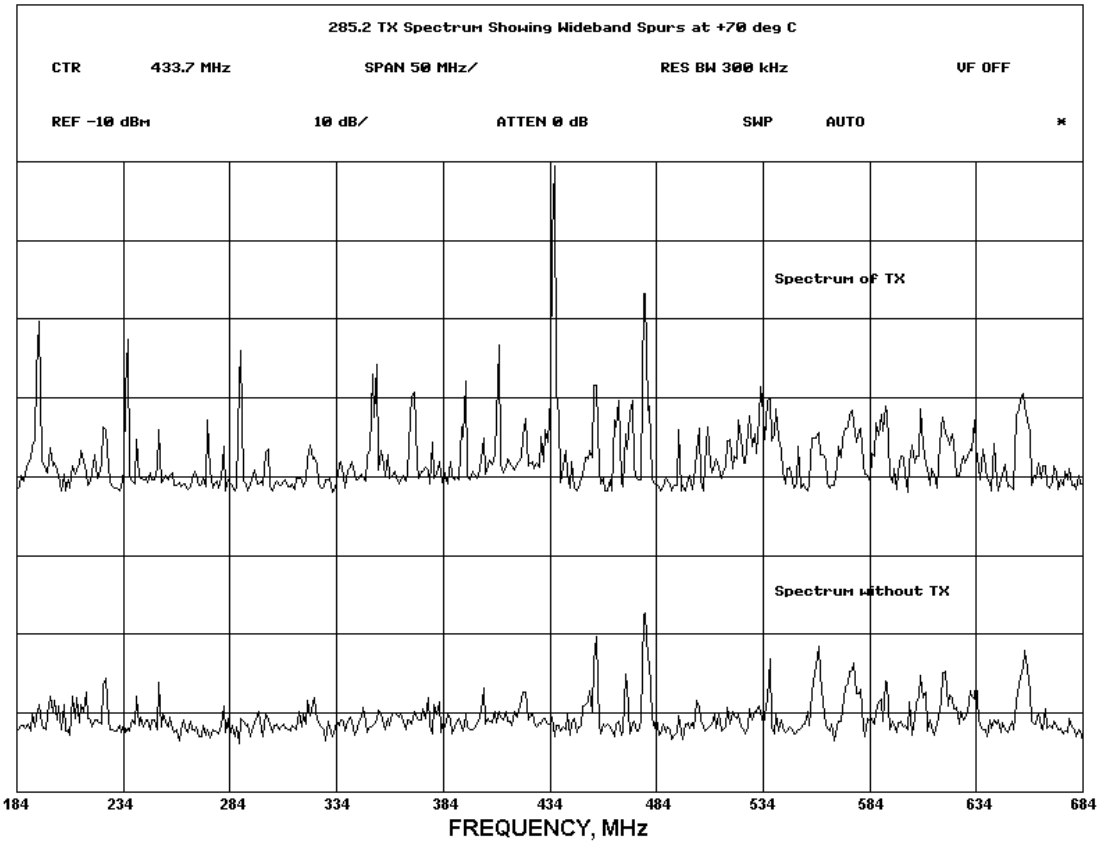
Temperature Extreme Testing
Using an environmental chamber, we subjected the receiver and transmitter modules to -30°C and +70°C, testing them for proper operation at receiver battery voltages from 9.0 through 16.0 volts. 360° did not subject the actuators to temperature extremes.

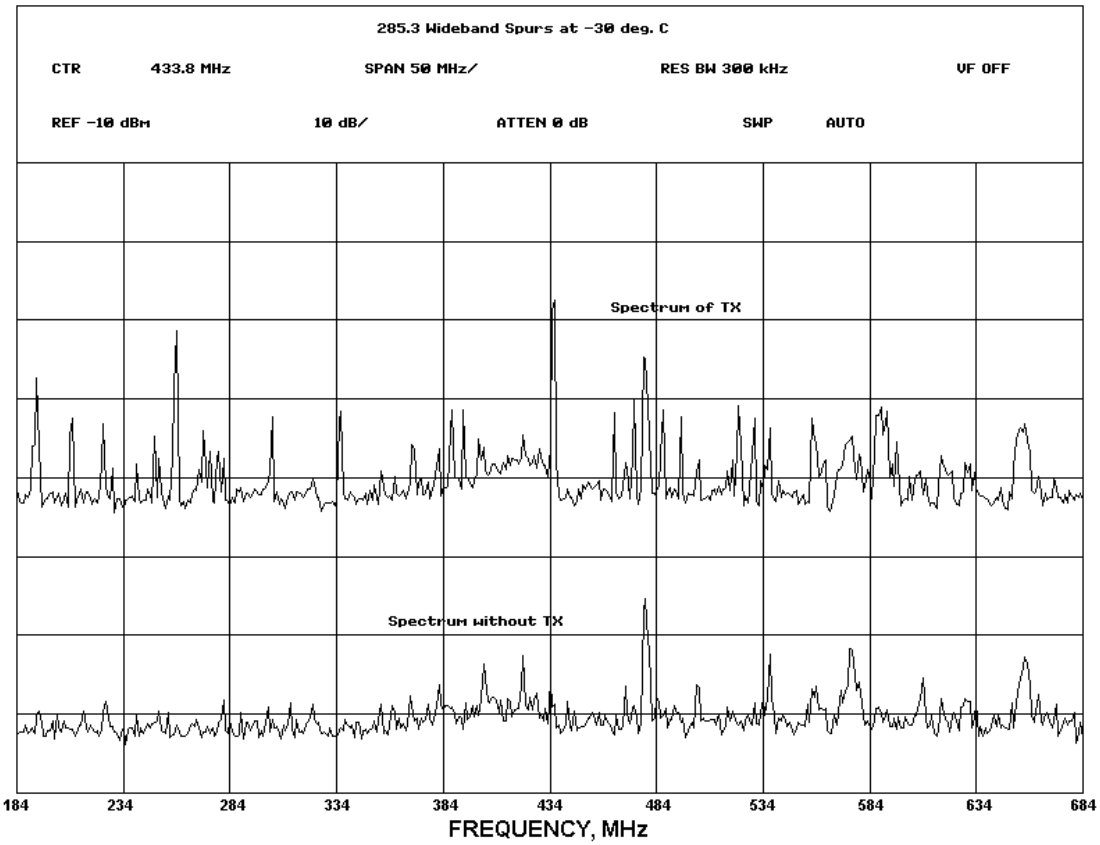
At both temperature extremes, engineers found that the transmitter modules would intermittently generate spurious emissions that swept from less than 200 MHz to over 700 MHz. However, the spurs are very intermittent and do not occur at all times. The following plots show the spurs from each transmitter. The transmitter spectrum in the top trace; the lower trace is the environment with the transmitter off. The trace was offset downward 30 dB (except the -30° C plot for 285.2, which was offset only 20 dB) to show the spectrum analyzer noise floor on a clear part of the graph.

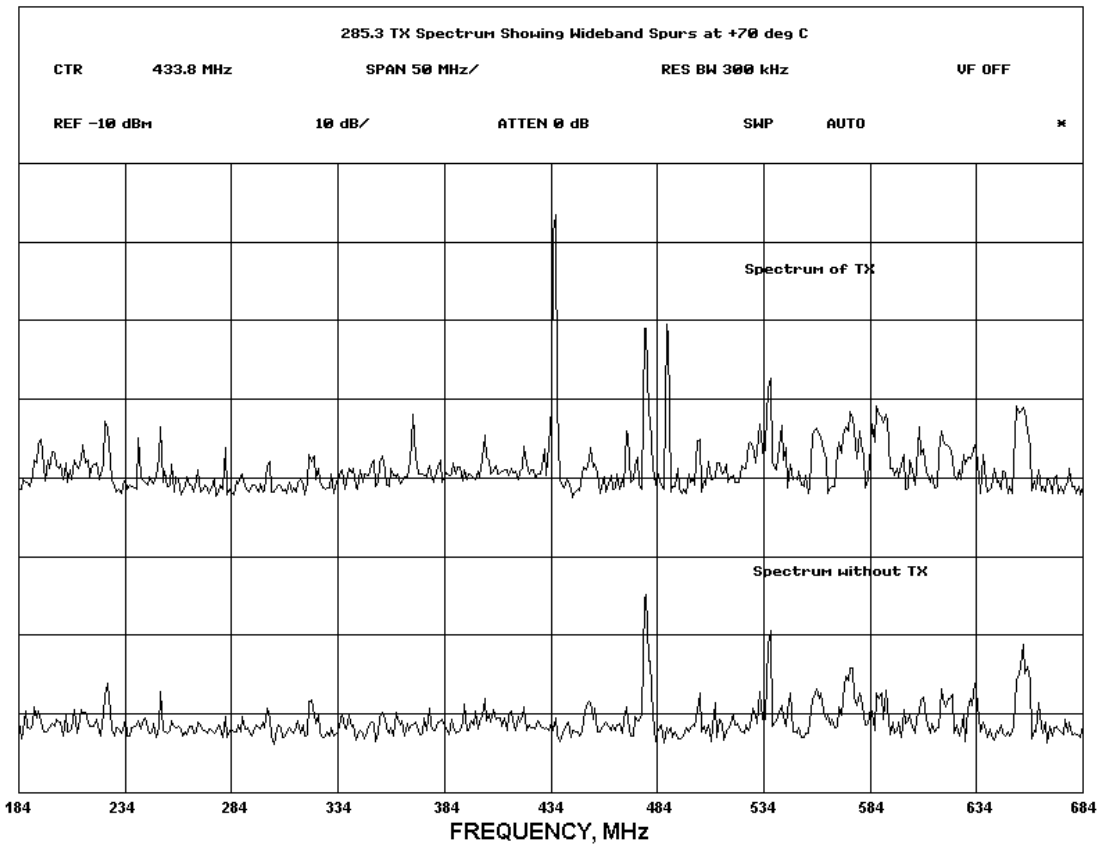

285.1 TX Spectrum Showing Wideband Spurs at -30 deg C
CTR 433.8 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz


285.1 TX Spectrum Showing Wideband Spurs at +70 deg C
CTR 433.8 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz


285.2 Wideband Spurs at -30 deg. C
CTR 433.8 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -20 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz


285.2 TX Spectrum Showing Wideband Spurs at +70 deg C
CTR 433.7 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz


285.3 Wideband Spurs at -30 deg. C
CTR 433.8 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz


285.3 TX Spectrum Showing Wideband Spurs at +70 deg C
CTR 433.8 MHz
SPAN 50 MHz/
RES BW 300 kHz
VF OFF
REF -10 dBm
10 dB/
ATTEN 0 dB
SWP AUTO
Spectrum of TX
Spectrum without TX
184 234 284 334 384 434 484 534 584 634 684
FREQUENCY, MHz

The plot above of the 285.3 transmitter at +70° C shows only a few spurs compared to the other two transmitters and the same unit at -30° C.

At the temperature extreme of +70° C, and the minimum desired receiver operating voltage of 9 volts, engineers found that one or the other relays in the receiver would not always pull in sufficiently as to make good electrical contact and pass battery voltage on to the actuator. The relays would pull in satisfactorily at 9.0 volts and -30°C, however. All receivers worked properly at the maximum voltage rating of 16 volts. The following table shows the minimum battery voltage for each receiver at each temperature extreme.

RX #	-30 deg C	+70 deg C
285.1	8.99	10.2
285.2	8.99	9.3
285.3	8.99	9.8

Transmitter Operating Voltage

360° connected each of the transmitters to a variable power supply, and found each one to still transmit down to about 1.6 volts, where the radiated output power had dropped nearly 40 dB.

Over the desired battery voltage range of 3.2 to 2.6 volts, engineers found the output power dropped only about 4 dB, however. At reduced voltage and room temperature (+25° C), the transmitters did not generate spurious emissions.