RVP7 V16 Release Notes

These notes cover changes made to the RVP7 code since release V15 of 25 August 1999. If you are upgrading from an earlier release, please read those notes also.

Bug Repairs

1. In dual-receiver systems, a bug was repaired in which the user's ZDR offset calibration value might be incorrect by a few tenths of a dB. This could happen if the FIR filters were redesigned after the correct offset value had been experimentally determined. This bug was introduced in Rev.15 (the first dual-receiver release).

2. Repaired bug in which LOG time series data were incorrect in the PPP time series mode. LOG output in the FFT and RPHASE modes, and "I" and "Q" output in all modes, were not affected. This bug was introduced in Rev.15.

3. An error was repaired in the documentation of the PROC command in Section 6.7 of the *RVP7 User's Manual*. The 16-bit time series format conversion should use the expression $2^{(Exponent-40)}$, rather than $2^{(Exponent-41)}$. Our thanks go to Kirk Swanson in the Atmospheric Programs group at Aeromet Inc. for tracking down and reporting this error.

New Features

1. The RVP7 will now run significantly faster in any configuration that was previously limited by the rate at which data could be output to the host computer. This includes most FFT and PPP modes that have a high bin count and rapid ray speed, and for which one or two RVP7/AUX boards are plugged in. The speedup applies both to SCSI and Parallel interface hookups.

   The following table summarizes the old (Rev.15) and new (Rev.16) performance under a variety of operating conditions. The number of rays that can be processed in one second is shown as a function of the operating mode, number of pulses per ray, PRF, bin count, and range resolution. The three ray rates in each category correspond to using zero, one, and two RVP7/AUX boards. A "—' means that the new rate is the same as the old rate; "n/a" means that the RVP7 can not run in that configuration.

Mode	Pulses	PRF	Bins	Spacing	Old Rays/Sec			New Rays/Sec		
FFT	32	3200	940	50m	n/a	82	82	--	106	159
FFT	32	1600	1880	50m	n/a	43	43	--	57	86
PPP	32	1600	1880	50m	n/a	43	43	--	50	50
RPHASE	16	3200	940	100m	n/a	66	83	--	--	108
RPHASE	32	3200	940	100m	n/a	43	73	--	--	--
RPHASE	32	3200	626	150m	14	65	106	--	--	--

   To summarize this table of measurements:

   - The biggest speedup is for the FFT mode, which now operates consistently faster whenever more RVP7/AUX boards are added. Previously, the computer I/O was often the limiting factor — which explains why plugging in additional RVP7/AUX boards sometimes produced no improvement in speed.

- The PPP mode will often be faster now, but may be more fundamentally limited by the non-overlapping geometry of each ray's dwell time.
- The RPHASE mode is generally limited by the formidable computations required at each bin, and not by the final I/O data rates. The first of the three RPHASE examples does show a speedup when two RVP7/AUX boards are used; but its 16-pulse configuration is not recommended (too short for the adaptive filter algorithms to work well).

2. In dual-receiver systems, you may now choose whether the (H+V) time series data consist of the sum of the "H" and "V" samples (as before), or the concatenation of half the "H" samples followed by half the "V" samples. The later is more useful when custom software is being used to analyze the data from the two separate receive channels.

   In the new format, the number of output (I,Q) data samples is still (BxN), where B is the number of bins in the current range mask, and N is the number of pulses per ray. However, the first half of these samples will be the first half of the "H" data in their normal order. This will be followed by a zero sample if (BxN) is odd; followed by the first half of the "V" data, also in their normal order.

   In other words, only the first halves of the individual "H" and "V" sample arrays are output by the RVP7. As an example, if you select 25 bins and 100 pulses, then the output data will consist of 1250 "H" samples (from all bins in the first 50 pulses), followed by 1250 "V" samples from the exact same set of bins and pulses.

3. The AFC/MFC control voltage that is normally generated at the RVP7/IFD can now be mirrored on either the "I" or the "Q" output of the main RVP7 chassis. This configuration would be useful, for example, in a dual-receiver magnetron system that needs a phase locked acquisition clock in the RVP7/IFD, but also needs an AFC tuning voltage to control the transmit frequency.

   The voltage range of the "I" and "Q" outputs is approximately $\pm$1 Volt, and is not adjustable. When AFC/MFC is mirrored on these lines, you will probably need to add an external Op-Amp circuit to adjust the voltage span and offset to match your RF components. We also recommend that you add significant low-pass filtering (cutoff at 3Hz) to remove any power line noise or crosstalk that may be originating within the RVP7/Main chassis.

4. The AFC servo loop can now be configured to operate with an external Motor/Integrator frequency controller, rather than the usual direct-coupled FM control. This type of servo loop is required for tuned magnetron systems in which the tuning actuator is moved back and forth by a motor, but remains fixed in place when motor drive is removed. These systems require that the AFC output voltage (motor drive) be zero when the loop is locked; and that the voltage be proportional to frequency error while tracking. Setup Change #4. describes the new configuration of AFC loop.

5. The RVP7 now supports a new major processing mode called "Dual PRT" (DPRT). In this mode the trigger generator produces alternate short and long pulses, and Doppler autocorrelations are computed using only the short pairs. DPRT is useful when a very high effective PRF (based on the short PRT) is needed, but the duty cycle of the transmitter must also be kept within bounds.

   In DPRT mode the requested PRF from the host computer will generally be quite large (up to 20KHz); and the reciprocal of this "effective instantaneous PRF" will determine the trigger's short PRT interval. In this way, all subsequent physical calculations will be scaled correctly, e.g., unambiguous velocity, maximum first trip range, etc., are all supposed to be based on the short PRT interval. The host computer must therefore be configured so that it can ask for these very high trigger rates.

   The duration of the long PRT interval is not specified directly by the host computer. Rather, the RVP7's "Maximum number of Pulses/Second" setup parameter is used to compute how much delay to insert in order to insure that the transmitter's duty cycle is not exceeded. This special treatment applies only in DPRT mode; all other modes that have uniform triggers continue to interpret the RVP7's trigger bound as a simple "Maximum PRF".

   ⚠ **Warning: Since the RVP7's "Maximum number of Pulses/Sec" is used to enforce the duty cycle limit, it is essential that it not be overwritten by the host computer's upper PRF limit, which typically will be much higher. To insure this, you must make sure that the PWINFO command is disabled in the RVP7 "Mc" setup menu. You will have no duty cycle protection if you do not do this.**

   Since DPRT mode uses only the short pairs of pulses, it is not possible to run the "R2" moment estimation algorithms. The RVP7 will return the GPARM "Invalid Processor Configuration" bit if "R2" is requested in DPRT mode. The error bit will also be returned if the number of pulses requested (sample size) is not even. All other error conditions are the same as FFT mode.

   You may request time series data in DPRT mode. The samples will be organized so that the first pulse of a short PRT pair always comes first.

   ℹ **Note: You may still choose to run Dual-PRF velocity unfolding within the DPRT mode. What will happen is that the short PRT will vary in the selected 3:2, 4:3, or 5:4 ratio, but the overall duty cycle will remain constant. The combination of Dual–PRF and DPRT is tremendously effective in extending the radar's unambiguous velocity interval.**

6. The RVP7 can now generate two new dual-polarization parameters: Φ_{DP} (Differential Phase), and ρ_{HV} (Cross-channel Correlation Coefficient). Both of these parameters can be viewed/saved in ASCOPE, and they are both fully supported in IRIS. Φ_{DP} can now be selected independently of KDP; previously you had to choose one or the other.

7. The RVP7 can now generate SQI (Signal Quality Index) parameter output, and these data may be viewed/saved in ASCOPE. For now, however, SQI is not supported in IRIS tasks. SQI is a handy diagnostic tool since it is often used as a threshold check when

qualifying other parameters. The RVP7 will always output SQI at every selected range; it is never thresholded away by any other criteria.

8. A new XARGS command has been added to the RVP7 command set (See "*RVP7 User's Manual*", Chapter 6). This command allows additional arguments to be passed to all existing opcodes in a backward compatible manner. It's immediate use was to augment the PROC command to handle the selection of several new output data types.

9. The format of the SOUTP command of the RVP7's Real Time Display serial stream has changed so that a wider range of parameters can be selected. The parameter select field now uses 4-bits rather than 3-bits.

10. The power-up memory checks that are performed by each DSP now report the specific byte in which an error was found. This gives enough information to decide the "U" number of the chip to replace.

11. The computation of ZDR and ρ_{HV} can now be done either with or without applying a correction for noise. We recommend that you do apply the noise correction in both cases, as this will give an unbiased estimate of each parameter. The estimates will become more scattered under weak signal conditions, but it is still a more honest representation of what is really happening.

12. The format of the Intervening Gaseous Attenuation constant in Word #17 of the SOPRM command has changed. An attenuation of G db/km is now computed from the unsigned 16-bit word N as follows:

    $0 \leq N \leq 10000$ $G = N / 100000$
    else $G = 0.1 + (N - 10000)/10000$

    This new format is backward compatible with the old format for all values between 0.0 and 0.1dB/km; but it extends the upper range of values from 0.65535 up to 5.6535. These larger attenuation corrections are needed for very short wavelength radars.

Setup Changes

1. There is a new setup question in the **Mp** section, "*DualRx – Sum H+V Time Series*", to choose how combined time series data are formatted in dual-receiver systems. See New Feature #2.

2. The limits on the trigger start times and widths have been increased. Trigger pulses may now be positioned anywhere within a ±5ms interval around range zero. Previously the limit was ±0.5ms. Keep in mind that when using large starting offsets or very wide trigger waveforms, the minimum trigger period is bounded by the total length of the entire group of defined waveforms. For example, if your collection of triggers runs from –1500 usec to +500 usec, then the maximum PRF that can be generated will be 500Hz.

3. AFC/MFC can now be mirrored on a backpanel output of the main chassis using the new setup question in the **Mb** section, "*Mirror AFC voltage on– 0:None, 1:I, 2:Q*". When either "I" or "Q" is selected, the AFC/MFC voltage will be present on the corresponding

BNC output, and the other output will be used for scope plotting. When "None" is selected, scope plotting will revert to its normal "Q" output.

4. There are several new/changed questions in the **Mb** section in support of the new Motor/Integrator servo mode of the AFC feedback loop (See New Feature #4.).

   The new question "*AFC Servo– 0:DC Coupled, 1:Motor/Integrator*" selects whether the AFC loop runs in the normal manner (direct control over frequency), or with an external Motor/Integrator type of actuator. The new question "*AFC minimum slew request:...*" provides additional control when interfacing to mechanical actuators whose starting and sustaining friction needs to be overcome.

   The DC-Coupled AFC loop questions (changes shown in bold) are now:

```
AFC Servo– 0:DC Coupled, 1:Motor/Integrator : 0
Wait time before applying AFC: 10.0 sec
AFC hysteresis– Inner: 5.0 KHz,  Outer: 15.0 KHz
AFC outer tolerance during data processing: 50.0 KHz
AFC feedback slope:     0.0100 D–Units/sec / KHz
AFC minimum slew rate:  0.0000 D–Units/sec
AFC maximum slew rate:  0.5000 D–Units/sec
```

   and the Motor/Integrator loop questions are:

```
AFC Servo– 0:DC Coupled, 1:Motor/Integrator : 1
Wait time before applying AFC: 10.0 sec
AFC hysteresis– Inner: 5.0 KHz,  Outer: 15.0 KHz
AFC outer tolerance during data processing: 50.0 KHz
AFC feedback slope:         1.0000 D–Units / KHz
AFC minimum slew request:  15.0000 D–Units
AFC maximum slew request:  90.0000 D–Units
```

   Notice that the physical units for the feedback slope and slew rate limits are different in the two cases. In the DC-Coupled case the AFC output voltage controls the frequency directly, so the units for the feedback and slew parameters use *D-Units/Second*. In the Motor/Integrator case, the AFC output determines the rate of change of frequency; hence straight *D-Units* are used.

   The above example illustrates typical values that might be used with a Motor/Integrator servo loop. The feedback slope of 1.0 *D-Units/KHz* means that a frequency error of 100KHz would produce the full-scale (100 *D-Units*) AFC output. But this is modified by the minimum and maximum slew requests as follows:

   - A zero *D-Unit* output will always be produced whenever AFC is locked.
   - When AFC is tracking, the output drive will always be at least $\pm$15 *D-Units*. This minimum non-zero drive should be set to the sustaining drive level of the motor actuator, i.e., the minimum drive that actually keeps the motor turning.
   - When AFC is tracking, the output drive will never exceed $\pm$90 *D-Units*. This parameter can be used to limit the maximum motor speed, even when the frequency error is very large.

   Manual Frequency Control (MFC) operates unchanged in both of the AFC servo modes. Whenever MFC is enabled in the **Ps** command, it always has the effect of directly controlling the output voltage of the AFC D/A converter. The MFC mode can be useful when testing the motor response under different drive levels, and when determining the correct value for the minimum slew request.

5. The choice of applying or not applying a noise correction now appears in the following two setup questions in the **Mp** section (See New Feature #11.):

```
ZDR    – Filtered: NO ,  Z/T from H+V: YES,  Sub.Noise: YES
RhoHV  – Sub.noise: YES
```

6. The “Maximum PRF” question in the “**Mt<n>**” section has been reworded so that it reads: “*Maximum number of Pulses/Sec*”. This serves as a reminder that the number shown is not only an upper bound on the PRF, but also a duty cycle limit when DPRT mode (See New Feature #5.) is enabled. Also, the upper bound on the typed-in value has been raised to 20000 pulses/sec.

7. A new setup question “*Maximum instantaneous ’PRF’* ” has been added in the “**Mt<n>**” section. This allows you to configure the maximum instantaneous rate at which triggers are allowed to occur, i.e., the reciprocal of the minimum time between any two adjacent triggers. This parameter is included so that you can limit the maximum DPRT trigger rate individually for each pulsewidth. Note that the maximum instantaneous PRF can not be set lower than the maximum number of pulses per second.

8. The factory default setting for the **Mc** question “*PWINFO command enabled*” has been changed to “NO”. This is a more safe setting in general, and is even more important when DPRT triggers are being generated.