APPENDIX 9: Adaptive Transmit Power Control

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Annex:

A. “ATPC Example Calculations”.
1 Introduction

Adaptive Transmit Power Control (ATPC) is a feedback control system\(^1\) which temporarily increases transmitter output power during periods of fading, thus eliminating or at least reducing the adverse effects of fade events on digital point-to-point microwave fixed services. ATPC offers immediate and long term advantages to the link operator including reduced average power consumption, extended equipment MTBF and lower long term RF interference levels.

Under the arrangements detailed in this document\(^2\) and subject to certain limitations, systems fitted with ATPC may also provide a coordination advantage over systems without this facility. Propagation statistics indicate that fade events on physically different propagation paths are non-correlated, thus the probability of simultaneous sensitivity to interference for two separate systems is small, at least for situations where multipath fading is the dominant limiting factor. As long as link paths are properly designed with adequate path clearance and are not significantly affected by rain fade events, the ATPC maximum transmit power boost is required only for appropriately short periods of time (with annual limits as detailed in Figure 1) and:

- a transmit power less than the maximum power may be used for the calculation of interference into other systems; and
- the calculation of interference into the receiver of a system using ATPC may assume that the wanted signal transmitter is operating at maximum transmit power.

![Fig. 1: Permitted Time Above Coordinated Transmit Power for ATPC Systems](image-url)

\(1\) A feature fitted to an increasing proportion of digital fixed service equipment. For basic principles and application, refer to chapters 4.3.4 and 5.3.5.2 of ITU-R "Digital Radio Relay Systems" Handbook, Geneva 1996.

Consequently, the use of ATPC can facilitate tighter intra-service frequency coordination, an important consideration in congested areas. The following sections detail regulatory criteria and limitations on the use of ATPC by microwave fixed services.

2 ATPC Power Level Definitions

Table 1 defines criteria for the coordination of microwave fixed services using ATPC.

<table>
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<tr>
<th>Level</th>
<th>Definition</th>
<th>Limits</th>
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| $P_{\text{t max}}$ | The maximum transmit power that will not be exceeded at any time, used for fade margin and path reliability (outage) computations; and for calculating the C/I into an ATPC receiver. | $\leq +43$ dBm ($1 \text{ GHz} < 10 \text{ GHz}$)  
$\leq +40$ dBm ($> 10 \text{ GHz}$)  
See Part 3.2.2 of the RALI FX 3. |
| $P_{\text{Coord}}$ | The coordinated transmit power selected by the ATPC system licensee as the power to be used in calculating interference into a victim receiver. | Between 0 to 10 dB below $P_{\text{t max}}$. |
| $P_{\text{nom}}$ | The nominal transmit power level at or below the coordinated power at which the system will operate in normal (unfaded) conditions. | $\leq P_{\text{Coord}}$. |
| $P_{\text{trig}}$ | Normal (unfaded) ATPC link receive level. | As designed with adequate link availability. |
| $P_{\text{trig}}$ | The receive level at which ATPC is activated - ie. ATPC Trigger Level. | At least 10 dB below $P_{\text{norm}}$. |

Table 1. ATPC Power Level Definitions and Limits.
3 Constraints on the use of ATPC

ATPC is a desirable equipment feature and in general there is no restriction on the deployment of systems fitted with ATPC. However, system planners and frequency assigners must note that an ATPC coordination advantage can only be claimed against other microwave fixed services if all of the following criteria are satisfied:

1. the system being coordinated is a compliant ATPC system operating in a band below 12.2 GHz. (Systems operating above 12.2 GHz may still make use of ATPC, but no coordination advantage may be claimed and for coordination purposes, \( P_{\text{t,coord}} = P_{\text{t,max}} \)); and
2. the ATPC system operational parameters must be consistent with the criteria and limits defined in Table 1 (see paragraph 1.2); and
3. full path clearance (0.6 of the first Fresnel zone for the worst month) exists over the ATPC system transmission path. (Systems operating over propagation paths that do not meet this criteria can still make use of ATPC, but no coordination advantage may be claimed and for coordination purposes \( P_{\text{t,coord}} = P_{\text{t,max}} \)); and
4. propagation reliability calculations, based on ITU-R Recommendation P.530 (see 4.1 of Appendix 4 to RALI FX 3), demonstrate that the expected annual time percentages for path fading do not exceed the limits specified in Table 2; and
5. ATPC power increases are triggered on the basis of propagation (ie. path fading). Interference or error correcting information alone is not sufficient justification for increasing transmit power, but either or both may be used as an additional criterion; and
6. the ATPC system must not remain at \( P_{\text{t,max}} \) for more than five consecutive minutes at a time. Any event which exceeds this criterion must be treated as an alarm condition which automatically returns the transmit power back to \( P_{\text{t,coord}} \). ATPC should not be reenabled until the reason for the problem has been established and corrected; and
7. if an ATPC system is fitted with space diversity, the ATPC control signal must be derived from the strongest signal of the diversity system where baseband switching is used. For systems employing IF (Intermediate Frequency) combiners, the ATPC control signal is derived from the combined signal of the diversity system. In calculating percentages of time above \( P_{\text{t,coord}} \), the space diversity improvement factor may be found to be less than unity if the fade depth is small. In this case, the space diversity improvement factor must be assumed as unity (no improvement or penalty).

If all of the above constraints are satisfied, then an effective coordination advantage (equal to \( P_{\text{t,max}} - P_{\text{t,coord}} \) of up to a maximum of 10 dB may be claimed in coordination against other terrestrial microwave fixed services - ie. interference calculations from an ATPC system may assume the lower coordinated \( P_{\text{t,coord}} \) transmit power level. Conversely, interference and fade margin calculations into the receiver of an ATPC equipped system can then assume that the maximum \( P_{\text{t,max}} \) transmit power level is in use over the wanted signal path.

Note: An ATPC coordination advantage can only be claimed for intra-service coordination against other microwave fixed services (refer to Section 5 of this document).

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3 The impact of rain rates and duration on interference events is subject to further studies.
Table 2. Time Permitted Above the Coordinated Transmit Power in an ATPC Link

Table 2 shows the permitted time percentages and annual power boost times for ramp type ATPC systems. For step type systems, only single values (e.g., +6 dB, +10 dB) need be considered.
4 Coordination and Licensing of Links Using ATPC

An applicant must clearly indicate on their licence application that ATPC is to be used and the type of ATPC (ramp or step) described. The coordination and licensing procedure must take account of whether or not a coordination advantage is being claimed for ATPC.

4.1 No Coordination Advantage Claimed

If no coordination advantage is claimed for an ATPC system, the Coordinated Transmit Power \( P_{\text{coord}} \) is deemed to equal the ATPC Maximum Transmit Power \( P_{\text{max}} \) and no special account needs to be taken in the coordination and licensing context.

4.2 Coordination Advantage Claimed

Where a coordination advantage is claimed for a proposed new link, the frequency assigner must be satisfied that compliance is demonstrated against all of the criteria specified in sections 2 and 3 of this document. Where an assigner is unable to verify compliance with all relevant criteria, no coordination advantage can be allowed unless the system licensee or their authorised agent furnishes a written statement certifying compliance.

The spectrum access record\(^4\) of a system for which a coordination advantage is approved should clearly indicate that ATPC is being used and must be endorsed with:

1. Special Condition FB which states, 'The licensed transmitter power may be exceeded for short periods of time but must not exceed the limits specified in Appendix 9 of the RALI FX 3 'Microwave Fixed Services Frequency Coordination'." and
2. Advisory Note FC which states, "This microwave fixed service uses Adaptive Transmit Power Control (ATPC) in accordance with the provisions of Appendix 9 of the RALI FX 3 'Microwave Fixed Services Frequency Coordination'. “

The coordination procedure for an ATPC system is the same as for systems without ATPC and consistent with Part 4 of the RALI FX 3. However, for the purposes of calculating:

- the wanted signal receive levels (Part 4.2.2 of RALI FX 3) into an ATPC system, \( P_t \) (the wanted signal transmit power) is deemed to equal the maximum available ATPC power \( P_{\text{max}} \); and
- the interference levels from an ATPC transmitter undergoing coordination against other systems, the ATPC transmit power is deemed to equal the coordinated transmit power \( P_{\text{coord}} \).

An essential requirement, consistent with section 3(4) of this document, is that propagation reliability calculations for the ATPC system must demonstrate that the expected annual time percentages for the wanted signal path fading do not exceed the limits specified in Table 2. Time percentages can be calculated using the relevant reliability prediction algorithms provided in ITU-R Recommendation P.530 (see section 4.1 of Appendix 4 of RALI FX 3). Reliability calculations are performed using the fade margin found as the difference between the receive signal level under the maximum available ATPC power \( P_{\text{max}} \), and the receiver threshold.

- For an ATPC system which steps (switches) to a single higher transmit power level, only a single calculation of the time that the fade depth to the ATPC Trigger Level \( P_{\text{trig}} \) is exceeded is necessary.

\(^4\) The current ACA licensing database does not support a specific ATPC identifier field.
• For a continuous (ramp) type ATPC system, calculations of the time that \( \text{Pt}_{\text{coord}} \) is exceeded and the time that \( \text{Pt}_{\text{max}} \) is reached are sufficient.

Future ATPC implementations that rely on different algorithms may require time percentage calculations for the entire range of transmit powers in excess of \( \text{Pt}_{\text{coord}} \). Example calculations of ATPC time above Coordinated Transmit Power are provided in Annex A to this document.

5 ATPC and Interservice Coordination

Interference events and their duration to/ from other (especially non-terrestrial) services may not be de-correlated in the same manner as the homogenous fixed service\(^5\). Accordingly, an ATPC coordination advantage cannot be claimed when calculating interference levels to/ from ATPC links against other (non fixed) radiocommunication services.

For the purposes of interservice coordination and the calculation of:

- the wanted signal receive levels (Part 4.2.2 of RALI FX 3) in an ATPC system, \( \text{Pt} \) (the wanted signal transmit power) is deemed to equal the Coordinated Transmit Power (\( \text{Pt}_{\text{coord}} \)); and

- the interference levels from an ATPC transmitter undergoing coordination against other (non-fixed) radiocommunication services, the ATPC system transmit power is deemed to equal the Maximum Transmit Power (\( \text{Pt}_{\text{max}} \)).

Note: In the absence of internationally accepted standards for ATPC, the arrangements detailed in this document are based on and generally consistent with Section 4.3 of (US) Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin TSB10-F, June 1994. The ACMA may consider other recognised standards in the future and detailed proposals may be forwarded to the Manager, Spectrum Planning Team, ACMA, for consideration.

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\(^5\) Refer to ITU-R Recommendation F.758 "Considerations in the Development of Criteria for Sharing Between the Terrestrial Fixed Service and Other Services".