

**ARCi 1255 Hub Outdoor Transceiver
And
ARCi 3155 Subscriber Outdoor Transceiver**

FCC Theory of Operations

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The **ARCi 1255 Hub Outdoor Transceiver** and the **ARCi 3155 Subscriber Outdoor Transceiver** operate together and in conjunction with DOCSIS¹-based head end processor and modem equipment to provide high speed fixed wireless broadband Internet access. Together, these comprise a standalone IP network that is connected to the Internet through a gateway and/or router external to the ARCi system.

Downstream packets (from the Internet to the user) are routed through the gateway to the DOCSIS head end processor where they are modulated onto a 6 MHz wide carrier centered at 44 MHz. This modulated continuous signal is translated by an adjacent upconverter to an intermediate frequency (IF) in the range of 481 to 571 MHz. The IF signal is transported over a coaxial cable (typically a premium grade of trade type RG6) to the rooftop or tower mounted 1255 Hub Outdoor Transceiver (Hub OT). The 1255 Hub OT, in turn, translates the signal to a frequency in the 5725 – 5825 MHz UNII² band, amplifies and radiates it via its integral flat panel transmit antenna.

This 1255 hub transmit antenna has a 3 dB horizontal beam width of approximately 60 degrees and a 3 dB vertical beam width of approximately 10 degrees and employs linear vertical polarization. The system operator orients this antenna in the direction of his subscriber units. If a hub station configuration requires coverage in excess of sixty degrees of horizontal arc, multiple 1255 Hub OTs are employed. A telemetry feature of the 1255 Hub OT allows the system operator to monitor performance of the 1255 Hub OT in real time. A separate 2 pair cable run in parallel with the IF cable provides 8.5 volt DC power to the 1255 Hub OT and returns the telemetry information.

The downstream packets transmitted by the 1255 Hub OT are received by the 3155 Subscriber Outdoor Transceiver (Sub OT) at the subscriber's location. The receiving antenna in the 3155 Sub OT has a 3 dB horizontal and vertical beamwidth of approximately ten degrees. The 3155 Sub OT translates the received signal from the 5725-5825 MHz band to an IF frequency between 429 and 519 MHz. This IF signal is transported over a coaxial cable (typically a premium grade of trade type RG6) to the subscriber DOCSIS modem.

¹ Data Over Cable Service Interface Specification. DOCSIS is a trademark of Cable Television Laboratories, Inc.

² Unlicensed National Information Infrastructure

The modem, in turn, demodulates the downstream packets, performs forward error correction and sends the packets through its 10BaseT Ethernet interface to the subscriber's personal computer. In some cases an Ethernet hub or switch is employed to distribute the downstream packets to several personal computers. The 3155 Sub OT is powered by a small indoor cord-mounted power supply that provides 12 volts DC to a power inserter, which is a small passive devices that superimposes the DC power onto the IF signal cable between the modem and the 3155 Sub OT.

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Upstream Packets are sent from the subscriber's personal computer (directly or through an Ethernet hub or switch) to the 10BaseT Ethernet interface on the modem. The modem modulates these packets onto a 3.2 MHz wide IF carrier with center frequency in the range of 6.4 to 48.0 MHz. The carrier is enabled and disabled under the control of the DOCSIS head end processor via control packets embedded in the downstream transmission to the modem.

This upstream IF signal from the modem is transported to the 3155 Sub OT on the same IF coaxial cable as the DC power and downstream signal. The 3155 Sub OT translates the IF signal to a frequency in the 5250 – 5350 MHz UNII band, amplifies and radiates it towards the 1255 Hub OT via its integral flat panel antenna.

The 3155 hub transmit antenna has both horizontal and vertical 3 dB beam widths of approximately 45 degrees and employs right hand circular polarization. The system operator orients this antenna in the direction of the 1255 Hub OT.

At the hub site the 1255 Hub OT receives the upstream packets transmitted by the 3155 Sub OT. The receiving antenna in the 1255 Hub OT has a 3 dB horizontal beamwidth of approximately 55 degrees and 3 dB vertical beamwidth of approximately 3 degrees. The 1255 Hub OT translates the received signal from the 5250 – 5350 MHz band to an IF frequency between 6.4 and 48.0 MHz. This IF signal is transported to the DOCSIS processor over a separate RG6 coaxial cable.

The DOCSIS processor then routes the upstream packets to the Internet via the gateway/router. Note that the DOCSIS processor is the central controller of the network and performs many functions including addressing, buffering, timing, forward error correction, modulation, demodulation, etc.

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Frequency stability is assured by the use of 2.5 ppm TCXO-controlled synthesizers on all transmitters and receivers. In addition, the frequency of the upstream path is continuously monitored at the head end processor, and any needed correction commands are sent downstream to the cable modem in real

time. The frequency plan ensures that the transmitted signals are sufficiently far from the band edges so as not to overlap, even at the edges of the emission masks.

Shutdown assurance is provided by different mechanisms for the downstream and the upstream. The downstream transmits a continuous TDMA signal that is monitored by all subscriber modems in the system. Thus, it is never shut down in normal operation. In the case of system maintenance shutdowns, powering off the DOCSIS head end processor removes its IF output signal. The 1255 Hub OT shuts off its RF transmission in the absence of an IF signal.

The 1255 Hub OT contains an RF output monitoring circuit that is, in turn, monitored by the onboard microprocessor that can also enable/disable the Hub OT output. In normal operation the Hub OT output is enabled 100 ms after power-up to allow the phase locked frequency synthesizer to reach the proper frequency. As long as there is a signal passing through the Hub OT its output will continue to be enabled. Should the signal disappear – due to the failure of the DOCSIS head end processor or its IF interconnection – the 1255 Hub OT output is turned off. The microprocessor will continue to poll the intermediate stages of the Hub OT for a signal, and when present, will enable the Hub OT output in the normal manner.

In the case of the upstream, the modem transmits in bursts when so instructed by the head end DOCSIS processor. There is no mechanism (other than password-protected manual maintenance mode) for the modem to transmit its IF signal absent a command received in the downstream. The 3155 Sub OT shuts off its RF transmission in the absence of an IF signal. The Sub OT will also not transmit if there is any failure of the modem. This is accomplished by a detector in the Sub OT which monitors the IF signal from the modem and enables the 3155 Sub OT only when an IF signal is present.

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