The performance of an amorphous silicon flat-panel imager (FPI) is reported in terms of measured and theoretical signal size, noise power spectrum (NPS), and detective quantum efficiency (DQE). Based upon a 1536x1920 pixel, 127 μm pitch array of a-Si:H TFTs and photodiodes, the prototype FPI was developed for examining the potential of flat-panel technology in diagnostic x-ray imaging. The x-ray sensitivity was measured for the FPI incorporating five Gd_2O_2S:Tb screens at 70-120 kVp. One- and two-dimensional NPS and DQE were measured for the FPI incorporating three such converters as a function of exposure. A cascaded systems model reported previously was extended to include the effects of noise aliasing and to describe FPI performance for a wide variety of configurations and imaging conditions. Theoretical x-ray sensitivity, NPS, and DQE are compared to empirical results, and good agreement is observed in each case. The model is used to describe the potential performance of FPIs incorporating a recently developed, commercially available array proposed for testing in diagnostic radiography and fluoroscopy. For chest radiography, the analysis suggests that such systems can potentially meet or exceed the DQE performance of existing screen-film and CR technology; however, for fluoroscopy, typical exposures are such that the DQE is limited by the system gain and additive electronic noise. The theoretical analysis provides a powerful means of predicting FPI performance, identifying system limitations, and developing FPI design strategies for various imaging applications.