MWA Antenna Description as Supplied by Reeve

Basic characteristics:

- Antennas are shipped broken down and require a few minutes to assemble in the field
- Each antenna is a dual assembly shaped like a bat wing and having linear polarization and wide beamwidth
- The antennas are installed over a ground screen (ground screen not included)
- Operating frequency range is 80 to 300 MHz
- Crossed-dipole dimensions are 74 L x 74 W x 50 H cm
- In multi-antenna installations such as an MWA Tile, the individual antennas are arranged in a planar, 4x4 pattern with 1.07-meter spacing corresponding to half a wavelength at 140 MHz
- A dual low-noise amplifier assembly is integral to each antenna and located in a central hub
- Each LNA is powered via the coaxial cable through a bias-tee
- Power for each LNA is 5 Vdc at 120 mA (240 mA total for both LNAs)
- The MWAPC-Q power controller (available separately) provides power for each antenna and includes a quadrature coupler to derive circular polarization from the linear polarized antenna

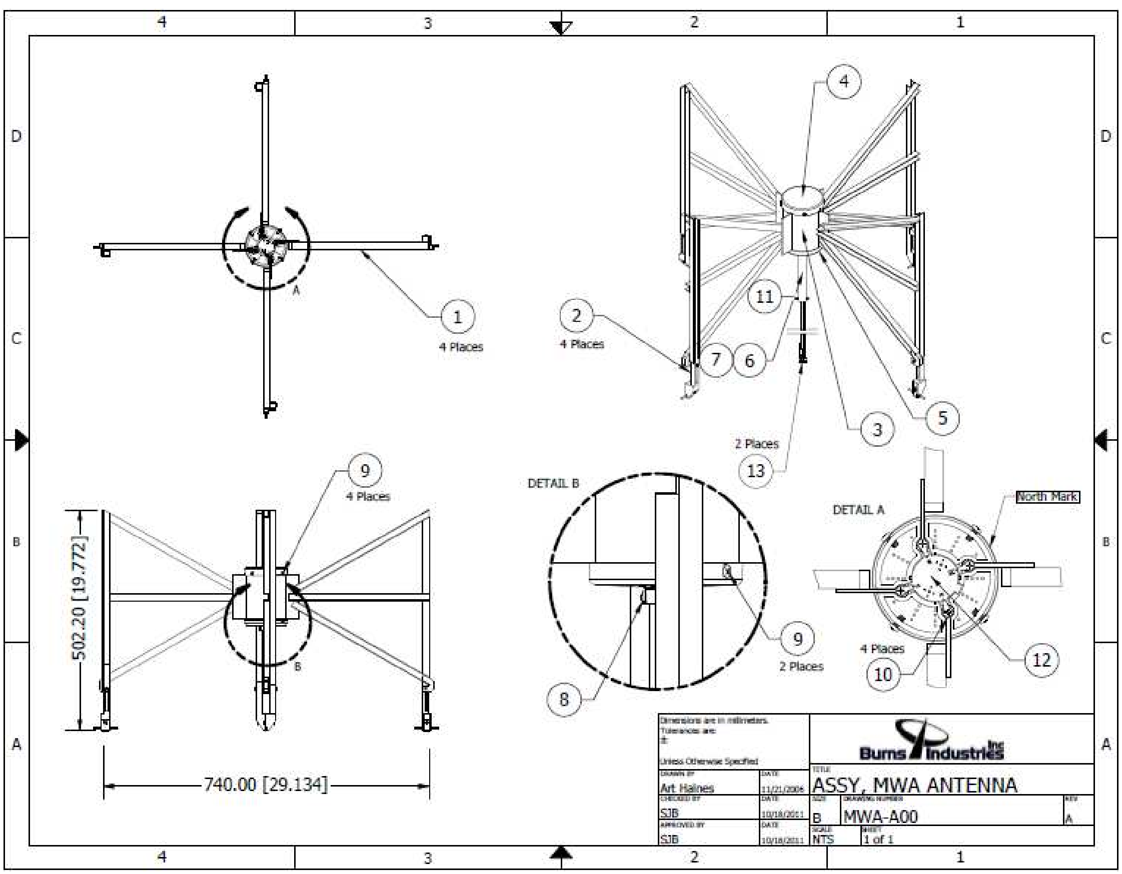

Figure 1 ~ MWA antenna assembly

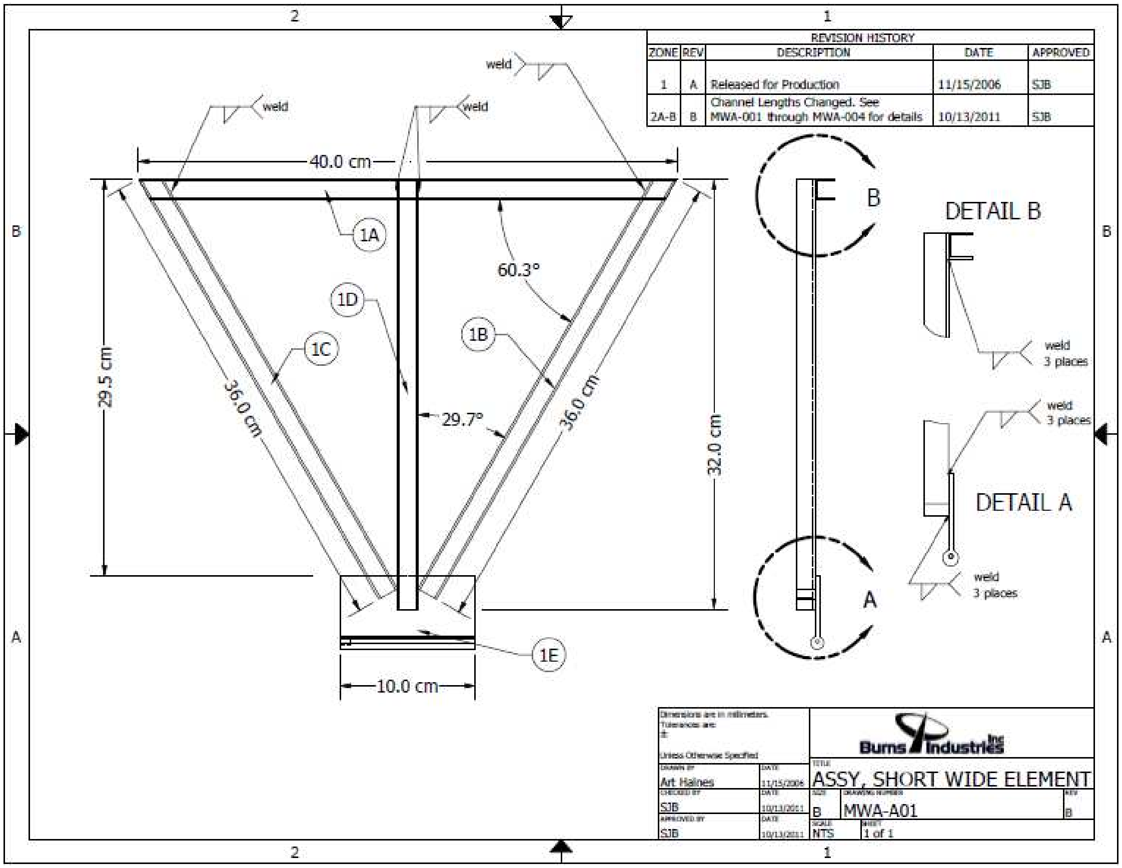

Figure 2 ~ MWA antenna element assembly

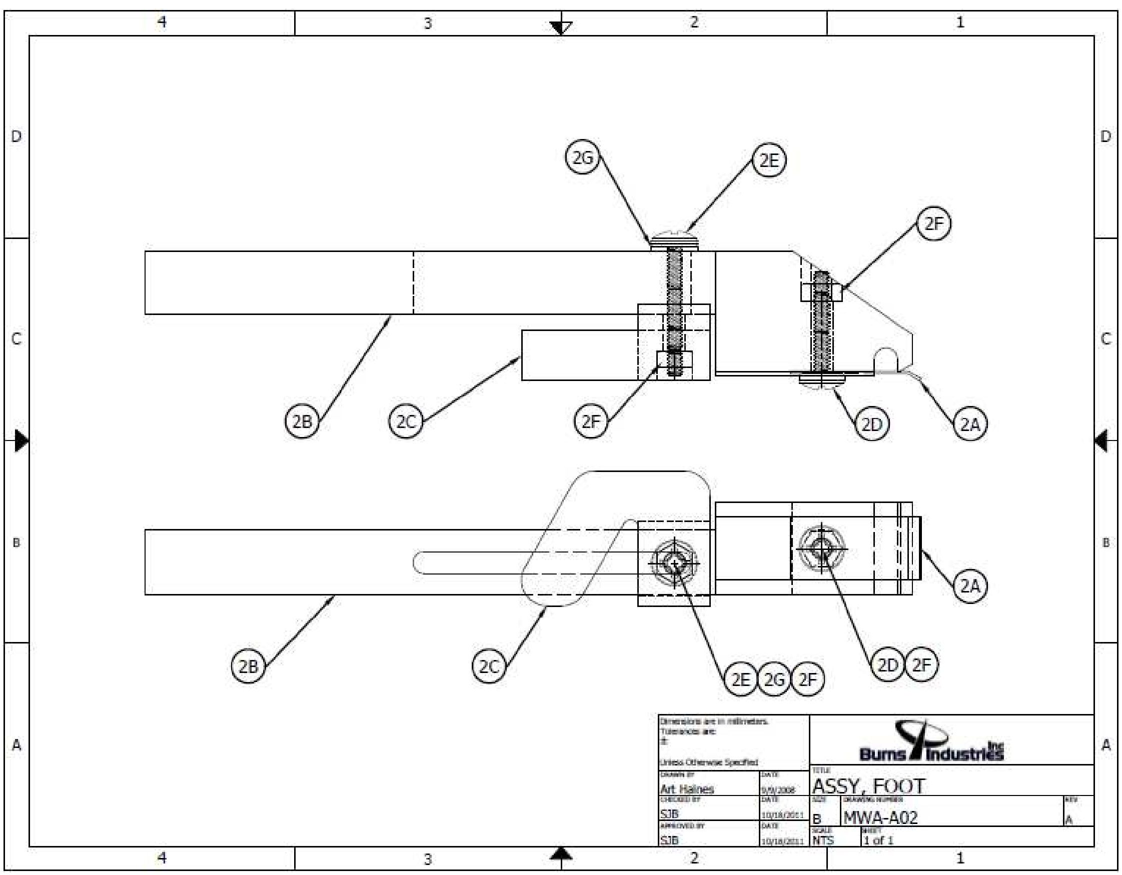

Figure 3 ~ MWA antenna foot assembly

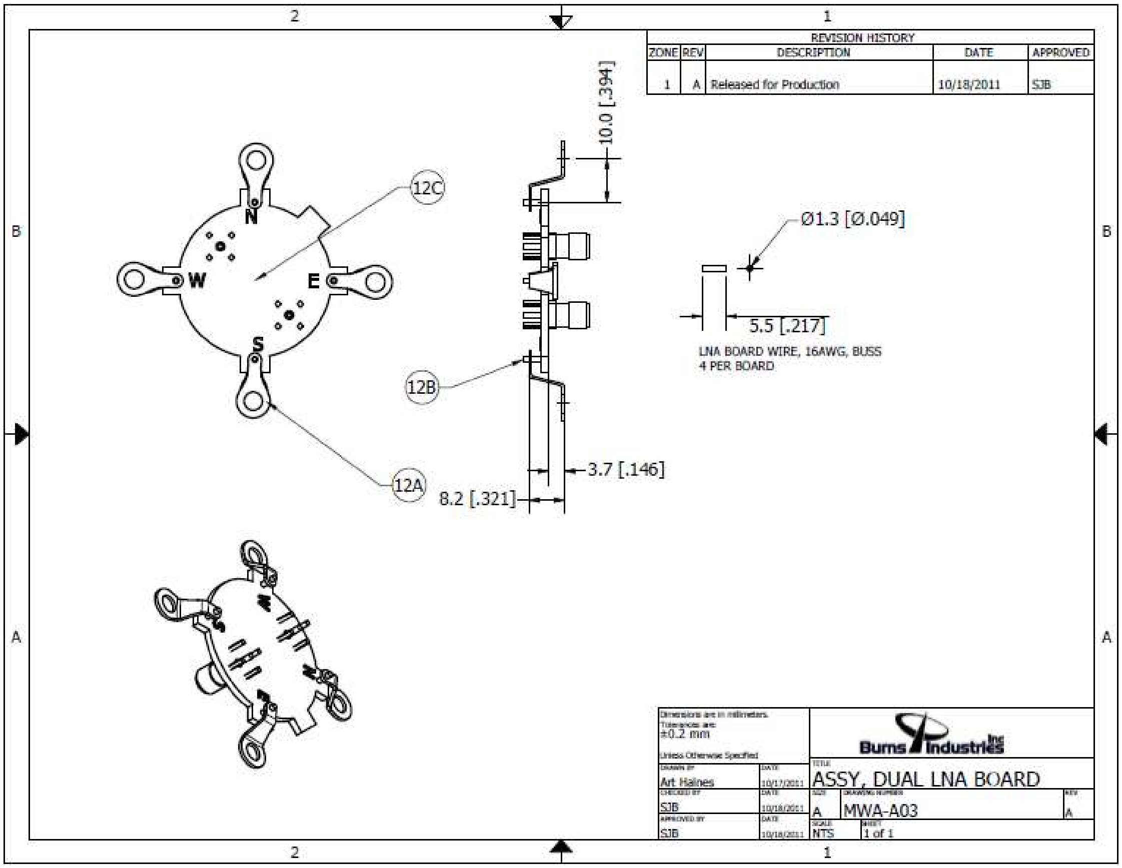

Figure 4 ~ MWA dual low noise amplifier assembly

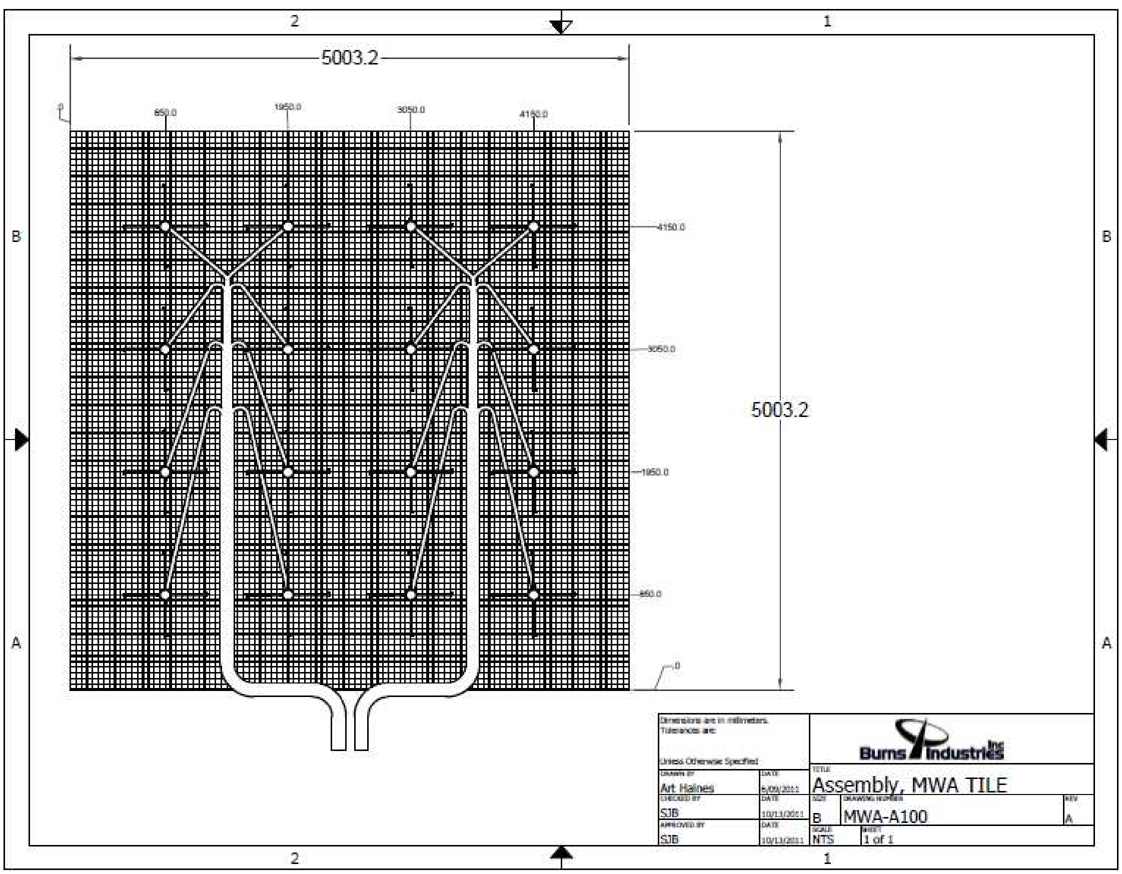

Figure 5 ~ MWA Tile layout

General Description of MWA Tile (derived from publicly available information)

Antenna:

Each MWA antenna Tile is a small phased array with operating frequency range of 80-300 MHz. The Tile consists of 16 dual, linear-polarization, wide-beamwidth, crossed-dipole antennas over a ground screen. The crossed-dipole dimensions are 74 L x 74 W x 50 H cm. In a Tile, the antenna elements are arranged in a planar, 4x4 pattern with 1.07-meter spacing corresponding to half a wavelength at 140 MHz. A dual low noise amplifier assembly is integral to the antenna and mounted in a central hub. Power required for each LNA is 5 Vdc at 120 mA (240 mA total for both LNAs). An analog RF beamformer is used that combines the 16 signals of each polarization with appropriate delays to form a beam 15-50° wide (FWHM) depending on frequency.

Receiver:

For maximum linearity of response, the MWA will use a direct RF sampling receiver architecture. The receiver consists of all components between the RF output of the analog antenna tile beamformer, and a high spectral resolution (8 kHz) digital data stream transmitted to the central processing facility. In this case, the "F" part of the "FX" correlator architecture becomes part of the receiver. The receiver consists of two parts. The front end is a small analog & mixed-signal board consisting of a single fixed low-pass and sky-noise equalization filter, final amplifier, and fast A/D converter sampling RF in the 1st Nyquist zone (the 6-bit Maxim MAX105 and the 8-bit National ADC081000 are currently under evaluation and testing). The back end is a purely digital part implementing coarse spectral filtering, decimation to a selected 32 MHz subset, final spectral filtering to 4K channels of 8 kHz resolution, and aggregation of signals for fiber transport to the central processing facility.

Correlator:

The correlation module is responsible for the X stage of the FX process: cross-multiplying and integrating up to 125,000 antenna pairs for each of 4 polarization products. In order to efficiently utilize the processing power of the FPGAs, the correlator is divided into eight 4 MHz slices to cover the full 32 MHz bandwidth. The data are formatted and dumped at 0.5 s intervals in order to maintain a full FOV. Each correlation module is based upon an 8x8 array of Xilinx Virtex II Pro FPGA's. The rows and columns of the array are driven by high speed (2 Gb/s) data streams, which contain the data for 64 antennas, broken into 8 kHz frequency channels. In turn, each FPGA has an internal 8x8 array of correlator cells, each of which are time-multiplexed to correlate 64 baselines. The time-multiplexing matches the 256 MHz processing speed of the dedicated multipliers in the FPGA to the slower data rate of 4×10 6 complex frequency samples per second. Overall, there are 125,000 baselines correlated within the WFC, producing ~4 billion visibilities every half second.

The array beamformer (in contradistinction to the analog beamformer in the antenna tiles) digitally forms voltage beams for the full array. These beams are linear combinations of the complex voltage samples in each 10 KHz channel. The complex factors that enter as the coefficients of each linear term must include the effects of instrumental gain in the look direction, a frequency-dependent ionospheric phase term, and a geometric phase factor based on look direction and antenna tile position. The various phase factors must be well-enough determined, and specified in both time and frequency, to avoid significant decorrelation (phase error < 10°).

Software Overview:

For the MWA, the software cost is budgeted to significantly exceed the hardware cost of the array. The code falls into three major categories - FPGA firmware, online software for control of hardware and processing the real-time data flow, and offline software, which in most cases is specific to the science topic under investigation. Apart from the FPGA code, which generally resides in the receiver, correlator and beamformer hardware subsystems, the major software components are:

- The Monitor and Control System
- The Real Time Systems

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