



# CECUBE LTD.

## Traction Model List

### SIMULATION COMPONENTS CATALOGUE

The following modules are members of the software component catalogue. To be included in the catalogue the latest revision of the component must have undergone software testing, and wherever possible comparison made with measured results. The components are designed around coding guidelines, which permit a hierarchy of components to be combined into a single project directory, and compiled without redesign.

#### POWER CIRCUIT COMPONENTS

**Substation** – 6 or 12 pulse substation rectifiers

**OHLE** - AC supply catenary model permitting 1, 2 or 4 pi sections, good for 0-20km from feeder station operation

**Transformer** - Models magnetising circuit of main transformer with settable remanent flux and voltage phase point at start and track circuit representations

**Converter** - Detailed 4 quadrant converter circuit, includes AC side filters

**Bridge** – Thyristor bridge front end with power factor correction

**DCLink** – DC link with 100Hz filtering for converter or bridge rectifier front-ends

**Load** - Resistive or constant power type load with parallel choppers for braking or overvoltage limiting

**Choppers** - Model of GTO line choppers

**Motor Choppers** - Model of GTO motor choppers

**Chopper** - Rheostatic brake resistor chopper with active compensation

**Inverter** - Decodes PWM switching state into 3 phase inverter output voltage

**IGBT** - Model V-I law of IGBT 1700V for inclusion in inverter model (Siemens BSM 150 GB 170 DN2)

**Chopper LRV** - Combined Armature and Field GTO choppers

**Step-up chop** - Front end DC chopper/AC converter with control and waveform generation

**Step-up chop power circuit** - Passive power circuit for use with DC/AC front end

**Dev\_Equation** - V-I equations for DG758BX45 GTO and CXC624 anti-parallel diode

**Conv\_loss** – Converter power device loss determination

**Inv\_loss** - Inverter power device loss determination

#### MACHINE COMPONENTS

**Motor DC** - DC motor model used in series field mode, with field divert

**Motor Sep-ex** - DC motor model used in Separately Excited configuration

**Motor** - AC induction motor dq model

**2 AC motors** - 2 parallel motor modelled individually to permit use of differing parameters

**Alternator** - Field controlled induction alternator - behavioural model with rectified output

#### WAVEFORM GENERATION COMPONENTS

**RSPWM** - Choice of symmetric or asymmetric versions of regular sampled PWM

**NatPWM** - Natural sampled PWM based on analogue hardware triangular comparison

**EPWM** - An alternative strategy to RSPWM for 4Q converters

**OPWM** – Wave generator with optimised switching angle calculation

**Asynch** - PWM asynchronous mode generator for 3 phase inverters

**Modeselect** - PWM mode selector for 3 phase inverters

**MA818PWM** - Double edge RSPWM simulation with 3rd harmonic addition



## CONTROL COMPONENTS

**Control AC** – 4Q-converter controller including timer and d/a accuracy effects

**Bridge Control** – Controller for single or series thyristor bridges

**Phase Lock** - Produces a pure version of the supply voltage with the phase lag cancelled out by resetting the phase at each zero crossing

**Control DC** - Line chopper and battery supply control for DC system

**Motor Control** - Motor chopper control system with pulse width outputs

**Scalar** - Inverter scalar torque controller

**Vector** – Inverter vector torque controller

**Control LRV** - DC motor control by armature current at low speed, field current in weak field

**Control DC6** - Independent control of six, parallel DC motor armatures by field control

## MECHANICAL COMPONENTS

**Mechanics A** - Axle hung motor arrangement and suspension modes

**Mechanics F** - Frame mounted arrangement and suspension modes

**B2B mech** – 2 mechanically coupled back to back motors

**Coupler** – Inter-car coupler model

**Adhesion** - Programmable wheel-rail adhesion characteristic

**Railjoint** - Models vertical wheel velocity variation at rail joint

**Train Load** – this comprises the train mass, that of the passengers, train air resistance characteristic, and gradient

**Quill tube** - Loco gearbox/quill tube & mechanics

**Mono Trans** - Mono motor transmission drive

**Diff gear 1** - Detailed model of differential gear drive for articulated tram. Includes modelling of ring and differential gears

**Diff gear 2** - As above, but a behavioural model of differential gears producing results very similar to above, but requiring less detailed knowledge of gear parameters

## BRAKE COMPONENTS

**Master** - Master Controller (driver handle) creating the BE demand

**Frame** - Brake Control Frame (failsafe inversion and brake pipe pressure restriction for wheel cylinder)

**BBV** - Brake Blending Valve (continuously variable on motor cars, while simpler open/closed type used on the trailer car)

**Loadweigh** - Load Weight Valve

**Dump** - Hold and release Dump Valves for Wheel Slide Protection (air system)

**BE Elec** - Electrical Brake Effort system including slide correction

**Brake interface** - Interfaces between electric and pneumatic system

**Speed** - Speed transducer slide (electric) detection system

## ANALYSIS COMPONENTS

**Spectrum** - windowing FFT based spectral and power factor analyser with programmable anti-alias filters

**Spectra** - Spectral analyser developed to study EPWM

**DFT** - Spectral analysis geared to BR 1914 infrastructure and track circuit criteria

**TC\_DC** - DC track circuit model on single, double, or multiple booster transformer or rail return track section with crossbonds, train length, structure earthing and ballast effects

**TC\_50** – 50Hz track circuit model on single or double track for DC electrified railways

**TC\_reed** – An electrical model of the electro-mechanical characteristics of a reed track circuit relay

**Wpsoph** - Psophometric weighting curve for telephony compatibility

