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**LIST OF SYMBOLS**

$V_{\text{mbatt}}$	-	Maximum battery volt
$V_{\text{m}}$	-	Maximum velocity
$V_{\text{batt}}$	-	Battery voltage
$V_{\text{ref}}$	-	Internal voltage reference



## LIST OF ABBREVIATIONS

WSN	-	Wireless Sensor Network
WUSN	-	Wireless Underground Sensor Network
TWSN	-	Tunnel Wireless Sensor Network
EM	-	Electromagnetic
ACO	-	Ant Colony Optimization
RTLD	-	Real-time Routing Protocol with Load Distribution
FFD	-	Full Function Device
RFD	-	Reduce Function Device
BIOTROP	-	Biological of Tunnel Routing Protocol
QoS	-	Quality of Service
BS	-	Base Station
CH	-	Cluster Head
WPAN	-	Wireless Personal Area Network
PAN	-	Personal Area Network
LMSC	-	Local and Metropolitan Area Network Standards Committee
LoWPAN	-	Low-rate Wireless Personal Area Network
PHY	-	Physical
MAC	-	Medium Access Control
ISM	-	Industrial Scientific Medical
DSSS	-	Direct Sequence Spread Spectrum
CSMA/CA	-	Carrier Sense Multiple Access / Contention Avoidance
RTS	-	Request-to-send
CTS	-	Clear-to-send
CAP	-	Contention Access Period

CFP	-	Contention Free Period
GTSs	-	Guaranteed Time Slot
MI	-	Magnetic Induction
FD	-	Frequency Diversity
AODV	-	Ad hoc On-Demand Distance Vector
BRIT	-	Bounce Routing in Tunnel
RREQ	-	Route Request
RREP	-	Route Reply
PRR	-	Packet Reception Rate
RSSI	-	Received Signal Strength Indicator
LQI	-	Link Quality Indicator
SFD	-	Starts of Frame Delimiter
RTR	-	Request To Reply
FA	-	Forward Ant
BA	-	Backward Ant
DA	-	Data Ant
OF	-	Optimal Forwarding
SNR	-	Signal to Noise Ratio
ITI	-	Industrial Training Institute
PDR	-	Packet Delivery Ratio
PDropR	-	Packets Dropped Ratio
O-QPSK	-	Offset – Quadrature Phase Shift Keying
DSR	-	The Dynamic Source Routing Protocol for Mobile Ad Hoc Networks

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