MC-EDGE System Planner

MN007441A01-B

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Revision History

Date	Description	Revision
September 2020	Initial version of the document.	MN007441A01-A
November 2020	Additions of Type 3, MOTOTRBO	MN007441A01-B

Acronyms

ACE	Advanced Control Equipment
AI	Analog Input
AO	Analog Output
APX	MSI ASTRO P25 radio
DI	Digital (Discrete) Input
DO	Digital (Discrete) Output
FEP	Front End Processor
HW	HardWare
I/O	Input/Output
RTU	Remote Terminal Unit
STS	System Suite Tool Configuration
SCADA	Supervisory Control and Data Acquisition
SW	Software

Related Information

For additional details please refer to the following documents:
MC-EDGE_Owners_Manual.pdf
MC-IoT_STS_User_Guide.pdf
MC-EDGE Ordering Guide.pdf
MC-IOT Advance System Security. User Guide.pdf

MC-EDGE System Overview

The Mission Critical EDGE as a general purpose Remote Terminal Unit provides users the ability to remotely control and monitor end node devices. MC-EDGE may be deployed in Industry SCADA systems, National infrastructure systems, Water, Oil, Gas, electricity, pumps, sirens, Smart City, indoor, outdoor and on modern IoT ecosystems connected to the Cloud.
The following figure depicts a typical high level MC-EDGE system deployment:

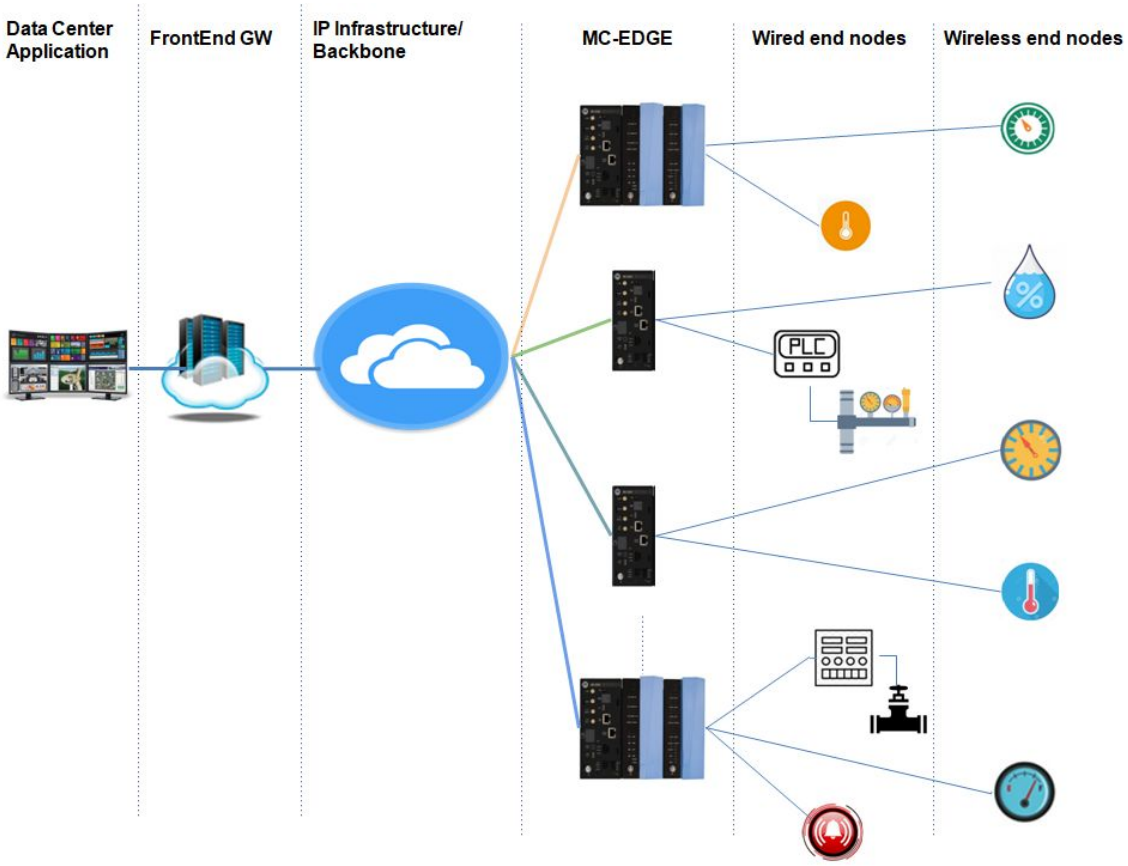

Figure 1-Typical high level MC-EDGE System deployment

MC-EDGE provides the following main optional capabilities:

- Built-in APX4000 radio for communication with center via digital ASTRO P25
- Built-in LTE modem for communication with center via Cellular operator
- Built-in LoRa RF module to communicate on LoRaWAN with far wireless end nodes
- External APX6500/APX4000 radio for communication with center via digital ASTRO P25
- External Analog radio for communication with center

- External MOTOTRBO digital radio for communication with center.
- External device connectivity for communication with center via ETH, USB, Serial
- MDLC and Non MDLC user application protocols
- Cyber Security Defense suite
- Local management capabilities of wired end node devices via up to 5 Expansion I/Os modules
- Local management capabilities of wired end node devices via MODBUS Master protocol
- Local management capabilities of wired end node devices via RS232/RS485, Eth protocol
- Management of wireless end node devices via LoRaWAN protocol
- Capability to act as MODBUS Slave
- User application development ro run inside MC-EDGE using built-in ‘C’ SDK toolkit or IEC 61131-3 (Codesys) programming languages
- Deployment in new systems where all RTUs are MC-EDGE types or with a mixture with Legacy ACE3600 RTUs

System components

End nodes

The end nodes are the wireline and/or wireless end devices, sensor, actuators, PLCs that are controlled and monitored. Users handle their own end nodes.

MC-EDGE

The MC-EDGE RTU resides in remote sites. It's capable of receiving commands and requests arriving from a remote data center and it's capable of transmitting to the data center messages such as status, replies, end nodes information, logs and more. Users can develop and deploy their own application to run on MC-EDGE. MC-EDGE as a continuation of the MSI ACE generations supports the MDLC protocol with all its advantages and benefits. MC-EDGE also supports non-MDLC IP user protocol.

IP Infrastructure/Backbone Communication

MC-EDGE can communicate with FEP/data center via a variety of IP communication types. The following IP network types have been SIT validated using MDLC:

- IP LAN
- Cellular (LTE, UMTS)
- Digital ASTRO P25 IV&D, Group Text
- Digital ASTRO P25 DMO
- Analog Radio

- Digital MOTOTRBO DMO, Capacity Max

Front End GW

The Front End GW provides a mediator between the RTUs MDLC communication and the Data Center Application protocol. The Front End GW provides the following main MDLC capabilities:

- Polling capability of RTU to get end nodes data and to get COS (Change Of State) events from RTU DB tables
- Sending commands to a certain RTU, a group of RTUs or all RTUs
- Receiving events by contention (data burst or RTU event) from RTUs
- Receiving time-tagged events logged in the RTUs
- Adjusting and Synchronizing System RTU clocks
- Ability to provide SW and configuration deployments to remote sites
- Retrieving sites status, diagnostics, logs, versions and more

The Front End GW may be a **FEP** or **ACE IP-GW**.

FEP

The MSI FEP provides an ability to connect to commercial 3rd party Data Center Application (e.g. Wonderware InTouch® and VTScada®) using the MODBUS protocol standard. By this the messages transfer between the Data Center and FEP is handled via MODBUS tables without any need to "touch" the Data Center side for unique MSI protocol. The FEP MODBUS can work over TCP/IP, UDP/IP or Serial communication. The FEP SW Application logic (e.g. mechanism for automatic periodic requests to get RTUs status each X hours) is the user's responsibility and the user shall develop their own FEP application using MSI provided FEP SW tools.

ACE IP GW

This component is MSI out of the box and does not require user application programming on it to work. The IP-GW includes a built-in MSI server with a set of predefined APIs. By this the user needs to "touch" the Data Center side and include on it a Client with support of ACE IP-GW APIs interface. The communication on APIs between Data Center and ACE IP-GW is handled via TCP/IP.

Data Center

The 3rd party Data Center provides users the ability to control and monitor the remote end devices via the RTUs. The data center may be a dedicated SCADA computer, Public/Private Cloud Computing or any other method of user applications. Whenever MDLC protocol is used with RTUs then a Front End GW component usage is required. The Data Center is at user/customer responsibility.

STS

The STS is a SW desktop application tool to handle MC-EDGE RTUs and FEP configurations, deployment and maintenance. The STS can be connected locally or remotely to units using MDLC over IP or locally via MDLC over RS232. The STS can be used for software download, ports configuration, retrieve MC-EDGE diagnostic, logs and much more.

MC-EDGE

The MC-EDGE is enclosed in a compact protective plastic housing. It is composed internally from two boards:

- CPU Host board
- Plug-in board - The board type and contents can be chosen from different options.

The MC-EDGE front panel provides access to connectors, ports, and antennas. Some of the MC-EDGE front panel ports and features are dependent on the installed plug-in board. The MC-EDGE can be deployed on any stable surface or be mounted on a DIN rail in a customer-supplied plastic or metal enclosure. For detailed information on mounting the unit and for enclosure requirements, see *MC-EDGE Owner's Manual,* section “MC-EDGE Installation”.
The following depicts an example figure of MC-EDGE w/o side cover:

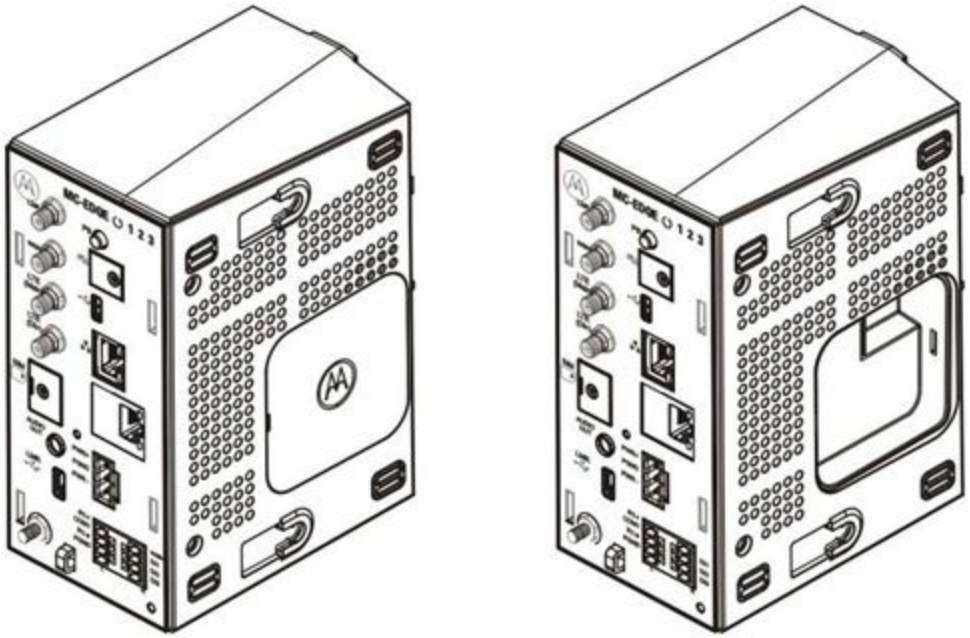

Figure 1a- MC-EDGE w/o side cover example

The MC-EDGE can be deployed with up to 5 MSI external expansion I/O modules. The following depicts an example figure of MC-EDGE connected with two I/O expansion modules:

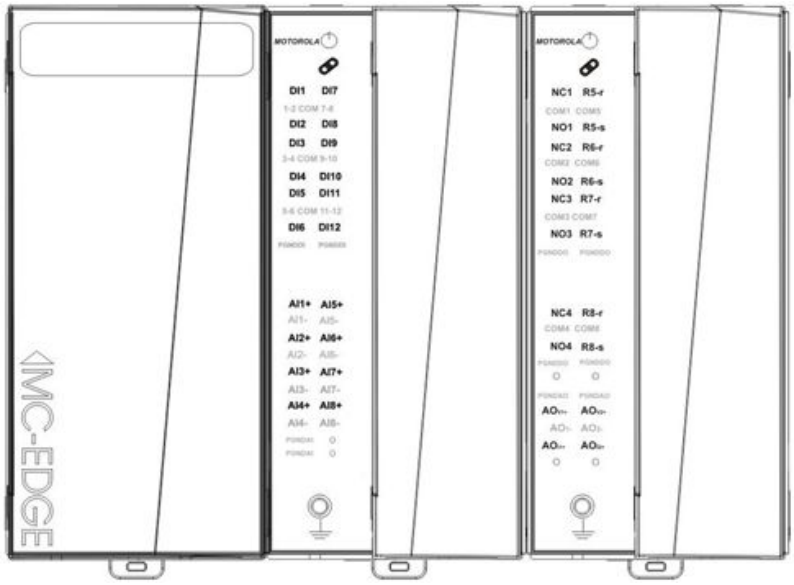

Figure 1b - MC-EDGE with two covered I/O Expansion Modules example

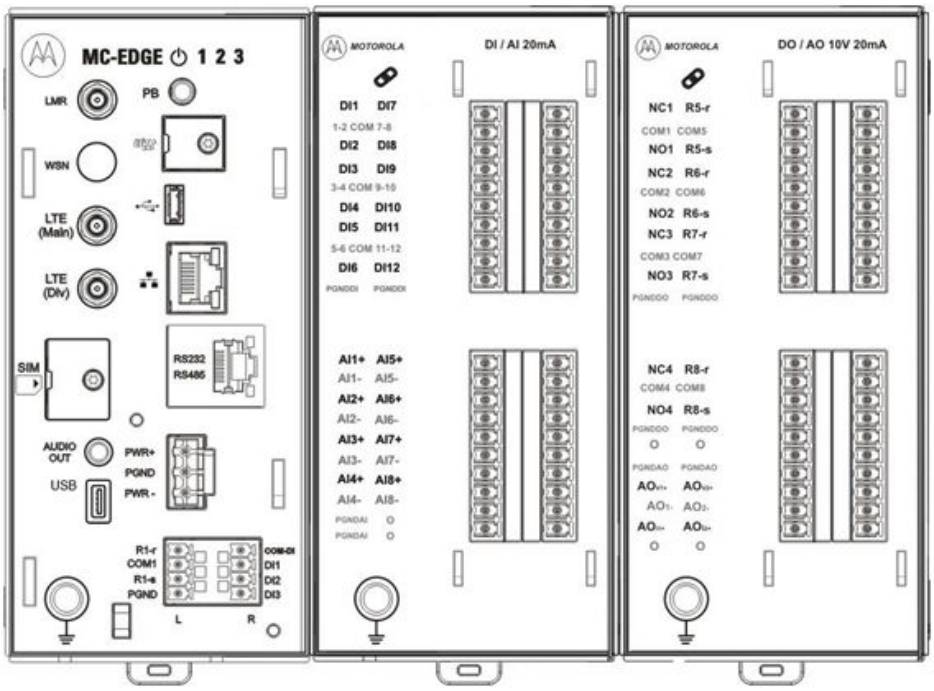

Figure 1c - MC-EDGE with two uncovered I/O Expansion Modules example

MC-EDGE CPU Host

The MC-EDGE CPU Host board (F0016A) controls and handles the MC-EDGE. It is composed of the following main HW components:

- TI AM3356 Sitara - 32-bit RISC Microprocessor based on ARM Cortex-A8. Main unit CPU
- MK10DX256VLK7 Kinetis - MCU 32-bit K10 ARM Cortex M4 RISC 128KB Flash. Controller to handle front panel PB, LEDS, I/Os
    - Three Digital Inputs (DI) and one Digital Output (DO) available on the CPU board from the front panel
- TI TPS65910A1RSL Pmic - Power Management Controller
- Flash: 2GByte MT29F16G08ABCCBH1-10ITZ. 4K paging 16 width data bus
- RAM: 1GByte DDR3 MT41K512M8 – 64 Meg x 8 x 8 banks 8 width data bus
- RTC
- Micro SD card interface
- Micro USB2.0 OTG Device interface
    - used for MC-EDGE local configuration

- USB2.0 Host interface
    - used for external devices connectivity
- USB2.0 Device interface
    - used for built-in RF modules configuration+connectivity
- Ethernet 10/100 Interface
    - used for IP communication, external devices connectivity and for MC-EDGE configuration
- RS232, RS485 Uart Interface
    - used for external devices connectivity
- Power Supply connector (for 9-30V DC)

MC-EDGE SW

The MC-EDGE is based on Linux OS. It is composed of a built-in platform SW layer with built-in utilities, features mechanisms and capabilities. The SW arrives with a 'C' toolkit SDK including a library with platform APIs for users to develop and deploy their own user application. The SW also provides IEC 61131-3 programming language for users that prefer to develop their application via these tools.

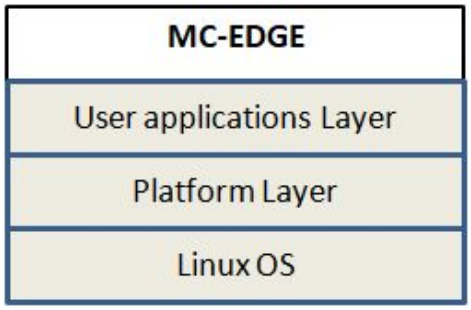

Figure 2 MC-EDGE SW

MC-EDGE Plug-In Board Types

VA00290AA

This plug-in board is referred to as 'T1'.

This Plug-in board can be ordered with any combination of all/partial/none following built-in RF modules: APX4000 LMR, LTE modem, LoRa RF module.

The built-in APX4000 is approved for usage in the US and North America. Any attempt to order this plug-in board installed with APX4000 for regions outside the US and NA requires an MSI approval.

The Built-in ASTRO APX4000 can be ordered in one of the following types:

- APX 4000 7/800 MHz frequency band
- APX 4000 900 MHz frequency band
- APX 4000 UHF1
- APX 4000 UHF2
- APX 4000 VHF

The Built-in LTE modem:

- Sierra HL7588 LTE CAT4 mPCIe. The MC-EDGE with this LTE modem is certified for US “Verizon” usage on LTE bands: B4, B13

The Built-in LoRa RF module:

- Laird RG191-M2 concentrator card. This module supports LoRaWAN regions:
    - US 902-928
    - AU 915-928
    - AS 923

Once a Plug-in board has been ordered with a built-in RF module(s), each RF module can be “Enabled or Disabled” for usage by the customer using the STS configuration tool.

An MC-EDGE ordered with T1 plug-in board will arrive with the following relevant front panel:

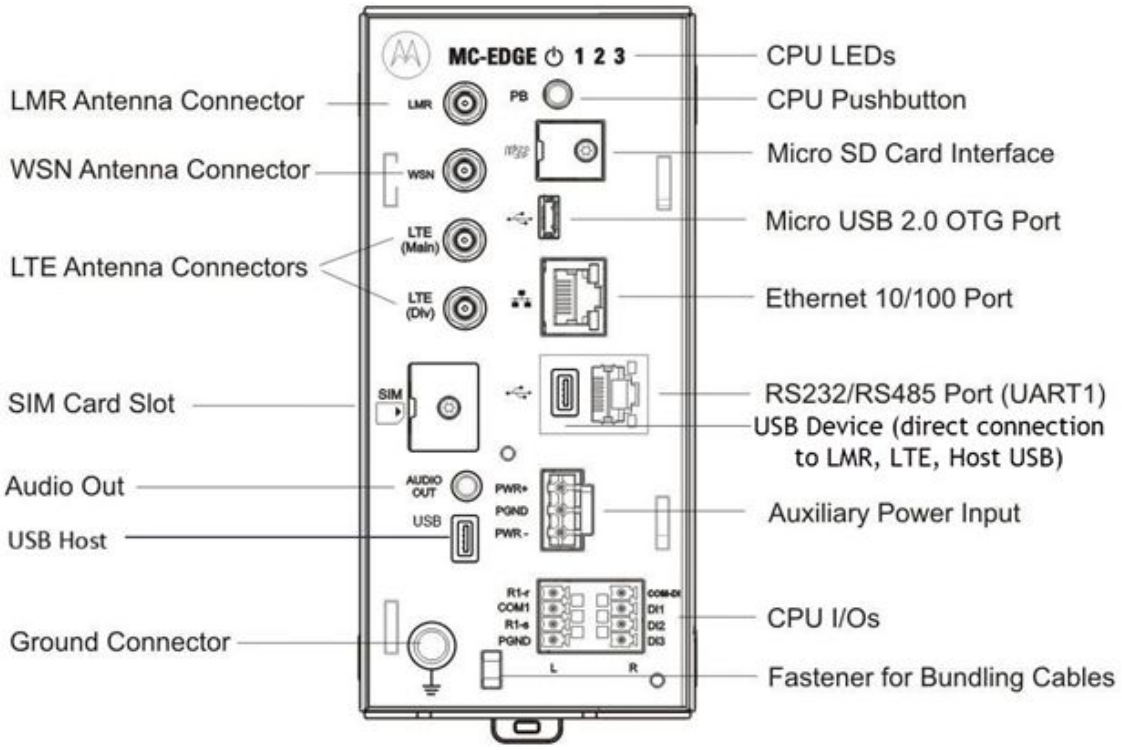

Figure 3- MC-EDGE Front Panel that fits T1-VA00290AA

VA00973AA

This plug-in board is referred to as ‘T2’.

This Plug-in board can be ordered with any combination of all/partial/none following built-in RF modules: LTE modem, LoRa RF module.

One of the following built-in LTE modem:

- For the US/NA region: Sierra HL7588 LTE CAT4 mPCIe. The MC-EDGE with this LTE modem is certified for US “Verizon” usage on LTE bands: B4, B13
- For the EMEA region: Telit LE910C4-EU CAT4 mPCIe. The MC-EDGE with this modem can be used on LTE B3, B7, B20 and 3G B1
- For the APAC region: Telit LE910C4-AP CAT4 mPCIe. The MC-EDGE with this modem can be used on LTE B3, B28 and 3G B5

One of the following built-in LoRa RF module:

- Laird RG191-M2 concentrator card. To be used for LoRaWAN regions:
    - US 902-928
    - AU 915-928
    - AS 923

- Laird RG186-M2 concentrator card. To be used for LoRaWAN regions:
    - EU 863-870

Once a Plug-in board has been ordered with a built-in RF module(s), each RF module can be “Enabled or Disabled” for usage by the customer using the STS configuration tool.

This ***T2*** plug-in board provides also the following capabilities:

- additional 2xEth 10/100 MB ports
- additional 1xRS232/RS485 serial communication port

An MC-EDGE ordered with T2 plug-in board will arrive with the following relevant front panel:

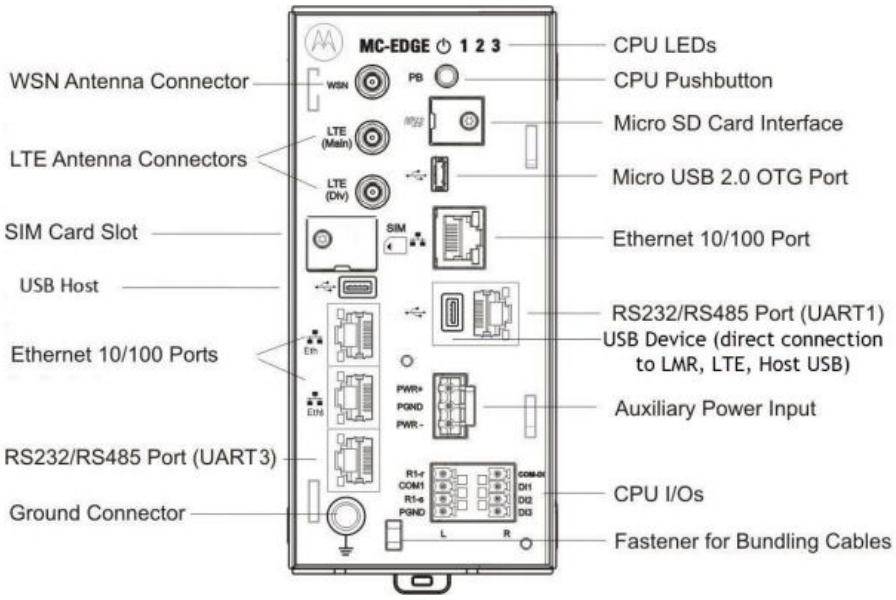

Figure 4- MC-EDGE Front Panel that fits T2-VA00973AA

VA00983AA & VA00984AA (MICROHARD N920)

These plug-in boards are referred to as ‘T3’.

The purpose of the ‘T3’ option is to provide MC-EDGE as a replacement of ACE1000.

The ‘T3’ option can be handled in any of the following combinations:

- MC-EDGE including CPU main board only (without any plug-in board)
- MC-EDGE including CPU main board with plug in board type VA00983AA
- MC-EDGE including CPU main board with plug in board type VA009884AA

The ‘T3’ option is provided without any built-in RF module.

VA00983AA

This plug in board provides:

- 1xRS232 port - used for external device connectivity
- 1xRS232/RS485 port - used for external device connectivity
- Aux DC Power Supply output connector

An MC-EDGE ordered with T3 VA00983AA option will arrive with the following relevant front panel:

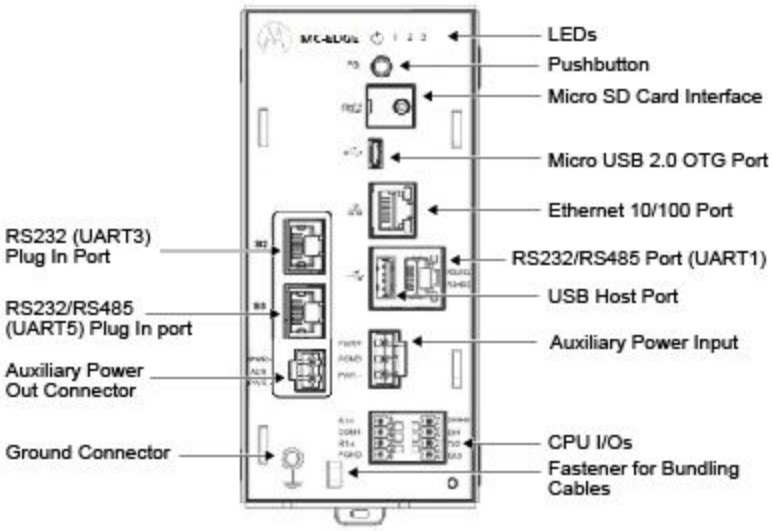

Figure 5a- MC-EDGE Front Panel that fits T3-VA00983AA

VA00984AA (MICROHARD N920)

This plug in board provides::

- 1xRS232 port - used for external device connectivity
- 1xRS232 port - used for **internal** device connectivity-not available via front panel. e.g may be use by customer for its own internal modem

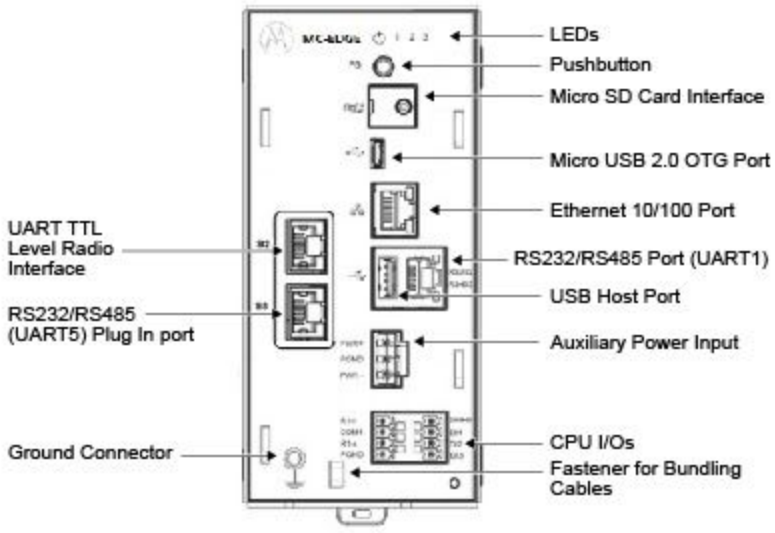

Figure 5b- MC-EDGE Front Panel that fits T3-VA00984AA

MC-EDGE CPU Pushbutton

The pushbutton on the MC-EDGE CPU front panel has several functions:

- LED activation – Hold the pushbutton pressed for one second to activate the LEDs for a preconfigured period of time.
- Status indications – Press the push button for three seconds to toggle between LED pages (see MC-EDGE CPU LEDs).

NOTICE: Pressing the button for more than 10 seconds causes the restart of the RTU MicroControllers (CPU+I/O).

MC-EDGE CPU LEDs

The MC-EDGE CPU front panel includes a power LED, status LEDs for onboard DIs/DO, and status LEDs on the communication ports. Some of the LEDs are single color (green) and some are bicolor LEDs (red or green). The LEDs are used to indicate various situations.

Figure 6 - MC-EDGE front panel CPU LEDs

By default, the CPU LEDs provide power, error, sleep mode, and DO status indications. Table 1 details the default display of the CPU LEDs (Page 0).
To see DI status indications (Table 2), press the push-button for three seconds, to toggle to Page 1. Table 3 details the CPU ports LEDs functionality. To toggle back to Page 0, press the push button again for three seconds.

The following is CPU LEDs – Page 0 (Default Display):

LED Name	Description	Status
⏻	Power/Error LED	Off - Unit is powered off. Steady Green - Unit is powered on. Steady Red - Unit is powered on with errors in the Error Logger. Fast Blinking Green (once per second) - Unit is in boot state. Medium Blinking Red or Green (once every 10 seconds) - Low input voltage fault state, when the processor is off. Slow Blinking Red or Green (once every 30-90 seconds) - Unit is in sleep mode.
1	DO Status	Reset state: The LED is off. Set state: The LED is on (green).
2	Not in Use	N/A
3	Not in Use	N/A

Table 1- MC-EDGE CPU LEDs – Page 0 (Default Display)

The following is CPU LEDs – Page 1 (DI Display):

LED Name	Description	Status
⏻	Power/Error LED	Fast Blinking Green (once in every 2 seconds) - Unit is powered on in Page 1. Fast Blinking Red (once in every 2 seconds) - Unit is powered on with errors in the Error Logger.
1	DI1 Status	Green - A powered-on DI is on (high from 6-30V). Off - DI is off (low 0–3 V).
2	DI2 Status	Green - A powered-on DI is on (high from 6-30V). Off - DI is off (low 0–3 V).
3	DI3 Status	Green - A powered-on DI is on (high from 6-30V). Off - DI is off (low 0–3 V).

Table 2 - MC-EDGE CPU LEDs - Page 1 (DI Display):

The following is CPU port LEDS:

Description	Status
Ethernet port LED	Green - Unit is connected to Ethernet. Green Blinking – Transmitting/receiving data
RS232/RS485 serial port (on-board) LED	Green - Transmitting data Yellow - Receiving data

Table 3 - MC-EDGE CPU Port LEDs

MC-EDGE I/O Expansion Modules

The MC-EDGE supports up to 5 expansion I/O modules. Each I/O module can be any of the following types:

- Input module type including
  - 12xDI 9-30 V
  - 8xAI 0-5 V, 0-20 mA
- Output module type including:
  - 8xDO types 4EE, 4ML
  - 2xAO 0-10 V, 0-20 mA
- Mixed IO module type including:
  - 7xDI 9-30 V
  - 4xAI 0-5 V, 0-20m A
  - 6xDO types 4EE, 2ML
  - 1xAO 0-10 V,0-20 mA

The I/O modules are attached in a daisy-chain, with the first module attached to the CPU, and the next module attached to the first. A cable with two RJ50 connectors is used to connect the I/O module to the CPU or to another I/O module.

Each I/O module includes a power LED, a link LED, individual I/O status LEDs, and an array of I/O connectors.

An I/O module can only be added/removed to/from an MC-EDGE unit when the unit is powered off.

For detailed specifications of each I/O expansion module, see the *MC-EDGE Owner's manual*, "Appendix A: General Specifications".

Figure 6 depicts the Input expansion module without a cover and with a cover.

Figure 7 depicts the Output expansion module without a cover and with a cover.

Figure 8 depicts the Mixed I/O expansion module without a cover and with a cover.

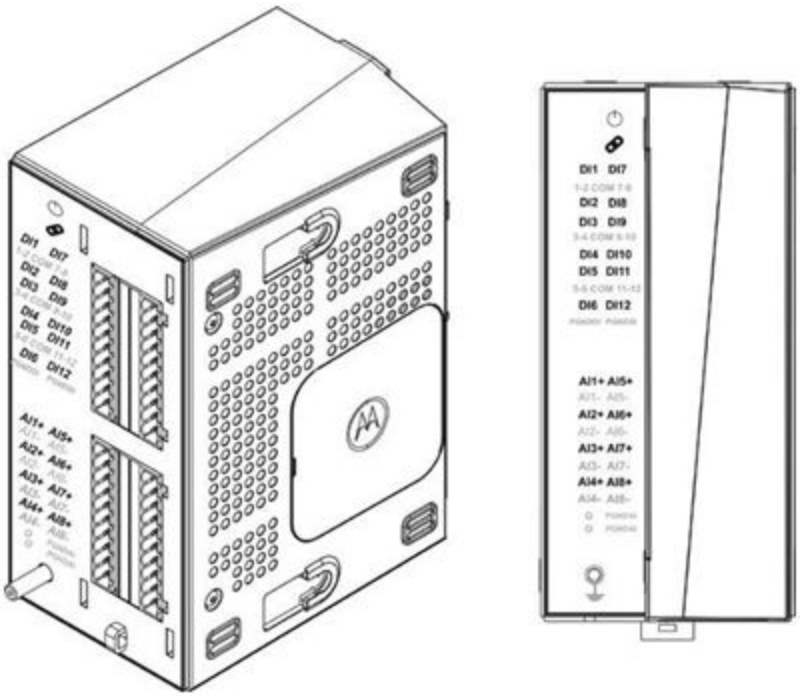

Figure 7- MC-EDGE Input Expansion Module

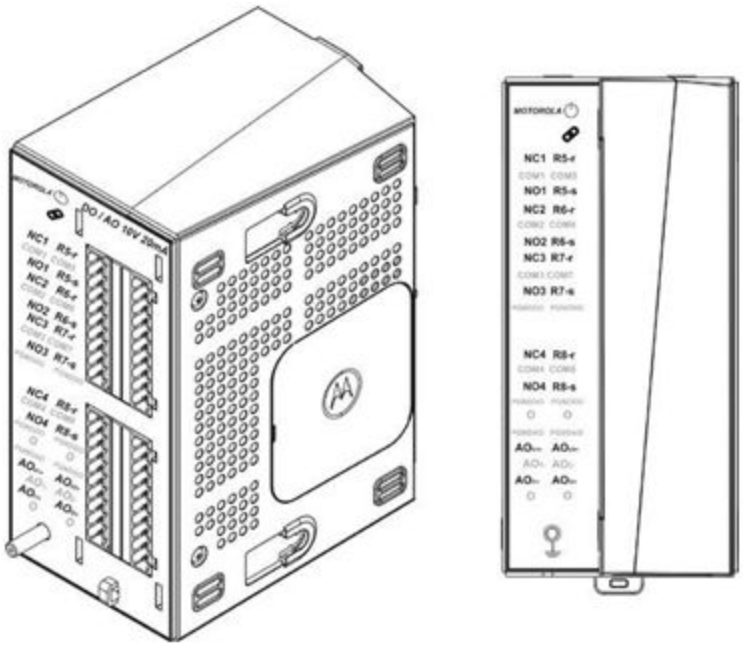

Figure 8- MC-EDGE Output Expansion Module

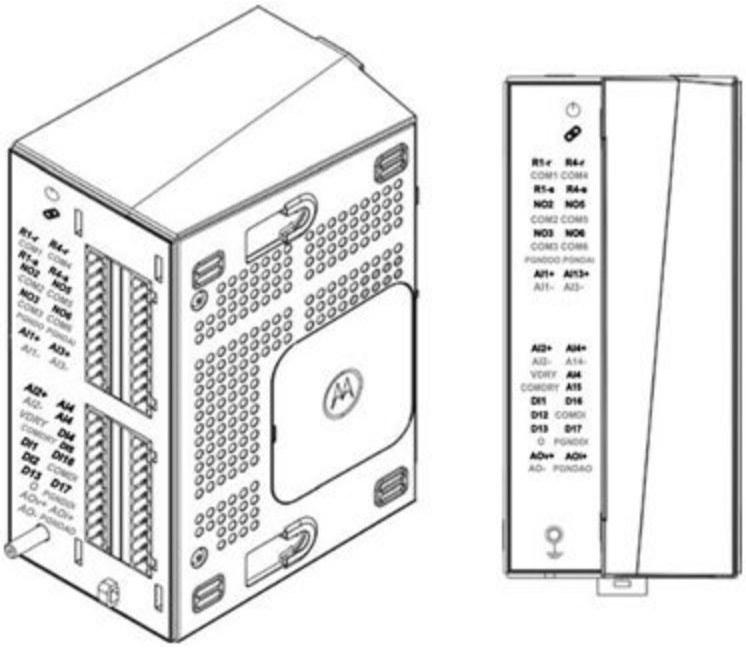

Figure 9 - MC-EDGE Mixed I/O Expansion Module

MC-EDGE I/O Module LEDs

The I/O module LEDs are used to indicate module and I/O status. LED indications are arranged according to the pins in the connectors.
The Input module has one LED indication for each I/O. The Output module has two LED indications for each DO and one LED indication for each AO. See *Table 5* and *Table 6* for LED functionality of the modules.

LED Name	Description	Status
⏻	Power LED	Off – I/O module is powered off. Steady Green – I/O module is powered on. Fast Blinking Green (once per second) – I/O module is in boot state.
🔗	Link LED	Future Use
DI1-DI12	DI Status	Green - A powered-on DI is on (high from 6-30V). Off - DI is off (low 0-3V).
AI1 - AI8	AI Status	Green - AI value is in range (0-20 mA, 4-20 mA, or 0-5 V). Red - AI value is not in range.

Table 4 - MC-EDGE Input Module LEDs

LED Name	Description	Status
⏻	Power LED	Off – I/O module is powered off. Steady Green – I/O module is powered on. Fast Blinking Green (once per second) – I/O module is in boot state.
🔗	Link LED	Future Use
NC1/NO1 - NC4/NO4	EE DO Relay Status	Default (non-operated) state: The NC# LED is on (green). The NO# LED is off.

		The NC# (normally closed) pin is connected to the COM# pin. Operate state: The NC# LED is off. The NO# LED is on. The NO# (normally open) pin is connected to the COM# pin.
R1-r/R1-s - R8-r/r8-s	ML DO Relay Status	Reset state: The R#_r LED is on (green). The R#_s LED is off. The R#_r pin is connected to the COM# pin. Set state: The R#_r LED is off. The R#_s LED is on (green). The R#_s pin is connected to the COM# pin. Note: The ML relay can be configured via software to preserve or reset the DO status at startup.
AOv1/2, AOi1/2	AO Status	Green - AO is active. Off - AO is not active.

Table 5 - MC-EDGE Output Module LEDs

LED Name	Description	Status
	Power LED	Off – I/O module is powered off. Steady Green – I/O module is powered on. Fast Blinking Green (once per second) – I/O module is in boot state.
	Link LED	Green – Proper Communication with Main CPU Red - No Communication with Main CPU.

NC2/NO2 – NC3/NO3 NC5/NO5 NC6/NO6	EE DO Relay Status	Default (non-operated) state: The NC# LED is on (green). The NO# LED is off. The NC# (normally closed) pin is connected to the COM# pin. Operate state: The NC# LED is off. The NO# LED is on. The NO# (normally open) pin is connected to the COM# pin.
R1-r/R1-s-R4-r/r4-s	ML DO Relay Status	Reset state: The R#_r LED is on (green). The R#_s LED is off. The R#_r pin is connected to the COM# pin. Set state: The R#_r LED is off. The R#_s LED is on (green). The R#_s pin is connected to the COM# pin. **NOTICE:** The ML relay can be configured via software to preserve or reset the DO status at startup.
DI1-DI12	DI Status	Green - A powered-on DI is on (high from 6-30 V). Off - DI is off (low 0-3 V).
AI1 – AI4	AI Status	Green - AI value is in range (0-20 mA, 4-20 mA, or 0- 5 V). Red - AI value is not in range.

Table 6 - MC-EDGE Mixed IP Module LEDs

MC-EDGE Input Module I/O Arrangement

In the Input module, the upper 20 pins belong to the 12 Digital Inputs (DI). DIs are arranged in groups of three pins, e.g. DI1:COM1-2:DI2. Each group is isolated one from

the other and has its own COM pin. PGNDDI pins must be connected to protected ground (ground screw).
The lower 20 pins of the Input module belong to the 8 Analog Inputs (AI). AIs are arranged in couples with positive and negative pins. Each AI channel is isolated from the other and isolated from the logic circuit. PGNDAI pins must be connected to protected ground (ground screw). AIs are calibrated in the factory.

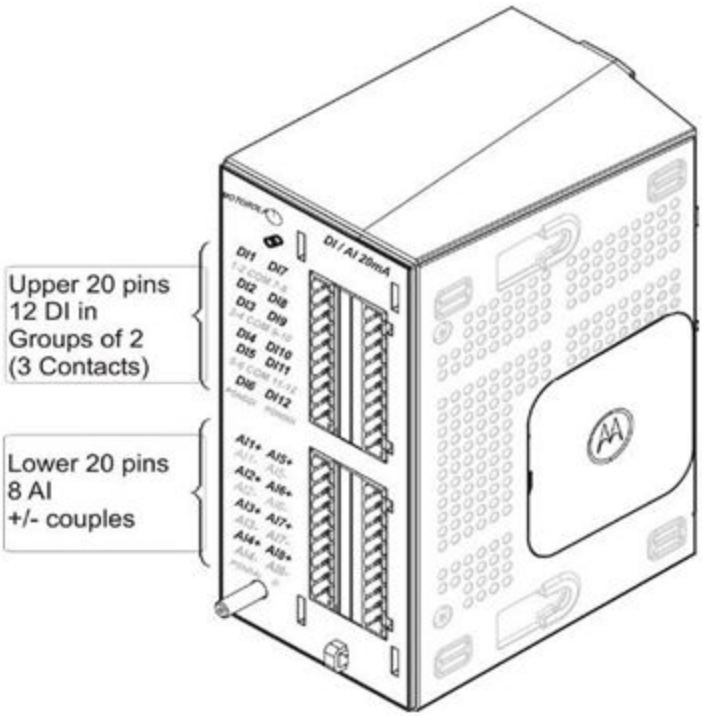

Figure 10 - MC-EDGE Input Module I/O Arrangement

MC-EDGE Output Module I/O Arrangement

In the Output module, the upper pins belong to the 8 Digital Outputs. The first four DOs are Electrically Energized (EE). The EE DOs are arranged in groups of three pins per relay, e.g. NC1:COM1:NO1. The second four DOs are Magnetically Latched (ML). The ML DOs are arranged in groups of three pins per relay, e.g. R5-r:COM5:R5-s. Each group is isolated from the other and has its own PGNDDO pin. PGNDDO pins must be connected to protected ground (ground screw).
The lower pins of the Output module belong to the 2 Analog Outputs (AO). The AOs are arranged in groups of three pins, e.g. AOv1+:AO1-:AOi1+.

- AOv1+:AO1- and AOv2+:AO2- are voltage output pins.
- AOi1+:AO1- and AOi2+:AO2- are current output pins.

The PGNDAO pins must be connected to protected ground (ground screw). The AOs are calibrated in the factory.

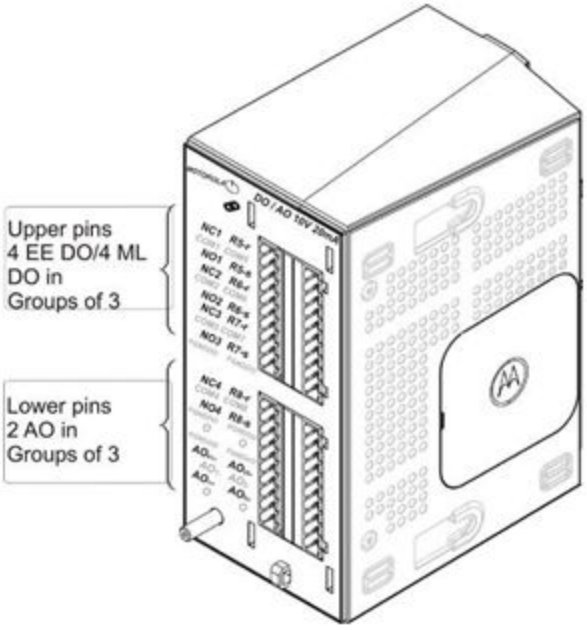

Figure 11 - MC-EDGE Output Module I/O Arrangement

MC-EDGE Mixed I/O Module Arrangement

In the Mixed module the upper pins belong to the 6 Digital outputs DOs 1 & 4 are Magnetically Latched (ML). The ML DOs are arranged in groups of three pins per relay, e.g. R4-r:COM4:R4-s. Each group is isolated from the other and has its own PGNDDO pin. PGNDDO pins must be connected to protected ground (ground screw).
DOs 2-3-5-6 are Electrically Energized (EE) .
The EE DOs are arranged in groups of two pins per relay, e.g. COM2:NO2.
There are 4 AI inputs located in the Middle of the module AIx+ - AIx-
The 1 AO voltage or current are located on the bottom of the module AOV+, AOI+, AO-.

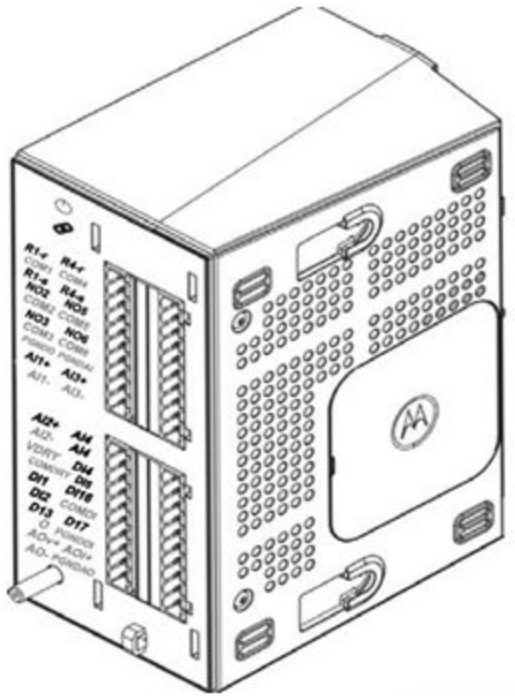

Figure 12 - MC-EDGE Mixed I/O Arrangement

MC-EDGE I/O Module Terminal Block Connectors

Each I/O module is equipped with a set of two terminal block (TB) connectors (5 mm pitch), with 20 pins each. Each TB connector has a fixed female side on the module and two male plugs for the sensor/device wire connection. The TB male side (#FHN0061) is screw type for up to 2 mm (12 AWG) wire. See the *MC-EDGE Installation* chapter for details on connecting MC-EDGE I/Os.

A TB extractor tool (FKN0024) is provided for easy removal of TBs. See the *MC-EDGE Installation* chapter for details on extracting the TB connectors from the module.

MC-EDGE Antennas

Only the approved antennas listed below can be used with the MC-EDGE.

- BMLPVMBLTENGP-VP: MLPV Low-Profile Vertical Antenna for 698-960 MHz, 1710-2700 MHz for LTE, Lora and APX 900 MHz (not for APX 7/800)
- MWV1365S: WIDEBAND VHF NO TUNE ANTENNA for 132-174 MHz + MVPHP Adaptor
- MWU4002S: Wideband No Tune UHF ANT Antennas for 380-520 MHZ + MVPHP Adaptor

- MLPV700-VP: for APX 7/800
- CBL-195-17FT-N1-S1: 5m coax N-Type to SMA Needed for all Antennas
- MC-EDGE Models, Options and Accessories

MC-EDGE External Power Supply or Battery

The MC-EDGE can be ordered with an external AC/DC power supply. These are drop ship items that are provided with the MC-EDGE unit. The following power supplies are available:

- Lambda Electronics DPP120-12-1 AC power supply 12VDC/10A, 120W, 90-264VAC (mounted on DIN rail) DC output
- Artesyn ADN5-24-1PM-C AC power supply 24VDC/5A, 120W, 85-264VAC (mounted on DIN rail) DC output, Limited temp. -25 - +70 ºC

Alternatively, a customer-supplied AC/DC power supply or DC power source (DC/DC converter or battery) can be used. See the MC-EDGE input voltage and power consumption specifications in *Appendix A: MC-EDGE Specifications*.

MC-EDGE External Devices

The following external devices have been tested and certified as MC-EDGE compatible:

- ASTRO radios: APX 6500, APX4000
- Analog radios: MOTOTRBO DM4400e, MOTOTRBO XPR5350e, CM200. The MC-EDGE connectivity with Analog radio requires a radio modem mediator. These Analog radio types have been tested with external 3'rd party radio modem type: Tigertronics RTX-12.
- MOTOTRBO digital radio: XPR 5350e, XPR7550e. These radio type has been SIT tested on a MOTOTRBO digital DMO and Capacity Max deployments.For additional details on above equipment and connections, please refer to *MC-EDGE Owners Manual*

Note: Other similar devices can be used with MC-EDGE and it is the user's responsibility to validate the compatibility of any other devices.

Ordering Information

For MC-EDGE ordering information please refer to *MC-EDGE Ordering Guide*

Installation Guide

General

The MC-EDGE is shipped from the factory ready for mounting on a wall or in a customer's enclosure.

WARNING:

Installation of the MC-EDGE should be done only by authorized and qualified service personnel in accordance with the US National Electrical Code. Only UL Listed parts and components will be used for installation. Use UL Listed devices having an environmental rating equal to or better than the enclosure rating to close all unfilled openings.

AVERTISSEMENT:

L'installation de l'unité MC-EDGE doit être effectuée exclusivement par le personnel de service autorisé et qualifié, conformément au code national de l'électricité des États- Unis. Seuls des pièces et composants identifiés UL seront utilisés pour l'installation. Utiliser des appareils identifiés UL dont l'indice de protection environnementale est égal ou supérieur à l'indice de protection du boîtier pour fermer toutes les ouvertures non couvertes.

If the installation involves high-voltage connections, technicians must be specifically qualified to handle high voltage.

Dans les cas où l'installation comporterait des connexions haute tension, les techniciens doivent être spécialement qualifiés pour travailler avec cette haute tension.

INSTALLATION CODES
This device must be installed according to the latest version of the country's national electrical codes. For North America, equipment must be installed in accordance with the applicable requirements in the US National Electrical Code and the Canadian Electrical Code.

CODES D'INSTALLATION
Cet appareil doit être installé conformément à la plus récente version des codes nationaux de l'électricité du pays. En Amérique du Nord, l'équipement doit être installé conformément aux exigences en vigueur dans le code national de l'électricité des États-Unis et le Code canadien de l'électricité.

INTERCONNECTION OF UNITS
Cables for connecting RS232 and Ethernet Interfaces to the unit must be UL-certified type DP-1 or DP-2. (Note: when residing in a non LPS circuit.)

INTERCONNEXION DES UNITÉS
Les câbles pour la connexion des interfaces RS232 et Ethernet à l'unité doivent être certifiés UL type DP-1 ou DP-2. (Remarque- dans un circuit non LPS.)

Do not remove the SD card when the unit is energized.

Ne pas retirer la carte SD lorsque l'unité est sous tension.

OVERCURRENT PROTECTION
A readily accessible 2-pole Listed branch circuit overcurrent protective device rated 20 A must be

PROTECTION CONTRE LA SURINTENSITÉ
Un appareil de protection contre les surintensités dans le circuit de dérivation,

incorporated in the building wiring.

de 20 A et à deux pôles, doit être intégré dans le câblage de l'édifice.

CAUTION: If the MC-EDGE is subject to high levels of shock or vibration, you must take suitable measures to reduce the acceleration or amplitude. We recommend that you install the MC-EDGE on vibration-damping materials (for example, rubber-metal anti-vibration mountings).

MISES EN GARDE: Si le module MC-EDGE est soumis à des niveaux élevés de chocs ou de vibrations, vous devez prendre des mesures adéquates pour en réduire l'accélération ou l'amplitude. Nous vous recommandons d'installer le module MC-EDGE sur une surface qui atténue les vibrations (sur un support de métal et caoutchouc antivibration, par exemple).

Ethernet LAN, RS485 and I/O cables can be a maximum length of 100 m.

Câbles Ethernet LAN, RS485 et E/S peuvent avoir un maximum de 100 mètres.

Mounting the MC-EDGE on a DIN Rail

The MC-EDGE is mounted on a customer-supplied 35 mm DIN rail, which can be installed either on a wall or in a plastic or metal enclosure.

The below figure shows the dimensions of the unit. Allow an additional 5 cm (2") (in W, H) and 10 cm (4") (in D) around the unit. When mounted in an enclosure, allow an additional 6 cm (2.4") (in W, H) and 7 cm (2.75") (in D) around the enclosure.

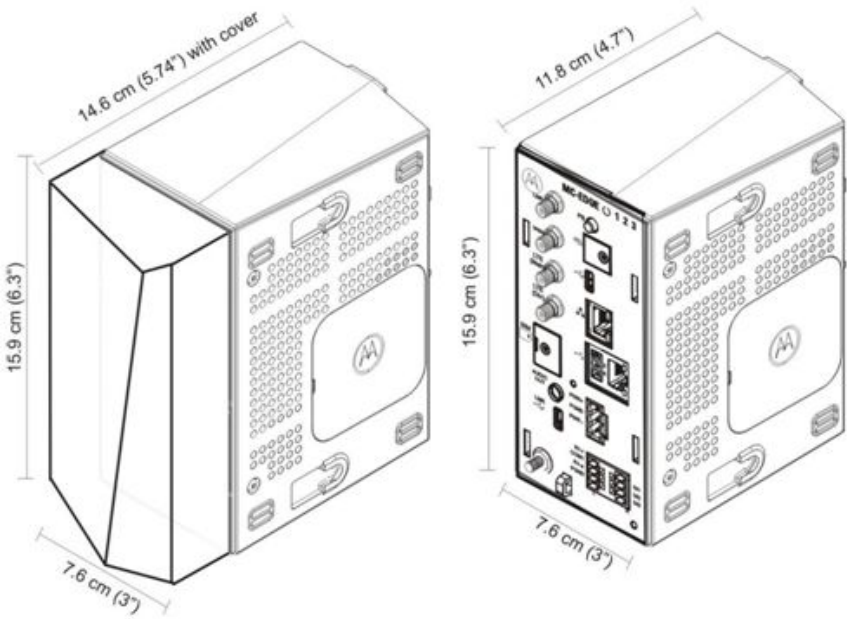

Figure 13 - Dimensions of MC-EDGE unit

Prerequisite: Before performing this procedure, secure the DIN rail using at least three M5 screws and three M5 washers.

Connect the MC-EDGE CPU to any I/O expansion modules before mounting on the DIN rail.

1. Slide the supplied plastic tab at the back of the unit all the way down to the bottom of the unit. See Figure 13. If the MC-EDGE unit includes one or more I/O expansion modules, repeat this step for all I/O expansion modules.

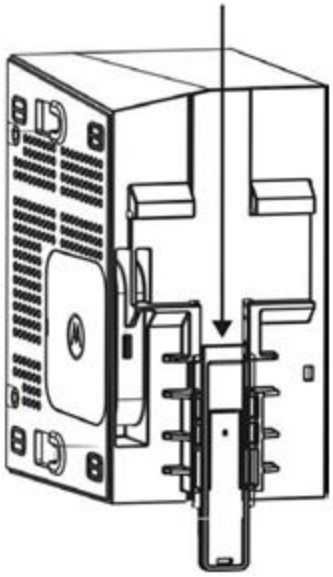

Figure 14 - Plastic Tab in MC-EDGE unit

2. Lift the MC-EDGE unit and hang onto the DIN rail, using the hooks in the back of the unit. See Figure 14.

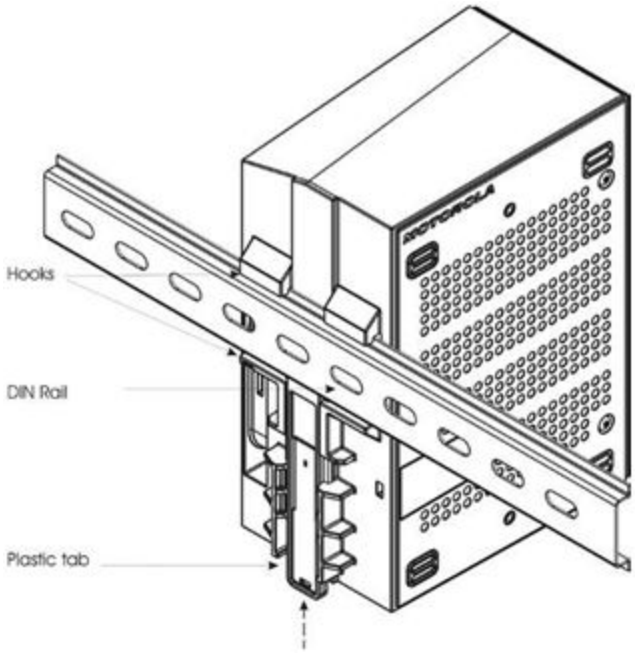

Figure 15 - Hooking the MC-EDGE unit onto DIN Rail

3. Slide the plastic tab upwards, until it locks against the DIN rail. See Figure 14. If the MC-EDGE unit includes one or more I/O expansion modules, repeat this step for all I/O expansion modules. See Figure 15.

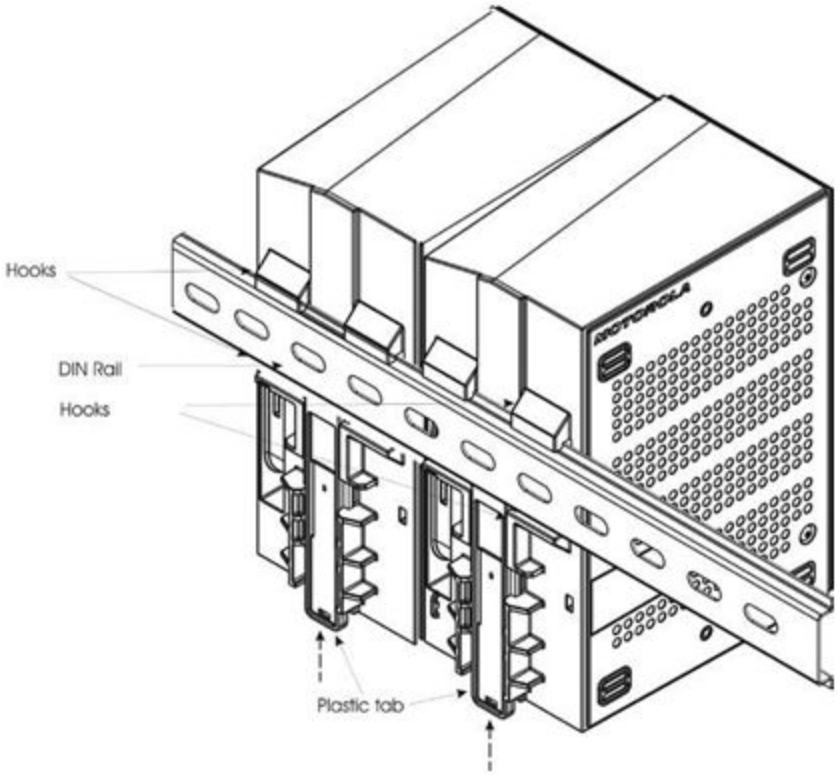

Figure 16 - Hooking the MC-EDGE Unit with I/O Expansion Module onto the DIN Rail

4. (Optional) Clip two stoppers onto the DIN rail, one to the left and one to the right of the unit to keep the unit in place. Tighten the built in screws.

5. Connect the data cables to the unit. See Connecting MC-EDGE Data Cables.

6. Connect the I/O sensors. See Connecting MC-EDGE I/Os.

7. Bundle the cables and attach them to the fastener on the module. See Bundling MC- EDGE Cables.

8. Insert the four legs of the front cover into the matching grooves on the front of each module and slide the cover down.

Connecting an I/O Expansion Module to the MC-EDGE CPU

The I/O expansion modules must be connected to the MC-EDGE CPU before the unit is mounted on the DIN rail. Follow the procedure below to connect an I/O expansion module to the MC-EDGE CPU.

1. Insert a narrow tool (e.g. flat screwdriver) into the groove of the side cover on the right side of the MC-EDGE CPU and remove the cover.

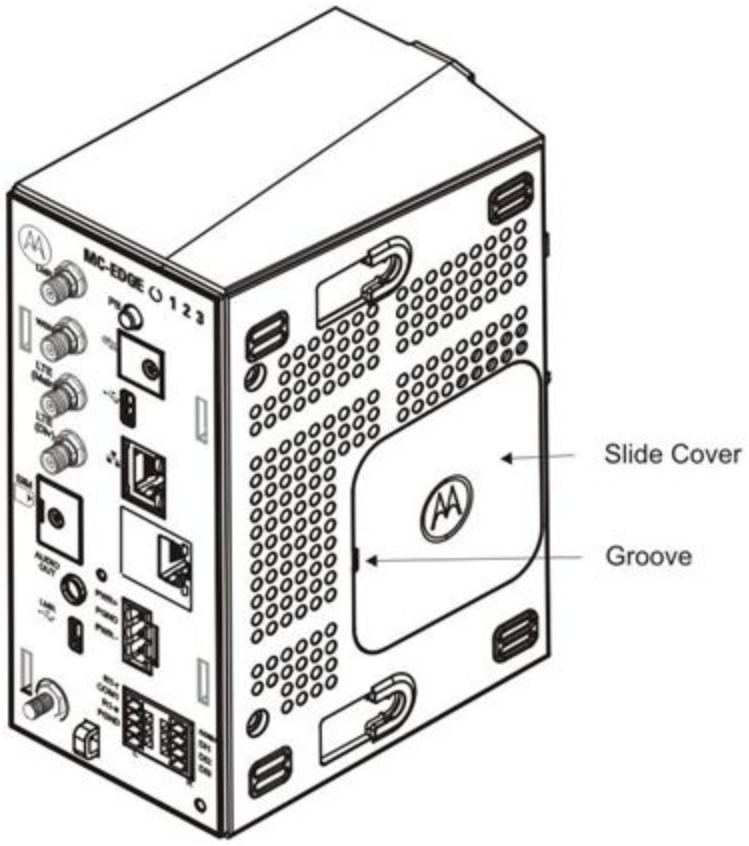

Figure 17 - MC-EDGE CPU Side Cover

2. Click the 90º bent end of the 10-pin I/O connector cable (#30013144001) into the RJ50 connector on the right side of the CPU. See Figure 17.

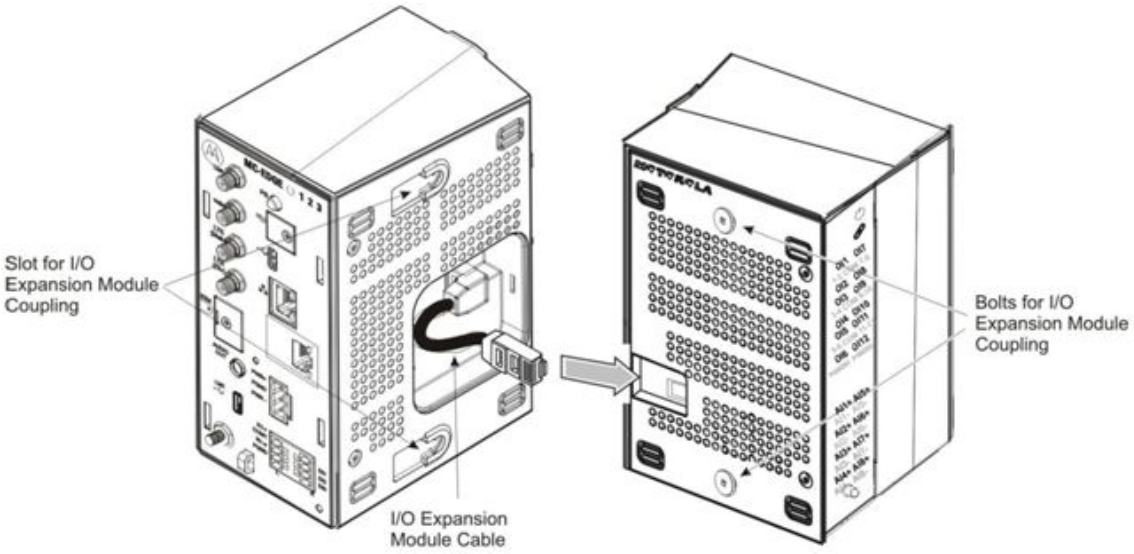

Figure 18 - MC-EDGE CPU Connection to I/O Expansion Module

3. Click the other end of the I/O 10-pin connector cable into the RJ50 connector on the left side of the I/O expansion module. See Figure 17.

4. With the front of the modules facing you, press the CPU and I/O expansion modules together while sliding the bolts on the I/O expansion module into the slots on the CPU. Be careful not to pinch the cable between the modules.

5. Press the I/O expansion module slightly back and the CPU module slightly forward until they click.

Connecting an I/O Expansion Module to another I/O Expansion Module

Follow the procedure below to connect more than one I/O expansion module to the MC-EDGE unit.

1. Remove the cover from the right side of the MC-EDGE I/O expansion module.

2. Click the 90º bent end of the 10-pin I/O connector cable into the RJ50 connector on the right side of the leftmost I/O expansion module. See Figure 18.

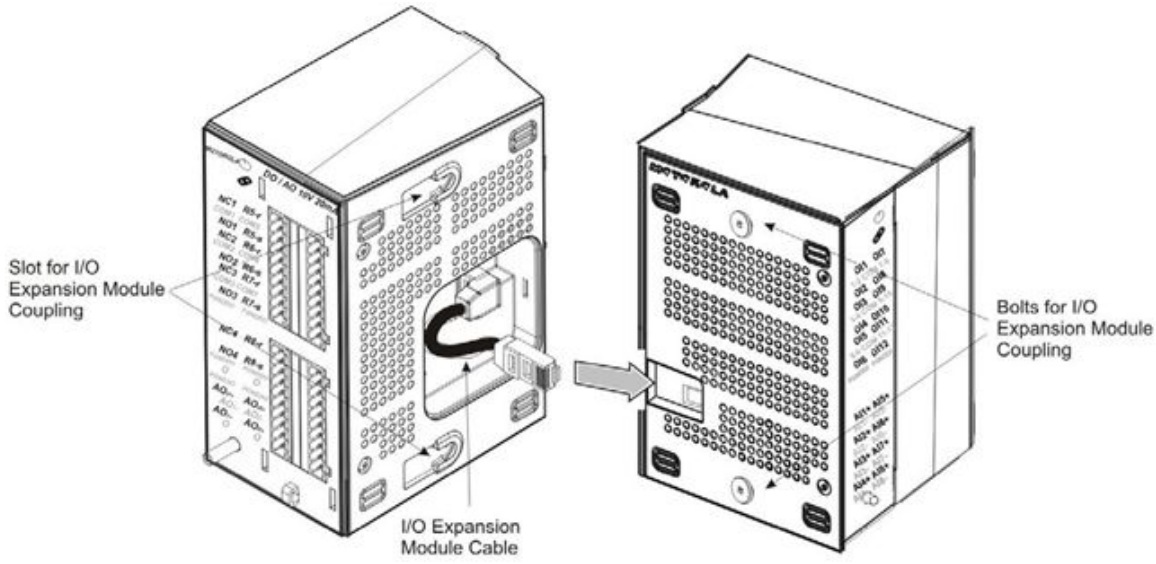

Figure 19 - MC-EDGE I/O Expansion Module Connection to I/O Expansion Module

3. Click the other end of the I/O 10-pin connector cable into the RJ50 connector on the left side of the next I/O expansion module. See Figure 18.

4. Press the two I/O expansion modules together while sliding the bolts on the rightmost module into the slots on the right side of the leftmost module. Be careful not to pinch the cable between the modules.

5. Press the rightmost module slightly back and the leftmost module slightly forward until they click.

MC-EDGE Power and Ground Connections

All internal electrical connections are performed in the factory and supplied with the RTU. During installation, only the main power and ground must be connected.

The procedures for the main power, ground and battery connections are provided below.

WARNING: The power and ground connections should be performed only by qualified and authorized service personnel. All power and ground connections must be in accordance with local standards and laws.

AVERTISSEMENT: Les connexions d'alimentation et de mise à la masse doivent uniquement être effectuées par un personnel de service qualifié et autorisé.
Toutes les connexions d'alimentation et de mise à la masse doivent être conformes aux normes et aux lois locales.

NOTICE: Make sure that the ground cable is long enough to reach the grounding point, but as short as possible. The wire gauge of the ground wire in the cable must be 6 AWG.

Only a single wire can be connected to a contact in the Terminal Block connector. Wire size for the CPU Power connector must be AWG 12.

Follow the procedure below to connect the MC-EDGE unit to power and ground.

1. Once the MC-EDGE unit (including any I/O expansion modules) is installed on the DIN rail, mount the power supply (not supplied) nearby.
2. Connect one end of the DC power cable (FKN0033) to the 9-30 VDC power supply (red to + and black to -).

NOTICE: The DC power cable includes a 5A fuse.

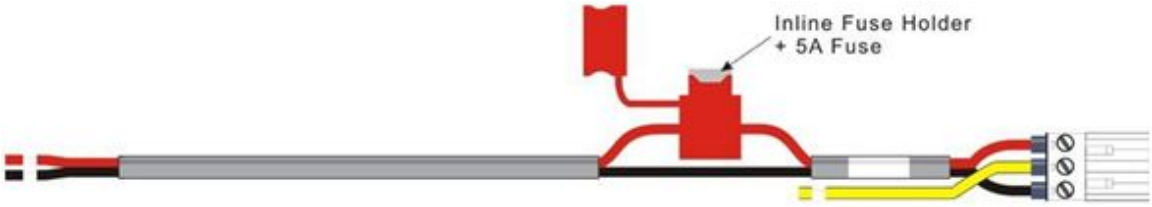

Figure 20 - MC-EDGE DC Power Cable with Fuse

3. Connect the other end of the power cable to the DC power connector on the front panel of the MC-EDGE unit.

4. Connect the yellow wire from the power cable to the grounding screw on the front panel of the MC-EDGE unit.

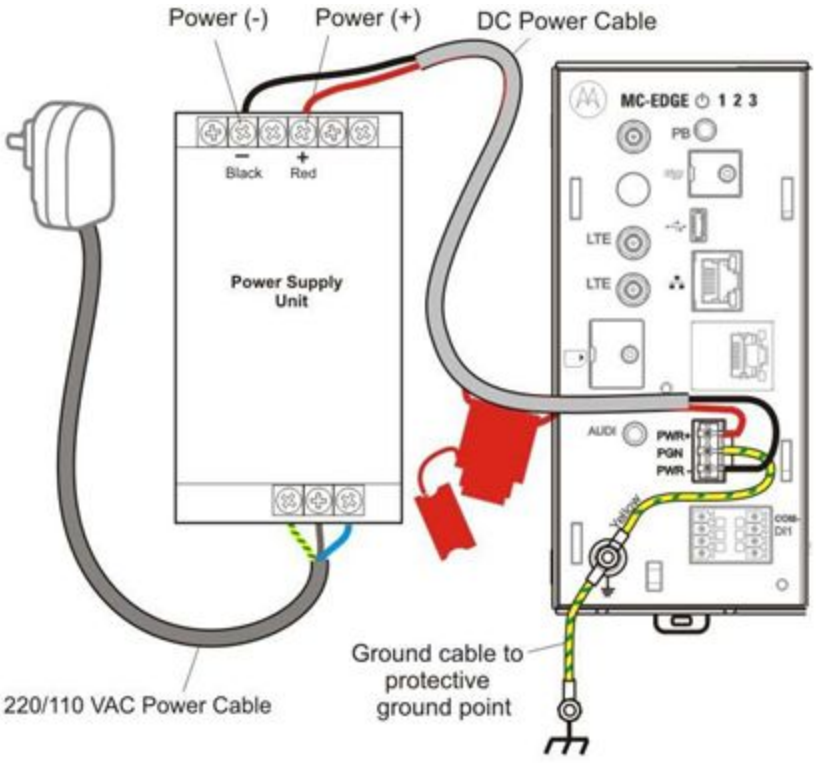

Figure 21 - MC-EDE Power and Ground Connections

5. Use the protective ground cable (optional FKN0034) to connect the grounding screw on the unit (CPU or I/O expansion module) (ground screw nuts torque 4 LB-IN) to the

grounding point outside of the enclosure. In an MC-EDGE unit with I/O expansion, all grounding strips should be connected to a common grounding point.

6. Bundle the cables as described in “Bundling MC-EDGE Cables”.

7. Connect the power supply power cable (AC power cable is not supplied).

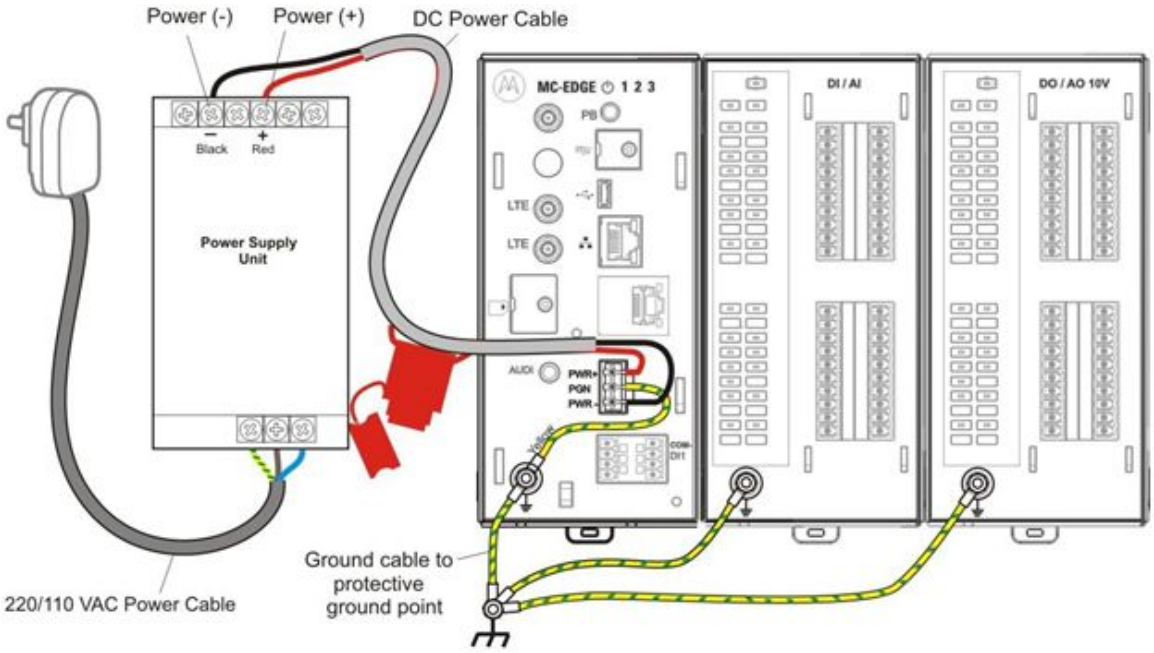

Figure 22 - MC-EDGE with I/O Expansion Power and Ground Connections

Connecting MC-EDGE Data Cables

Follow the procedure below to connect the data cables to the MC-EDGE RTU ports.

1. Connect the data cable(s) (RS232, RS485, LAN) from the MC-EDGE CPU to the appropriate device(s). For details, see “Appendix B: Cables and Adaptors”.

2. Bundle and attach the cable(s) to the fastener on the CPU module, as described in “Bundling MC-EDGE Cables”.

Connecting MC-EDGE I/Os

Follow the procedure below to connect a user-supplied I/O sensor/device to the MC-EDGE RTU I/O modules.

NOTICE: Only a single wire can be connected to a contact in the TB connector. Wire size for the CPU I/O connectors can be AWG 16, 18, 20, 22, 24, 30. Wire size for the I/O expansion module connectors can be AWG 12, 14, 16, 18, 20, 22, 24, 26. Wire size for the PGND must be AWG 12.

1. Using a small flat screwdriver, loosen the screws on the TB connector (#FHN0061A). Insert the exposed wire tips from the I/O sensors/devices. Tighten the screws (torque 2 LB-IN).
2. Line the TB connector up to the corresponding connector on the I/O module and press it forward into the module, as shown in Figure 22. Then press downwards to lock.

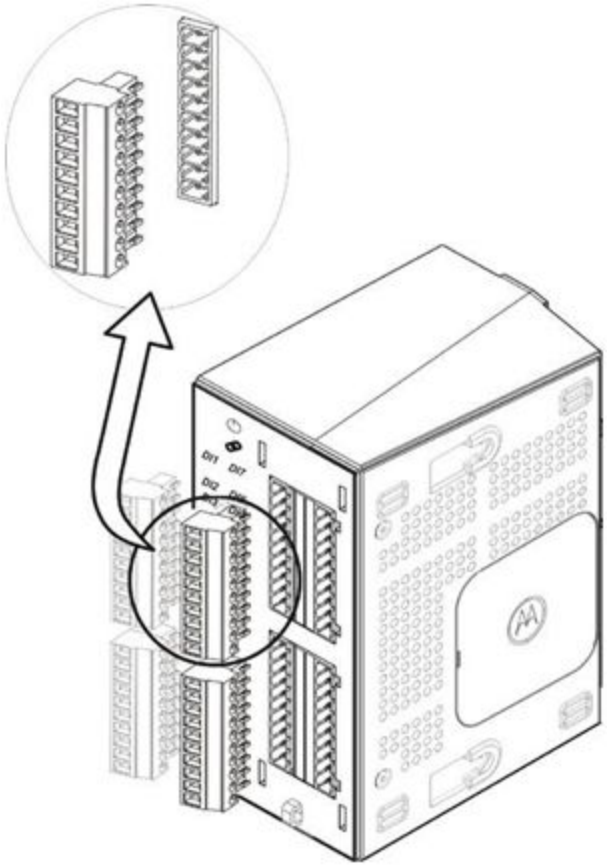

Figure 23 - MC-EDGE I/Os connections

3. Bundle and attach the I/O cables to the fastener on the I/O module, as described in Bundling MC-EDGE Cables.

Bundling MC-EDGE Cables

All MC-EDGE cables must be bundled in a tear-off cable tie for strain relief at the bottom of the module's front panel. Follow the procedure below to bundle the MC-EDGE cables.

1. Once all cables are connected to the module, collect all cables in one or more tear-off cable tie(s) (not supplied). See Figure 22.

2. Thread the cable tie through the plastic fastener at the bottom of the front panel.

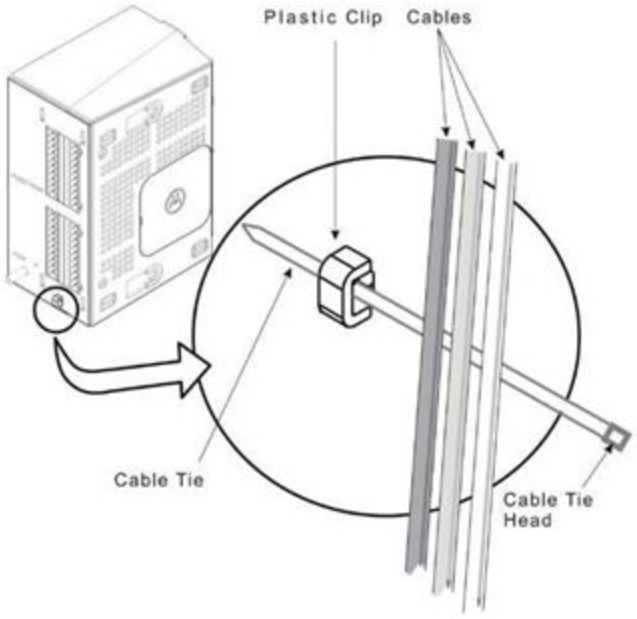

Figure 24 - MC-EDGE Cables in Plastic Fastener

3. Slide the pointed tip of the cable tie through the head and pull tightly.

4. Snip off the extra plastic at the end of the tie.

Extracting Terminal Block Connectors from the I/O Module

Follow the procedure below to extract the TB connector from an MC-EDGE I/O module.

1. Lift and remove the cover of the I/O module to expose the TB connectors. (See I/O module with and without cover in Figure 3.)

2. Position the TB extractor to the right of the preferred TB connector, and fit the curved tip behind the TB. (See Figure 23.)

3. Press down on the TB extractor, rotate counter-clockwise, and then rotate clockwise to extract the TB connector from the I/O module. See Figure 24.

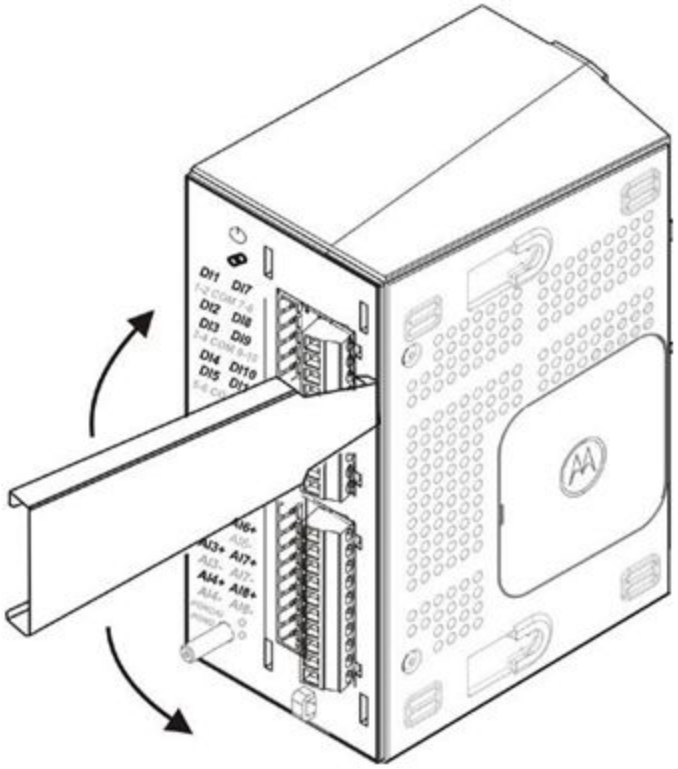

Figure 25 - Extracting Terminal Block Connectors from the I/O Module

Adding an Optional SD Card

Follow the procedure below to add an optional SD card (not supplied) to an MC-EDGE CPU.

1. Using a Phillips screwdriver, loosen the screw on the SD cover (torque 2 LB-IN). See Figure 25.

2. Gently pull the screw outwards, on its axis, to remove the SD cover.

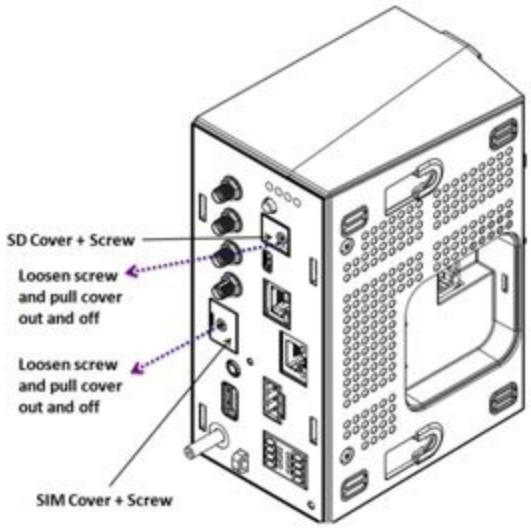

Figure 26 - MC-EDGE CPU SD Cover

Connecting Antennas to the MC-EDGE

Once the MC-EDGE unit is installed, install the supplied antennas and connect the antenna cable connectors on the front panel of the MC-EDGE unit.

Before installing the antennas, read the installation instructions provided with each antenna installation kit.

NOTICE: Before installing the antennas, refer to RF Energy Exposure Training and Product Safety Information for Fixed Site Infrastructure Installed as Fixed Site Stations guide PN: MN004607A01-A

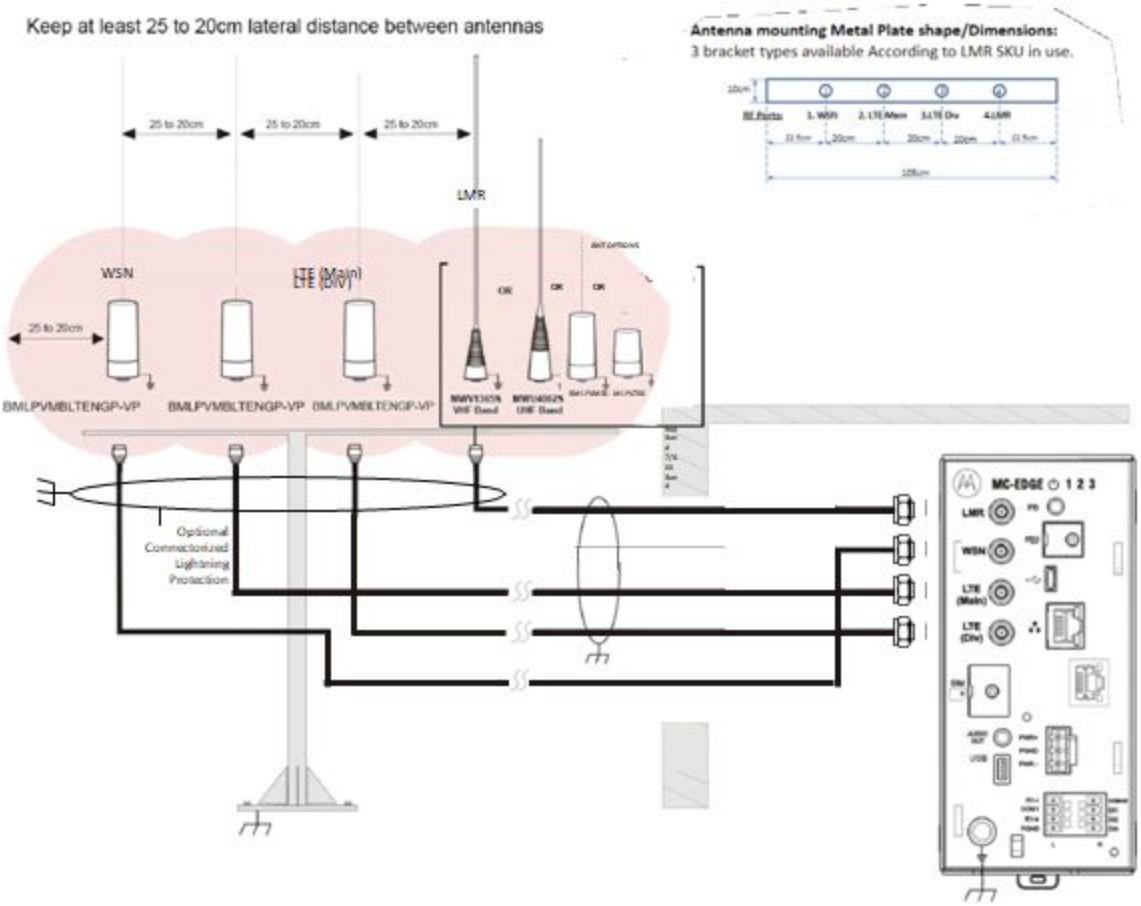

Figure 27 - Connecting Antennas to the MC-EDGE T1

For VA00973AA different antenna connecting schema below

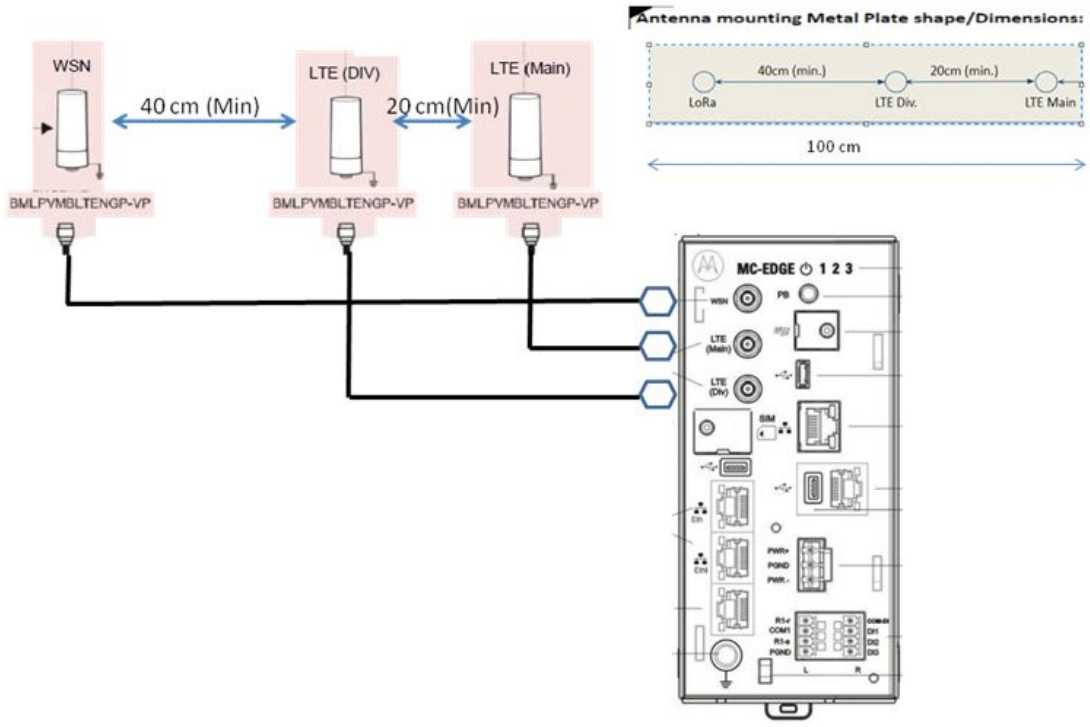

Figure 27a - Connecting Antennas to the MC-EDGE T2

Replacing the MC-EDGE DC Power Cable Fuse

Follow the procedure below to replace the fuse on the MC-EDGE DC power cable (FKN0033).

1. Remove the faulty 5A fuse from the fuse holder. See Figure 18.
2. Plug the new 5A fuse (# 6580283E03) into the fuse holder.

Communications

The MC-EDGE is capable of working over a variety of IP communication links such as: Cellular network, Radio network, LAN. The MC-EDGE arrives with the MSI built-in proprietary MDLC communication protocol. This protocol provides lots of built-in features and utilities such as transmit/receive messages, automatic retries, ACK management, message transfer transparent to IP link type, support of automatic primary/redundancy links transfer, support of simultaneous communication with all links, cyber security suite in a secured system, built-in diagnostic logs, error logs, security logs, files download and more.

The system can be relatively simple, comprising several RTUs and one control center. It can be modularly expanded to a more hierarchical system, where several subsystems (comprising intelligent RTUs and/or sub-centrals controlling their peripheral RTUs) communicate with a central computer.
The communication network is flexible, enabling each RTU to communicate with hierarchies above it (RTU-to-central), parallel to it (RTU-to-RTU), under it (another RTU), and also relaying messages through it (when the RTU serves as a communication node).

MDLC Protocol

The MDLC protocol is based on the Open System Interconnection (OSI) model recommended by the International Organization for Standardization. MDLC utilizes all seven layers of the OSI model. This protocol is designed for optimum operation in SCADA systems which operate with diverse communication media such as two-way radio, line, LAN, etc. Each RTU, FEP has all seven layers of the MDLC protocol available to them. The functions of the seven layers are summarized below.

Layer	Function
Layer 1: Physical	This layer caters to communications over conventional radio, trunked radio, data radio, serial data channels, modems, Ethernet or telephone lines. The layer is also responsible for channel access and collision control on shared media.
Layer 2: Link	This layer ensures proper communications over a physical link. The layer arranges the data in variable-length frames and attaches addresses, frame sequence numbers, and Cyclic Redundancy Code (CRC) to the frames.
Layer 3. Network	This layer is responsible for the establishment of end-to-end communication paths in a network. This is necessary since communications may take place on more than one link and a message may travel through several nodes before reaching the final destination.

Layer 4. Transport	This layer ensures end-to-end integrity of the information flow between two nodes in the network. This is achieved by remote-end acknowledgement that data has been received completely and passed in the correct order to the next layer.
Layer 5. Session	This layer allows the definition of any number of entities capable of conducting simultaneous sessions with an equivalent entity in some remote unit. This enables transparent communications among multiprocessing machines without interference in their applications.
Layer 6. Presentation	This layer structures the information to/from various applications. This layer may also perform format conversion, data authentication, etc. if implemented.
Layer 7. Application	This layer interfaces to the various applications such as data transfer, configuration downloading, application software monitoring, remote diagnostics, etc.

The MDLC protocol is intended for operation in point-to-multipoint links, such as two-way radio or multidrop wireline, as well as in point-to-point communication networks. The protocol facilitates communications among all sites in the system, including extensive diagnostic messaging. MDLC is transparent and liberates the system engineer from the technical constraints and complexities of network operations, thus allowing the intended application to be the item of focus.

MDLC uses a semi-synchronous data format on two-way radio and an asynchronous format on wirelines. It is not correct to refer to message size in byte notation because of the 16-bit architecture; the data may not be sent in asynchronous format—no start and stop bits—but it is not true synchronous format, because there is no single network-provided clock signal. Instead, each CPU has a clock that is entirely adequate to provide the synchronized signal for data transfer. It is therefore better to refer to MDLC in terms of data words where each word may be variable in length, consist of both header and body components, and contain up to 80 16-bit variables within the body. A physical message may consist of a single word or may consist of a concatenated series of words (packets), each word addressed to one or more destination sites with some or all words requiring subsequent store-and-forward operation by the recipient site(s). The concatenated data words may be any combination of the supported functions, i.e. data upload to the SCADA Manager, error logger data to the STS/Easy Configurator, etc.

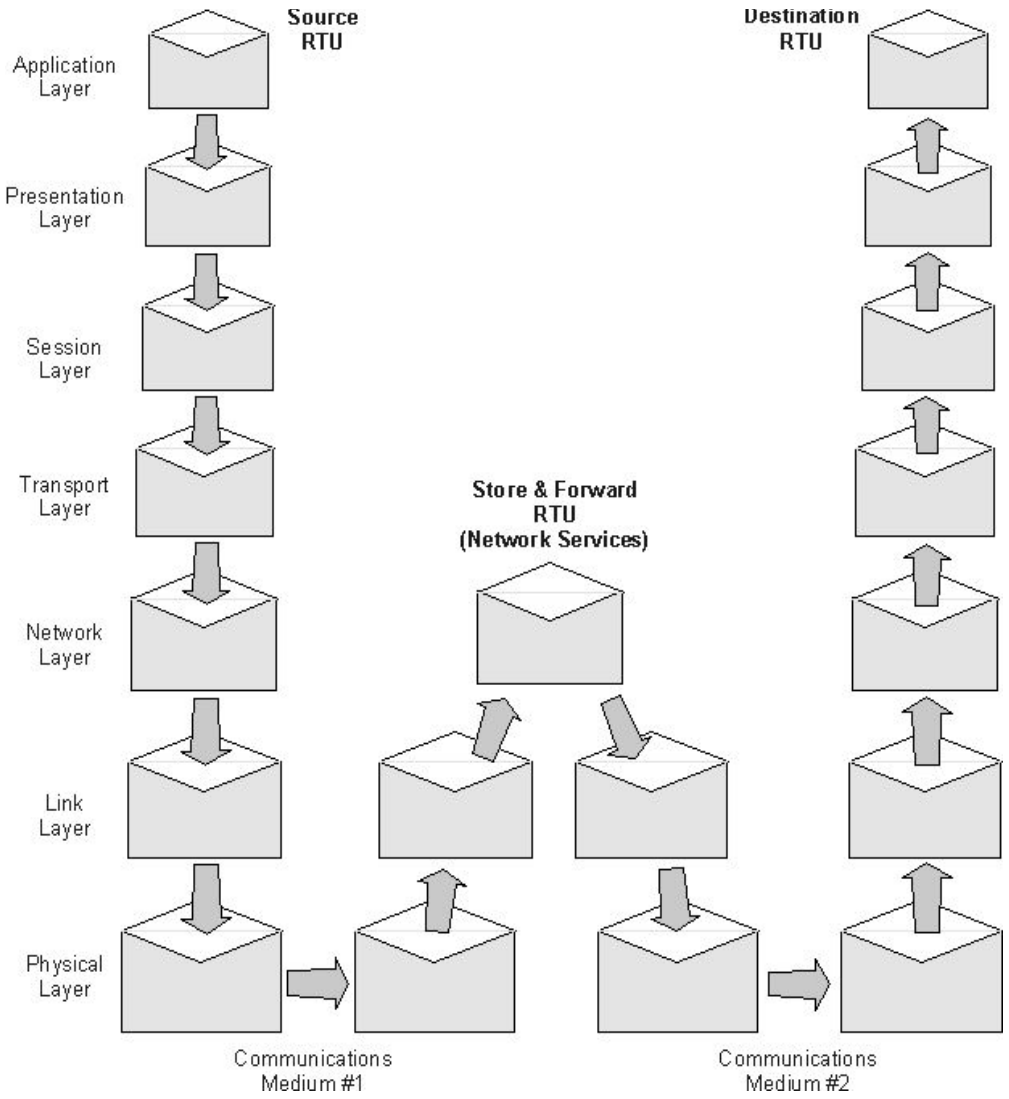

Figure 28 - MDLC layers

The lower three layers of the MDLC protocol stack are commonly known as Network Services. These layers are only used when communicating with intermediary sites which make it possible to pass any data through the system and do not require the entire system to know the details of the data. Each layer adds (removes) data to what was received and thereby communicates with equivalent layers in the destination (source) site—see figure above.

RTU-to-RTU communications suppress the Presentation, Session, and Transport layers; all layers are present for SCADA Manager-to-RTU communication and for communications with the STS.

MDLC Data Transfer Methods with FEP/GW

Three messaging methods are commonly used by the Motorola RTU: Contention (transmission upon change-of-state; also called burst), Polling (interrogation), and Report-by-Exception. The Contention method has the RTU report upon a change-of-state (COS) of conditions/values without waiting for a poll from the SCADA Manager. The RTU recognizes a COS and reports relevant data to the SCADA Manager or to another site as soon as the shared communication medium becomes available. The RTU will repeat the data message until confirmation of reception is received. The RTU listens to the shared communication medium before sending a message and then uses a slotted channel acquisition method to avoid synchronized message collisions. This is the messaging method most often used by Motorola RTUs because it uses the shared communication medium properly.

The Polling (interrogation) method is a periodic activity used to confirm the proper operation of the normally silent RTUs and/or to update the SCADA Manager database at specified intervals or when manually instructed by the operator. The Report-by-Exception method has the RTU report only the conditions/values that have changed since the last poll. The SCADA Manager retains all data conditions and values in a local database for instant use.

MC-EDGE Communication Interfaces/Links

The MC-EDGE unit includes a set of communication interfaces for MDLC communication (between the FEP-RTU and RTU-RTU) and for non-MDLC communication.

The following communication ports are supported via the MC-EDGE CPU board:

- OTG port, micro USB 2.0 port (maximum inrush current 100mA) (USB1)
    - Console port (device), MDLC protocol, IP RNDIS
    - usage examples: connectivity with a local STS for configuration
- ETH1 port, LAN Ethernet 10/100 Mb/s
    - MDLC protocol, IP Non-MDLC protocol, MODBUS Master protocol, MODBUS Slave protocol
    - usage examples: management of local end node device, connectivity with center via IP LAN
- SI1 port, Configurable RS232 or RS485 serial port (UART1)
    - RS232 Serial communication: MDLC protocol, User protocol non-MDLC, PPP over RS232 protocol, MODBUS Master protocol
    - RS485 Serial communication: MDLC protocol, User protocol non-MDLC, MODBUS Master
    - usage examples: management of local end node device, connectivity with center via external device
- USB port, USB 2.0 Host port (USB4)
    - MDLC protocol, IP RNDIS
    - usage examples: connectivity with center via external Radio
- USB port, USB 2.0 Device port (USB3)
    - USB device direct connectivity for configuration of MC-EDGE built-in RF modules
    - usage examples: CPS configuration of internal APX4000 radio

The following additional ports can be added to the CPU on an optional plug-in board:

T1- VA00290AA:

- APX port:
    - MDLC protocol via the internal built-in APX4000
    - usage examples: connectivity with center via ASTRO P25 IV&D
- LTE port:
    - MDLC and IP non-MDLC protocols via the internal built-in LTE modem
    - usage examples: connectivity with center via cellular LTE
- LoRa port:
    - LoRaWAN protocol via internal built-in LoRa RF module and internal LoRaWAN network.
    - usage example: connectivity with wireless LoRa end nodes

T2 - VA00973AA:

- SI2 port, Configurable RS232 or RS485 serial port (UART1)
    - RS232 Serial communication: MDLC protocol, User protocol non-MDLC, PPP over RS232 protocol, MODBUS Master, MODBUS Slave
    - RS485 Serial communication: MDLC protocol, User protocol non-MDLC, MODBUS Master, MODBUS Slave
- ETH2 port, LAN Ethernet 10/100 Mb/s
    - MDLC protocol, IP Non-MDLC protocol
- ETH3 port, LAN Ethernet 10/100 Mb/s
    - MDLC protocol, IP Non-MDLC protocol
- LTE port:
    - MDLC and IP non-MDLC protocols via the internal built-in LTE modem
    - usage examples: connectivity with center via cellular LTE
- LoRa port:
    - LoRaWAN protocol via internal built-in LoRa RF module and internal LoRaWAN network.
    - usage example: connectivity with wireless LoRa end nodes

T3- VA00983AA:

- SI2 port, RS232 serial port (UART1)
    - RS232 Serial communication: MDLC protocol, User protocol non-MDLC, PPP over RS232 protocol, MODBUS Master, MODBUS Slave
    - RS485 Serial communication: MDLC protocol, User protocol non-MDLC, MODBUS Master, MODBUS Slave
- SI3 port, Configurable RS232 or RS485 serial port (UART2)
    - RS232 Serial communication: MDLC protocol, User protocol non-MDLC, PPP over RS232 protocol, MODBUS Master, MODBUS Slave
    - RS485 Serial communication: MDLC protocol, User protocol non-MDLC, MODBUS Master, MODBUS Slave
- Aux DC Power Supply output connector

T3- VA00984AA (MICROHARD N920):

- SI2 port, RS232 serial port (UART1)
    - RS232 Serial communication: MDLC protocol, User protocol non-MDLC, PPP over RS232 protocol, MODBUS Master. MODBUS Slave
    - RS485 Serial communication: MDLC protocol, User protocol non-MDLC, MODBUS Master, MODBUS Slave
- 1xRS232 port - used for **internal** device connectivity-not available via front panel. e.g may be used by customers for own internal modem (originally

developed for connecting a 3’rd party Microhard n920 900 MHz spread spectrum wireless modem)

-

RS232 Ports

The RS232 ports can be configured to Async or Sync operation mode and they enable local connection of a PC with the STS to the RTU, direct connection of another RTU, connection of modems, radios, third-party PLCs and other devices. In addition, the MC-EDGE supports RS232 links to standard modem over PPP on the built-in serial ports and on the plug-in ports.

RS485 Ports

The RS485 ports permit up to 32 2-wire RS485 devices to be parallel-connected (multi-drop) onto one pair of wires for the exchange of data. Usage examples for RS485 is the interconnection among multiple RTUs in the same site or connection with various devices in the site to the RTU using the MODBUS protocol or a user defined protocol. The RS485 Connection Box is available to make this interconnection; or the installer may make the cables by using the small handset-size connectors commonly found on modular telephones. The RS485 port may operate at data speeds up to 115200 460 kbps (depending on the total wire length).

The RS485 specification calls for the circuitry to be capable of communicating at 10 Mbit/s for 40 feet (12 meters). At 4000 feet (1200 meters), maximum cable length, the data rate is reduced to 100 Kbit/s. There are other factors involved including the network configuration; wire characteristics, the device used, biasing resistors and termination resistors (see later) that can influence the data rate. One of the most frequently asked questions and one of the most difficult to answer is the speed/distance/number of drops tradeoff.

Different studies in the industry have given some of the following (often conflicting) results, however the table below provides a conservative estimate based on the assumption of a daisy chain topology with no stubs.

Data Rate (Kbps)	**Distance (feet)**	**Distance (meters)**
<100	4000	1200
200	2000	600
300	1000	300
400	800	240
500*	700	210

The following factors affect how far one can reliably transmit at a given data rate:

- Cable length: At a given frequency, the signal is attenuated by the cable as a function of length.
- Cable construction: Cat 5/6 24AWG twisted pair is a very common cable type used for RS485 systems. Adding shielding to the cable enhances noise immunity, and thereby increases the data rate for a given distance.
- Cable characteristic impedance: Distributed capacitance and inductance slows edges, reducing noise margin and compromising the ‘eye pattern’. Distributed resistance attenuates the signal level directly.
- Termination: A long cable can act like a transmission line. Terminating the cable with its characteristic impedance reduces reflections and increases the achievable data rate.

Although normally required at higher transmission frequencies, it is good practice to terminate the cable runs with a resistor equal to the characteristic impedance of the cable. This reduces the reflection of a signal when it reaches the end of the cable. Avoid adding a termination resistor at other locations as this can overload the driver and reduce the reliability of the data transfer. The distance can be increased by the use of repeaters.

IP Ports

The MC-EDGE IP ports: LTE, ETH, USB OTG, USB Host, RS232 PPP support MDLC over IP and non-MDLC-user application IP protocol.
The MC-EDGE APX port supports MDLC over IP.
The MC-EDGE LORA port supports LoRaWAN protocol

MDLC over IP

The MDLC over IP can be handled via digital radio, Cellular, LAN.
MDLC over IP is handled only on **UDP**/IP. From the network perspective, the MDLC layers are encapsulated as an application layer and transferred as standard UDP datagram via IP socket. The default port is 2002 and it is user-configurable via STS.

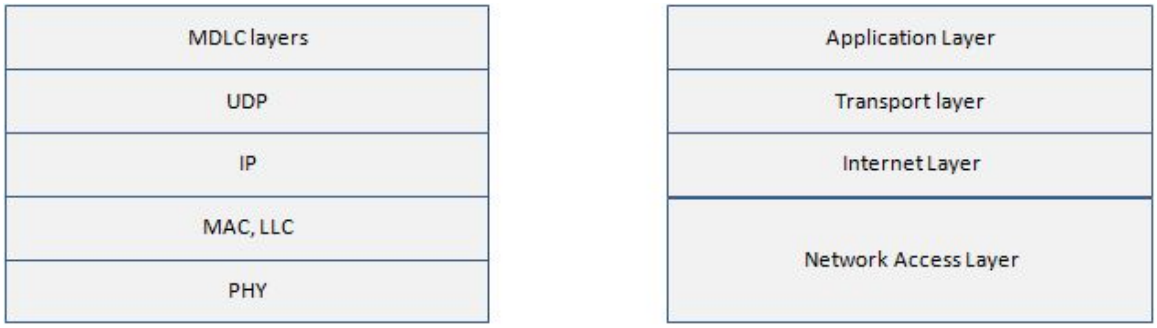

Figure 29 - MDLC enveloped over UDP/IP

The MDLC over IP is used for communication between RTU-RTU, RTU-FEP/IP GW, RTU-STS.

The MC-EDGE can have several MDLC over IP ports, each identified by its own link ID: MDLC over RS232 PPP ports, MDLC over LAN/Ethernet ports, MDLC over USB (RNDIS), MDLC over APX, MDLC over LTE.

Each MDLC over IP port has its own unique link ID. An IP address identifies each port, and is set by the user in a static LAN port (fixed IP address). For DHCP and PPP this address is learned automatically (dynamic IP address), and the user does not need to define it.

The usage of MDLC over IP ports depends on user definition and usage. The IP ports links can be configured as primary/secondary in which the MDLC mechanism automatically handles from which port the MDLC message is transferred or all IP ports can work simultaneously regardless of their status.

MDLC over IP - Broadcast and Setcalls

Most wireless packet data networks do not support broadcast IP. When transmitting a group call (Site 0), a separate frame is transmitted to each site specified in the IP Conversion Table over UDP/IP. If broadcast IP exists, this IP can be specified in the IP Conversion Table under Site 0 with the proper link ID (port). Sending to Site 0 with that link ID will transmit a single message, through that port, to all RTUs over UDP/IP using that address. Note that in ASTRO IV&D, LTE and most wireless media, this is not supported, so a separate message is transmitted to each site. It is preferable to transmit to each site separately, rather than send this setcall.

Dynamic IP Address

In a Dynamic IP address system, the RTU's modem IP address is not fixed and may be periodically changed by the network operator. For that, the RTU's IP address cannot be pre-configured in the FEP IP conversion tables. In such Dynamic IP address systems, the FEP is the only component that must have a **static fixed** IP address. The RTUs shall be pre-configured to know the FEP IP address. If the network operator assigns a host name to the FEP instead of a numeric address, this can be set in the IP conversion table. When the RTU detects that its modem is connected, it will notify the modem IP address to the FEP so the FEP will update its table in runtime.

Since this process does not guarantee that the FEP will be updated, it is highly recommended that user applications periodically send a message to the FEP so the FEP will always have the updated RTU modem IP address. For example, if the user application expects an interrogation every two minutes from the FEP, and it has not received that, it should send a message to the FEP. This will update the RTU address in the FEP.

MDLC over IP Port Routing

In the example mentioned in *Dynamic IP Address*, for RTU-to-RTU (modem to modem) communication, set the 'Enable routing of MDLC over IP port' parameter in the FEP. Then assign to the RTUs an IP conversion table which lists the RTU site IDs as having the FEP IP address.

Non-MDLC User Protocol over IP

All MC-EDGE IP ports can be used also for non-MDLC protocols - user application IP protocol. Users can enable an MC-EDGE IP port and define a port number for it on the MC-EDGE IP firewall. Then, a user can bind and create a relevant IP socket for it in their own developed application. For example, a user can use TCP/IP via LTE to transfer their own communication with the center. The user application IP non-MDLC usage can be handled via the MC-EDGE native linux environment, or via the IEC 61131-3 environment.

MC-EDGE Deployments

MC-EDGE MDLC over LAN/Ethernet

The MC-EDGE can communicate over Ethernet media, via the onboard CPU Host Ethernet port or via the optional plug-in Ethernet ports.

The figure below illustrates an example of an MC-EDGE system with FEP/IP Gateway and MC-EDGE RTUs connected to Ethernet LAN:

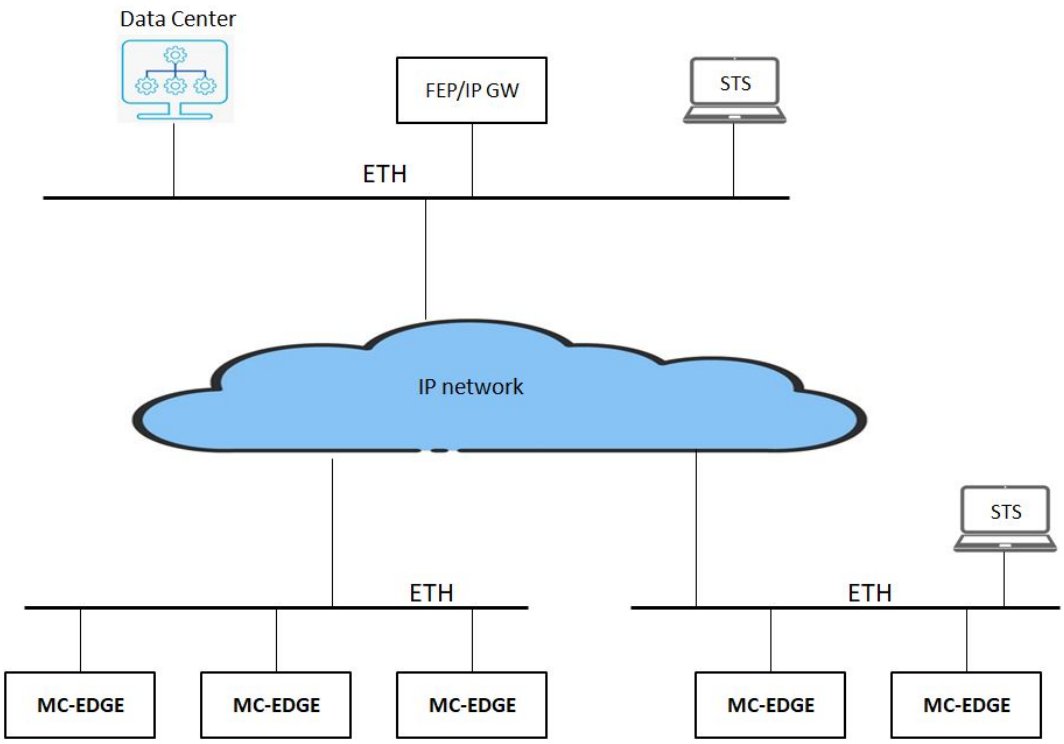

Figure 30 - MC-EDGE MDLC ver LAN/Ethernet deployment example

A number of connection methods are available when configuring an Ethernet-based RTU:

- Static IP address – The user sets the IP address within the configuration of the device in the STS. To use this method, follow the instructions for configuring an RTU in the "Operation" chapter in the *STS User Guide*. All DHCP parameters will remain at default values.
- DHCP-supplied reserved IP address – For every MC-EDGE RTU, an IP address will be reserved within the DHCP server. The link between the RTU and the reservation will be based on a unique ID. In the DHCP Server, set the unique ID. The default unique ID is the MAC address. In the DHCP server, define a reservation for a specific RTU based on its MAC address.
- DHCP-supplied dynamic IP address – A dynamic IP address is distributed from the DHCP server to the MC-EDGE RTUs. The IP address of each MC-EDGE device is unpredictable. In this case, you will need a DNS server that will resolve the link between the IP address and the RTU. You will have to supply a name for each RTU. This name will be updated within the DNS server along with the IP address of the RTU. Within the IP conversion table of MC-EDGE RTU, you will use this DNS name instead of the IP address.

The communication between the MC-EDGE RTUs and the FEP/IP-GW is handled via MDLC over UDP/IP.

When a FEP unit is used, the communication between the Data center and FEP is handled via MODBUS over IP. When an IP-GW is used, the communication between the Data center and IP-GW is handled via GW APIs.
The STS can be connected locally and/or remotely to each MC-EDGE.

MC-EDGE MDLC over ASTRO P25 Trunking IV&D

The MC-EDGE system can communicate via the ASTRO P25 IV&D radio network. The MC-EDGE with relevant optional plug-in board includes an internal ASTRO APX4000 radio to provide that connectivity. The FEP unit connection to the ASTRO may be handled directly via IP LAN on the CEN to the ASTRO Zone core or via external APX IV&D radio outside CEN.

The following figure depicts an example of MC-EDGE deployment over ASTRO IV&D where the FEP is installed on CEN:

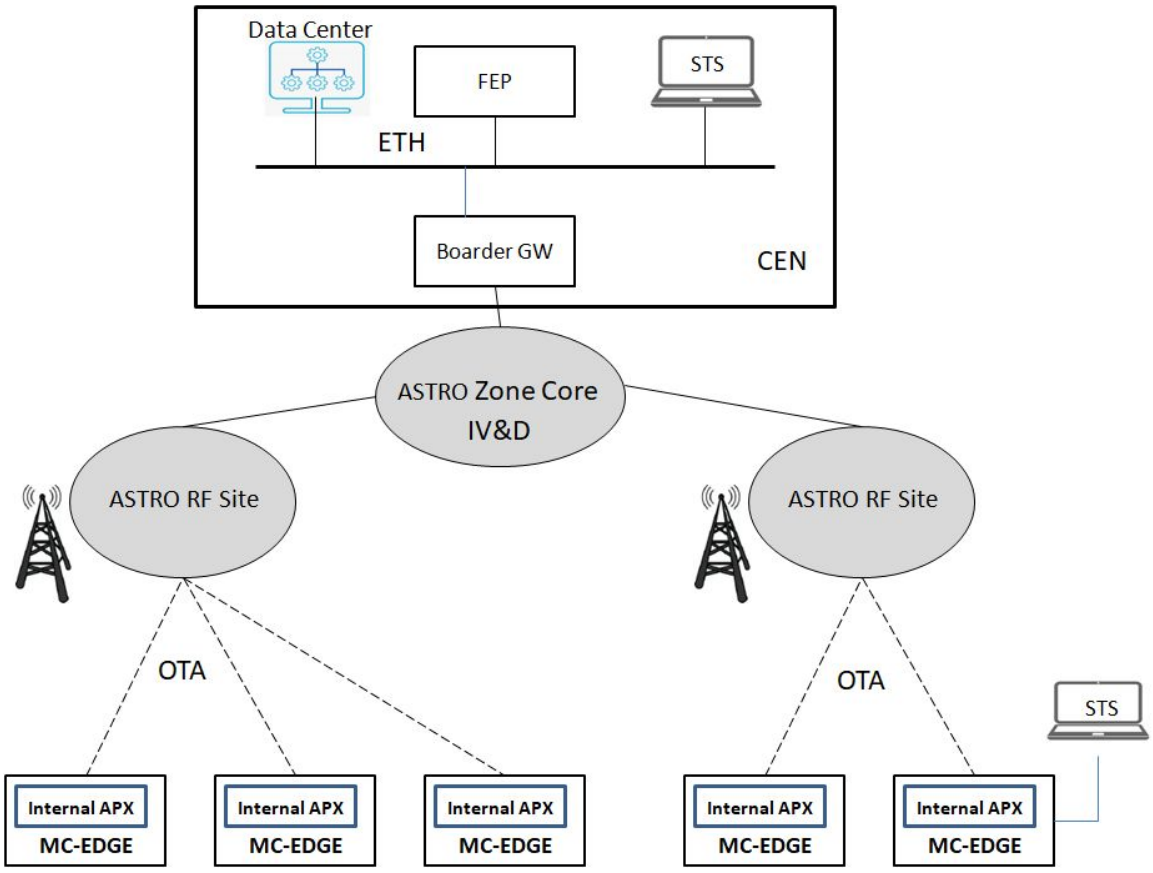

Figure 31 - MC-EDGE MDLC ver ASTRO P25 IV&D deployment example

The communication between the MC-EDGE RTUs and the FEP is handled via MDLC over UDP/IP.

The FEP communication with the Data center can be handled via MODBUS over IP. The STS can be connected locally and/or remotely to each MC-EDGE.

MC-EDGE MDLC over ASTRO P25 Digital Group Text Voice

The MC-EDGE supports capability of downlink messages from CEN towards MC-EDGE RTUs using the ASTRO P25 Group Text capability. The ASTRO Group Text is an existing ASTRO feature which allows to send a short text message from ASTRO console to a group of ASTRO subscribers via ASTRO Voice channel. By using the ASTRO Group Text the system deployment provides the following benefits:

- Faster message transfer
  ASTRO Voice channel has higher priority and preemption capability over ASTRO Data channel.
- Group Activation
  The message is transmitted to a set of pre-defined groups of subscribers. This prevents a use-case of triggering all system wide subscribers, even those not belonging to the required agency but still residing in the same region frequency.

Group Text limitation:
The ASTRO Group Text is unidirectional. It can only be activated from the control center Console towards subscribers and not vice versa. For message RTU reception, validation and interrogation from FEP on the IV&D is required.
The deployment requires ASTRO with a dispatch console site, MC-EDGE Proxy and SW to support it. The MC-EDGE proxy acts as a mediator between MDLC protocol with FEP and HTTPS protocol with Dispatch Console.
The following figure depicts an example of MC-EDGE Group text deployment:

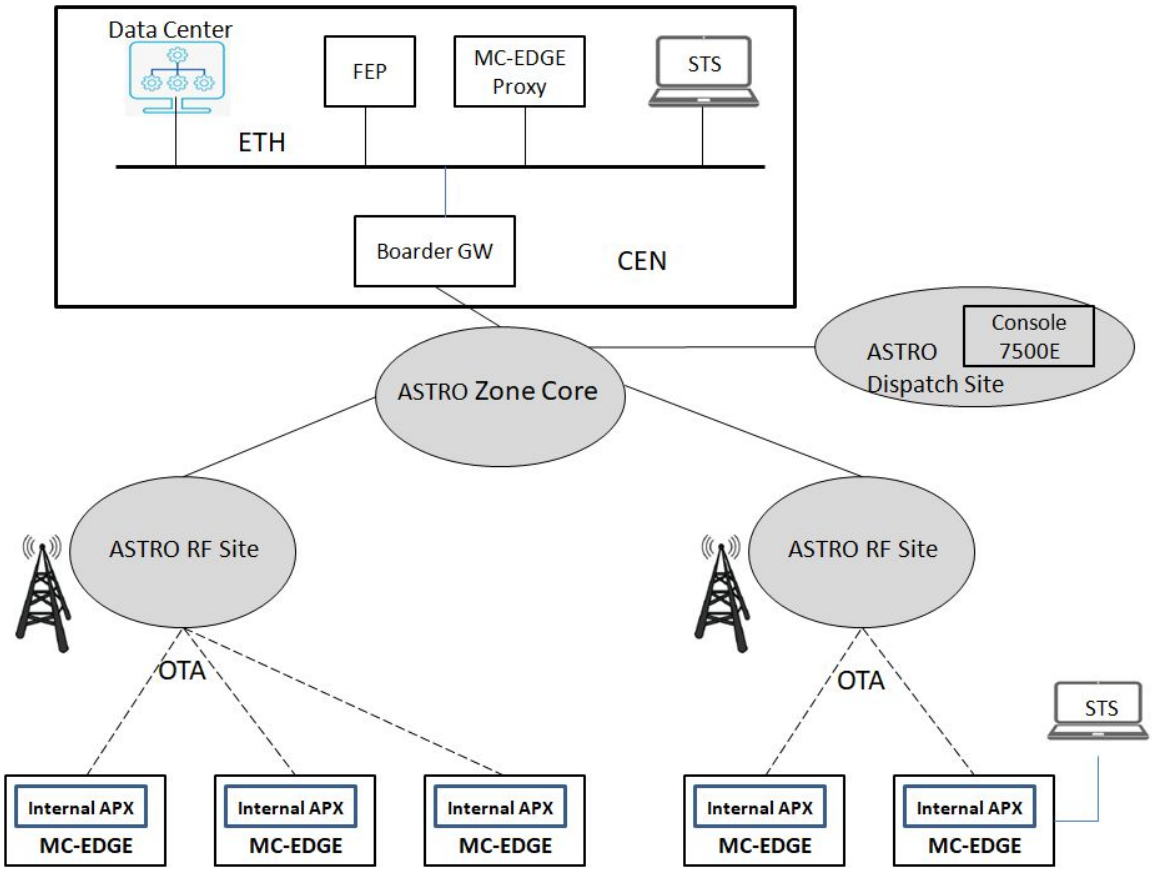

Figure 32 - MC-EDGE ver ASTRO Group Text deployment example

The communication between the MC-EDGE RTUs and the FEP is handled via MDLC over UDP/IP. The downlink Group Text message itself is handled as MDLC until the MC-EDGE Proxy and as Group Text message inside Voice channel frames from Dispatch Console till MC-EDGE internal APX4000. There is no uplink group text capability.

The FEP communication with the Data center can be handled via MODBUS over IP. The STS can be connected locally and/or remotely to each MC-EDGE.

MC-EDGE MDLC over ASTRO P25 Digital DMO

The MC-EDGE system can communicate via the ASTRO P25 DMO radio network. In this deployment, the MC-EDGE DMO is handled via external APX6500 radio connected to MC-EDGE USB Host port. The FEP DMO is handled via an external APX6500 radio connected to its RS232 ppp port.

The following figure depicts an example of MC-EDGE deployment over ASTRO DMO:

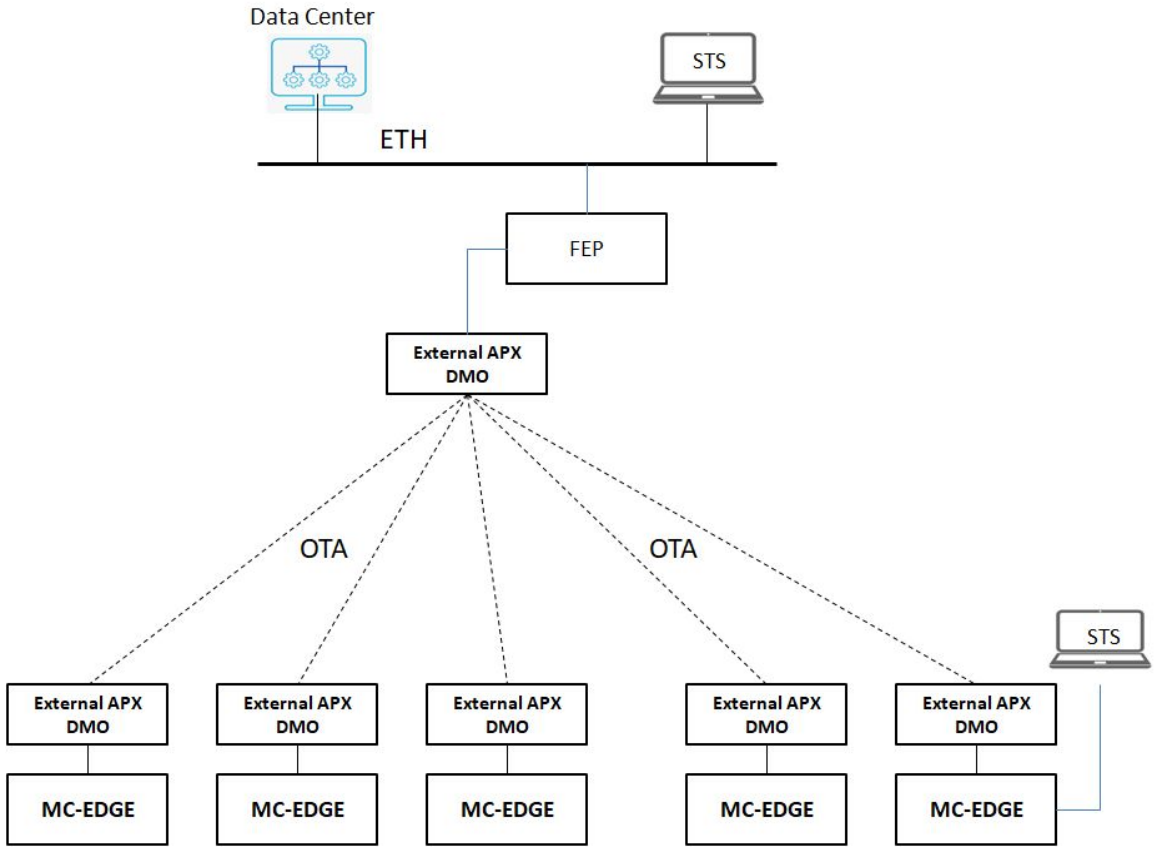

Figure 33 - MC-EDGE MDLC ver ASTRO P25 DMO deployment example

The communication between the MC-EDGE RTUs and the FEP is handled via MDLC over UDP/IP.

The FEP communication with the Data center can be handled via MODBUS over IP. The STS can be connected locally and/or remotely to each MC-EDGE.

The FEP via the external APX DMO supports two data downlink message types:

- Unicast - one to one message
- Broadcast - one to many message

The MC-EDGE using the external APX DMO will use unicast only for uplink.

Contrary to the ASTRO Trunking which can provide a system wide RF coverage in a state and even wider ranges, the DMO option is useful only for a limited region area.

MC-EDGE MDLC communication over Cellular

The MC-EDGE system can communicate via Public and Private LTE Cellular networks. The MC-EDGE with relevant optional plug-in board includes an internal cellular modem to provide that connectivity. The FEP itself is connected to the cellular network via an external modem connected on its RS232 ppp port.

The following figure depicts an example of MC-EDGE deployment over LTE cellular:

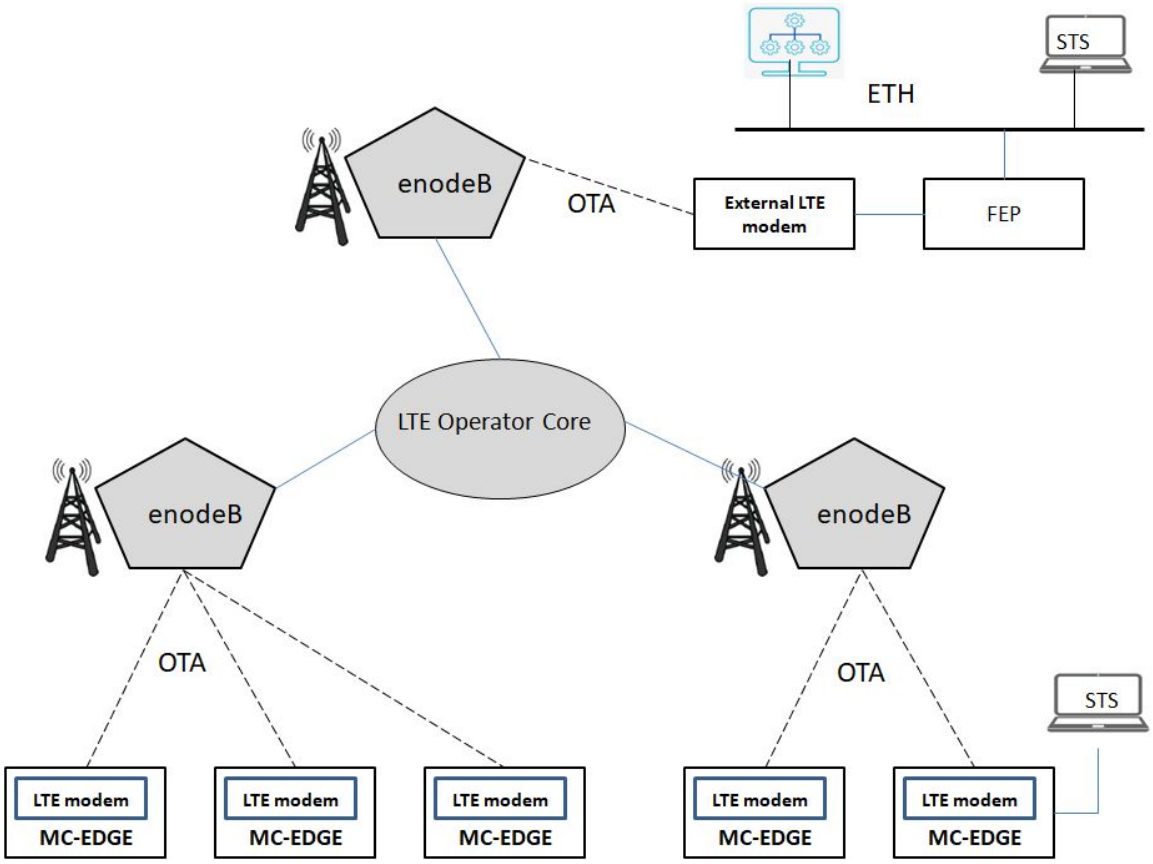

Figure 34 - MC-EDGE MDLC ver LTE deployment example

Cellular modem can be assigned with Dynamic or Static IP, according to the user's ordering agreement with Cellular operators. On Dynamic IP, the operator can set the modem IP to any IP address and it can change it to another IP at any time. In any case, the operator always ensures that the assigned IP is unique on its cellular network. On a static IP, the operator pre-assigns the modem IP and does not change it at any time. The MC-EDGE supports both options: Dynamic and Static modem IP. On a static IP system, the FEP can be pre-configured with all RTUs modems IP addresses, but on a Dynamic system there is no option to pre-configure that. So on a dynamic IP system, it's up to the RTU user application to make sure to transmit the FEP an MDLC message which will allow the FEP to "learn" that RTU IP address upon RTU startup, periodically, or on any IP change.
Regardless of whether the system is Dynamic or Static, the FEP is the only unit that **must** have a pre-configured Static IP so the RTUs will know how to approach it.

The communication between the MC-EDGE RTUs and the FEP is handled via MDLC over UDP/IP.

The FEP communication with the Data center can be handled via MODBUS over IP.
The STS can be connected locally and/or remotely to each MC-EDGE.

MC-EDGE MDLC communication over Analog Radio

The MC-EDGE system can communicate with MDLC via Analog Radio system. In this deployment the connectivity with Analog radio is handled via radio modem mediator. Both analog radio and radio modem are external to MC-EDGE.

The following figure depicts an example of MC-EDGE deployment over Analog Radio:

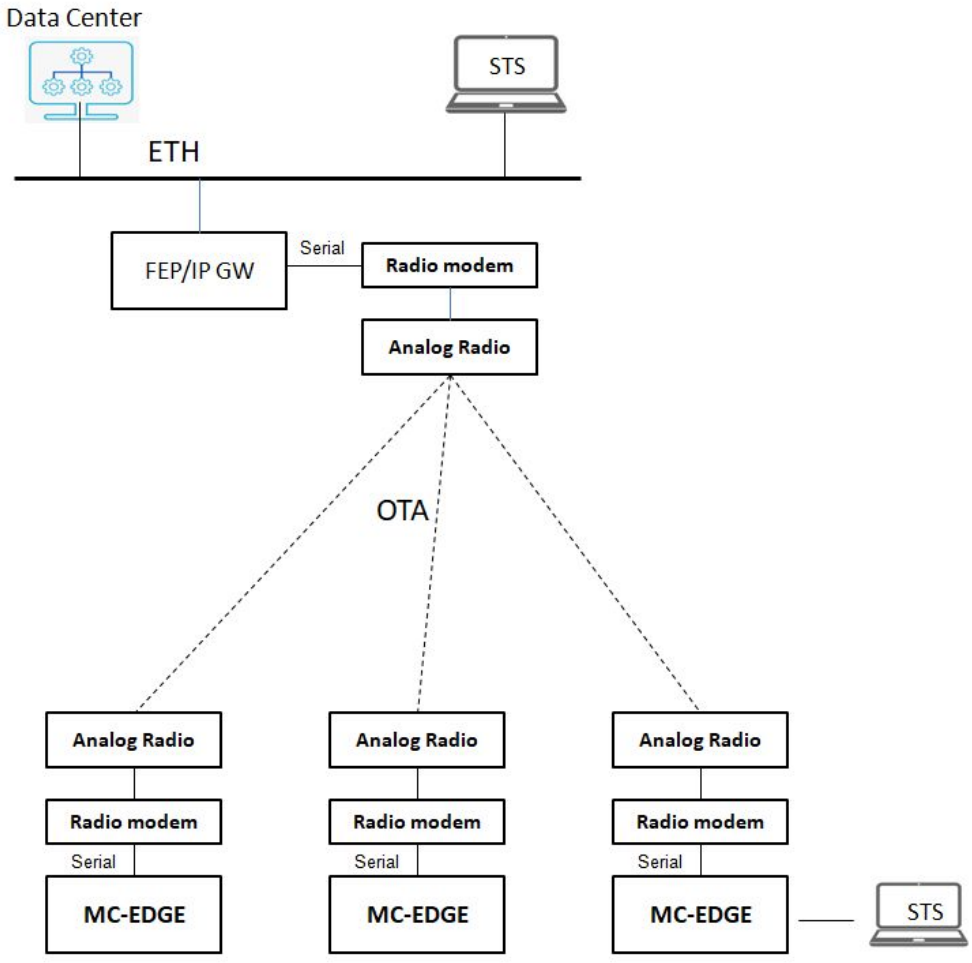

Figure 35- MC-EDGE MDLC over Analog Radio deployment example

The radio modem is a 3rd party component compatible with Bell 202 modem standard. On one side the radio modem is connected to MC-EDE RS232 serial line to receive/transmit MDLC frames over RS232, and on the other side the radio modem is connected to Analog radio via dedicated radio cable to transmit/receive data at a rate of 1200bps half-duplex encoded inside Audio Frequency Shift Key (AFSK).
The Analog radio itself is used to transfer the encoded MDLC AFSK OTA between RTU-FEP/IP-GW. The FEP/IP-GW is also connected to a same (3rd party) radio modem type via serial RS232 and Analog Radio.

The MC-EDGE Analog Radio feature can also fit customers having legacy ACE3600 Analog radio deployment and would like to expand or replace them with MC-EDGE.

The following figure depicts an example of combined MC-EDGE and legacy ACE3600 deployment over Analog Radio:

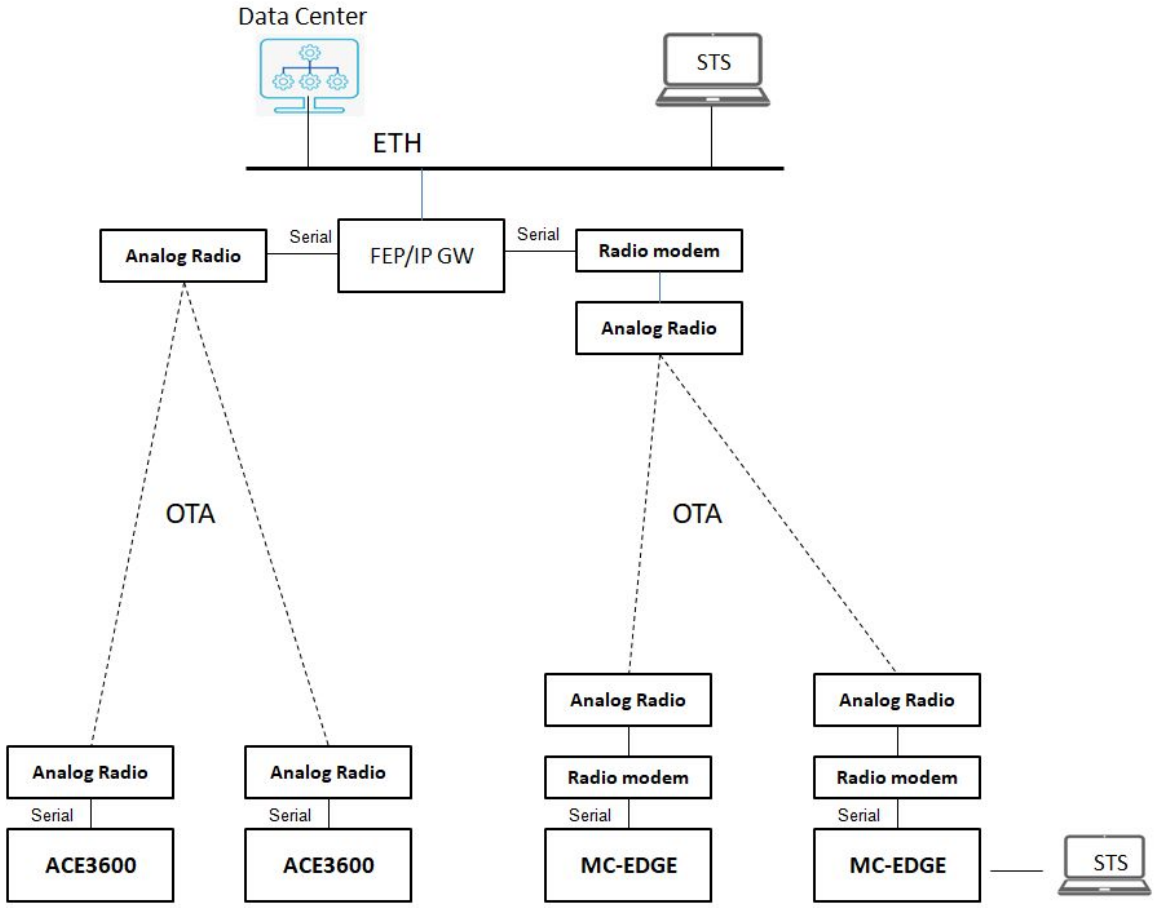

Figure 36-Mixed system MC-EDGE and ACE3600 MDLC over Analog Radio deployment example

The ACE3600 RTU is connected directly to Analog Radio without a Radio Modem mediator as the ACE3600 already contains within it a built-in FSK modem card.

The MC-EDGE Analog Radio can also be deployed in a store & forwarded system using radio reapers for use cases of no coverage or obstacles interference.

The following figure depicts an example of MC-EDGE and radio repeaters deployment over Analog Radio:

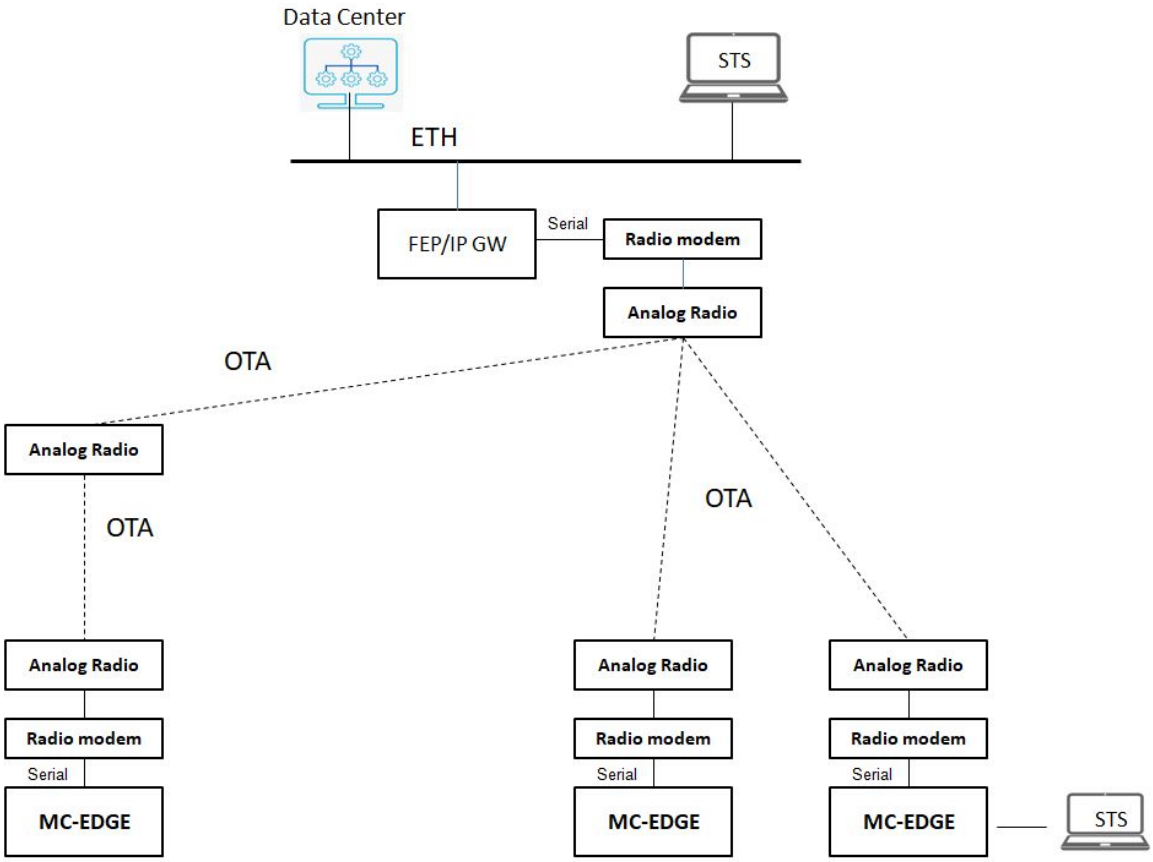

Figure 37- MC-EDGE and radio repeaters MDLC over Analog Radio deployment example

MC-EDGE MDLC communication over MOTOTRBO Radio

The MC-EDGE system can communicate with MDLC via Digital MOTOTRBO Radio system.. MOTOTRBO PCR supports several types of system deployments and in all of them the MC-EDGE RTU is connected with MOTOTRBO radio via USB. The FEP itself may be connected to MOTOTRBO radio via USB or to MOTOTRBO data core component -MNIS via ETh port.

The following figure depicts an example of MC-EDGE deployment over MOTOTRBO DMO:

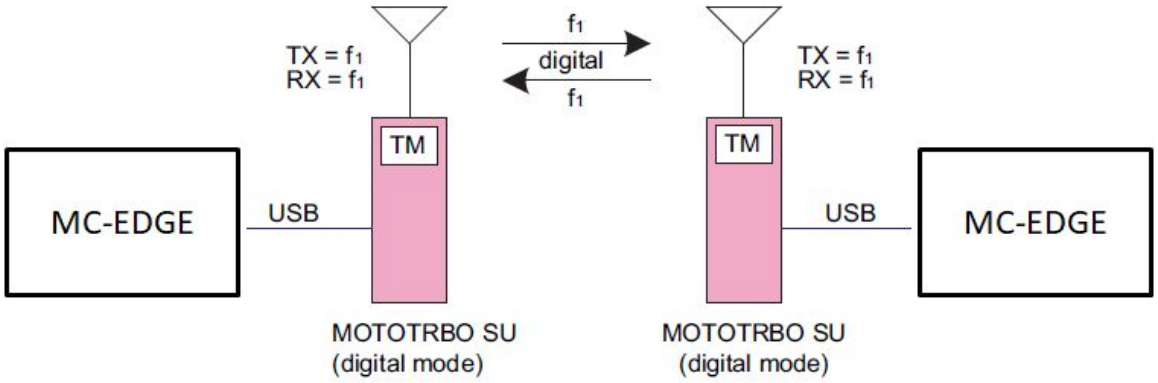

Figure 38- MC-EDGE MDLC over MOTOTRBO DMO deployment example

The following figure depicts an example of MC-EDGE deployment over MOTOTRBO Capacity Max:

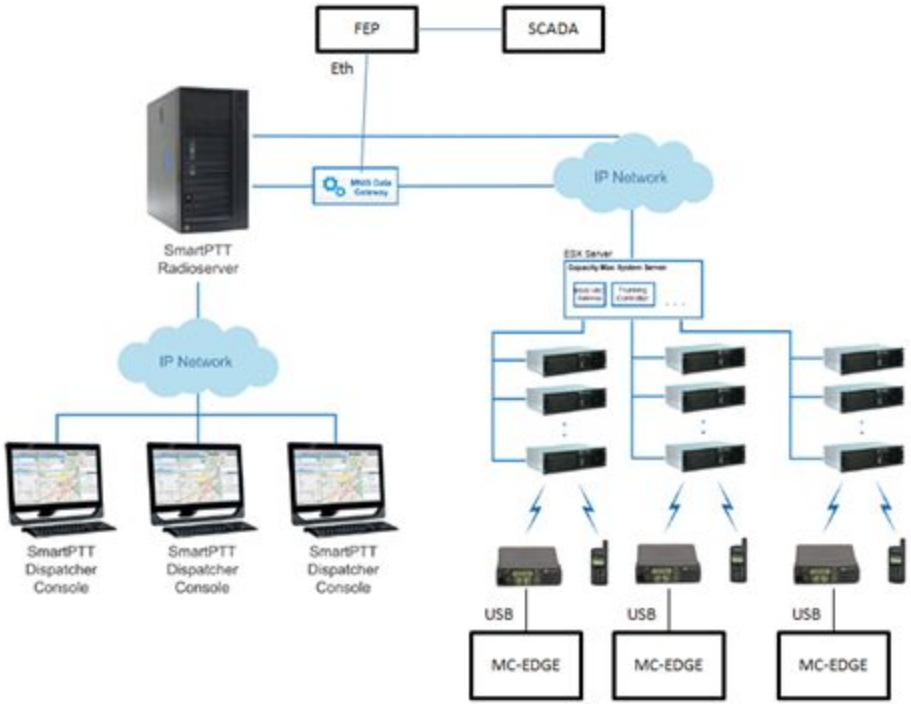

Figure 39- MC-EDGE MDLC over MOTOTRBO Capacity Max deployment example

MC-EDGE LoRaWAN

The LoRaWAN is used to handle communication with wireless LoRa end nodes for use-case such as monitoring, retrieving events, control. Each MC-EDGE provides a full LoRaWAN end-end termination. It includes iinetranly : LoRa GW, Join Server, Network server and Application server. The LoRaWAN protocol is terminated inside MC-EDGE and users can pull out the LoRa information via internal or external user application. The advantage of LoRa termination inside MC-EDGE is that it becomes similar to treatment like other wireline I/Os or devices. By that the LoRa information can be pulled by user application into MC-EDGE user tables and be handled towards the center via the MDLC. The MC-EDGE LoRaWAN supports connectivity with all LoRa end devices types: class-A, class-B, class-C.

The following figure depicts an example of MC-EDGE LoRaWAN using MDLC with center via ETH and LTE deployment:

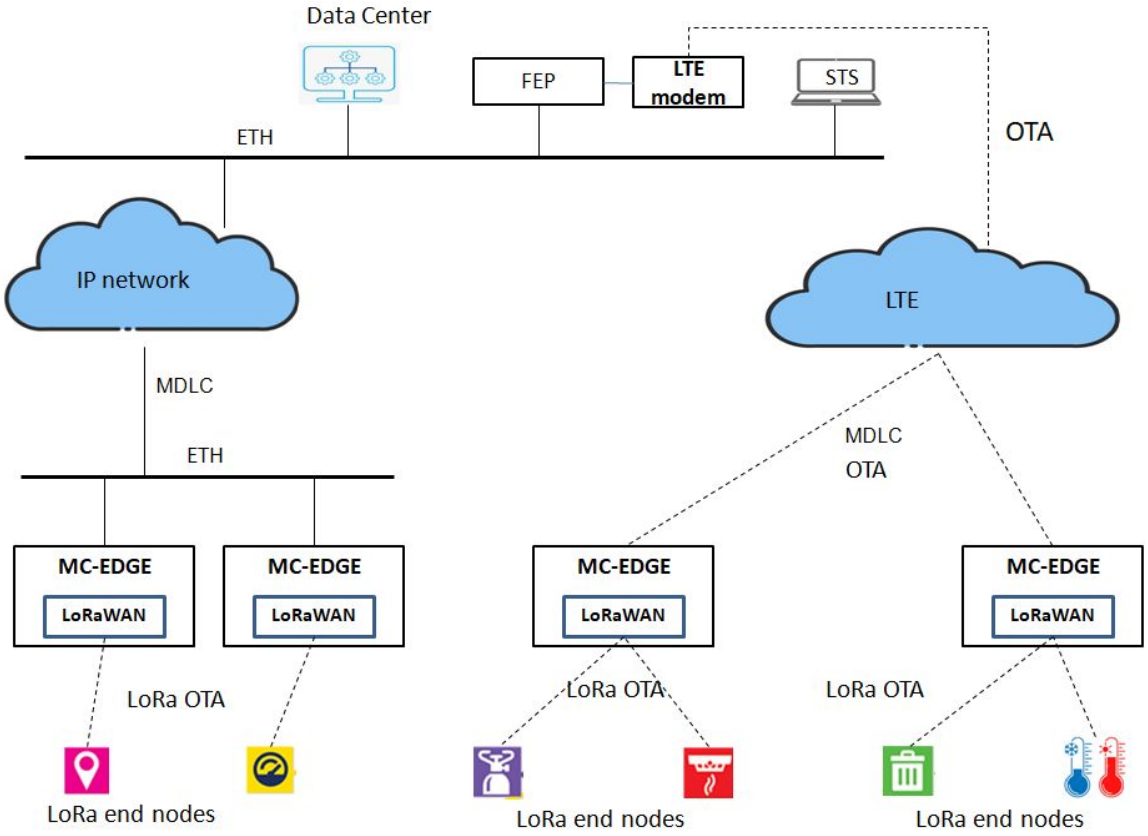

Figure 40- MC-EDGE LoRaWAN using MDLC communication with center example

The following figure depicts an example of MC-EDGE LoRaWAN using MQTT with center via ETH and LTE deployment:

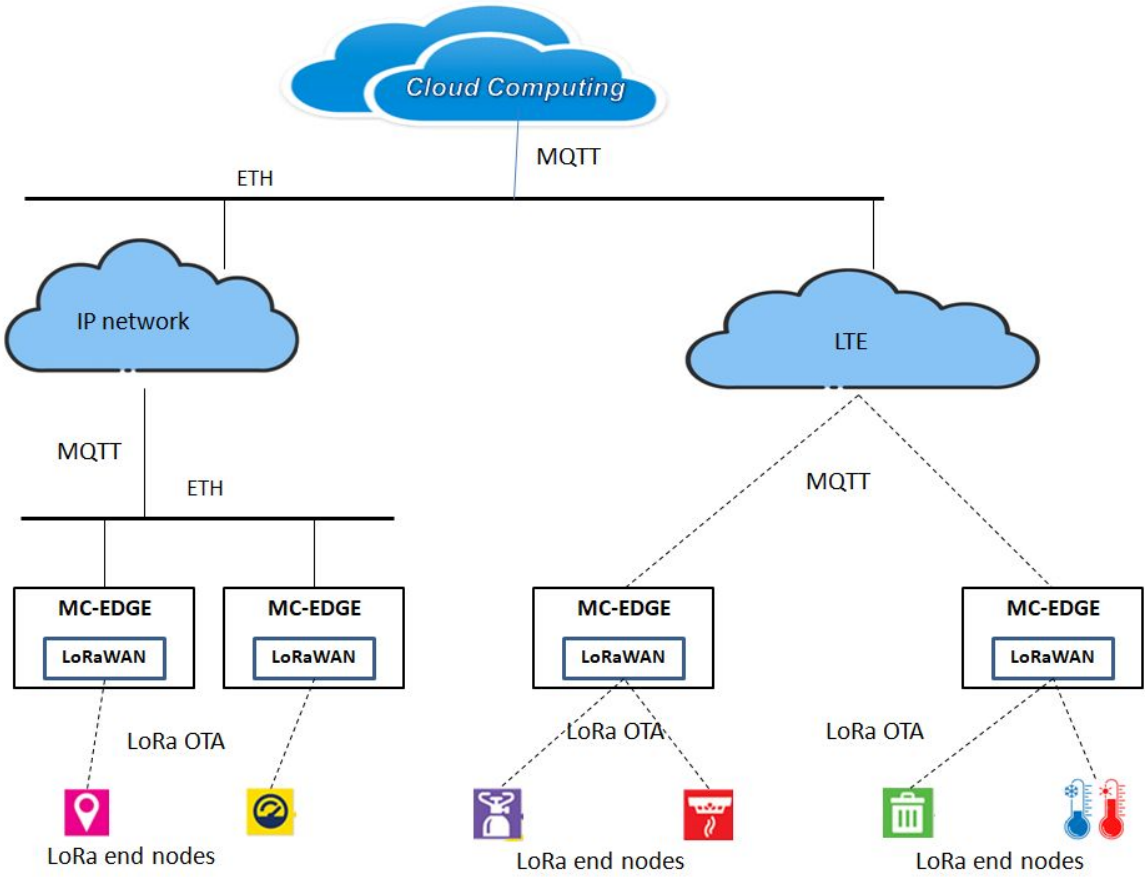

Figure 41- MC-EDGE LoRaWAN using MQTT communication with center example

The following figure depicts an high level architecture of single MC-EDGE including internally full LoRaWAN and its interaction relations to handle LoRa data:

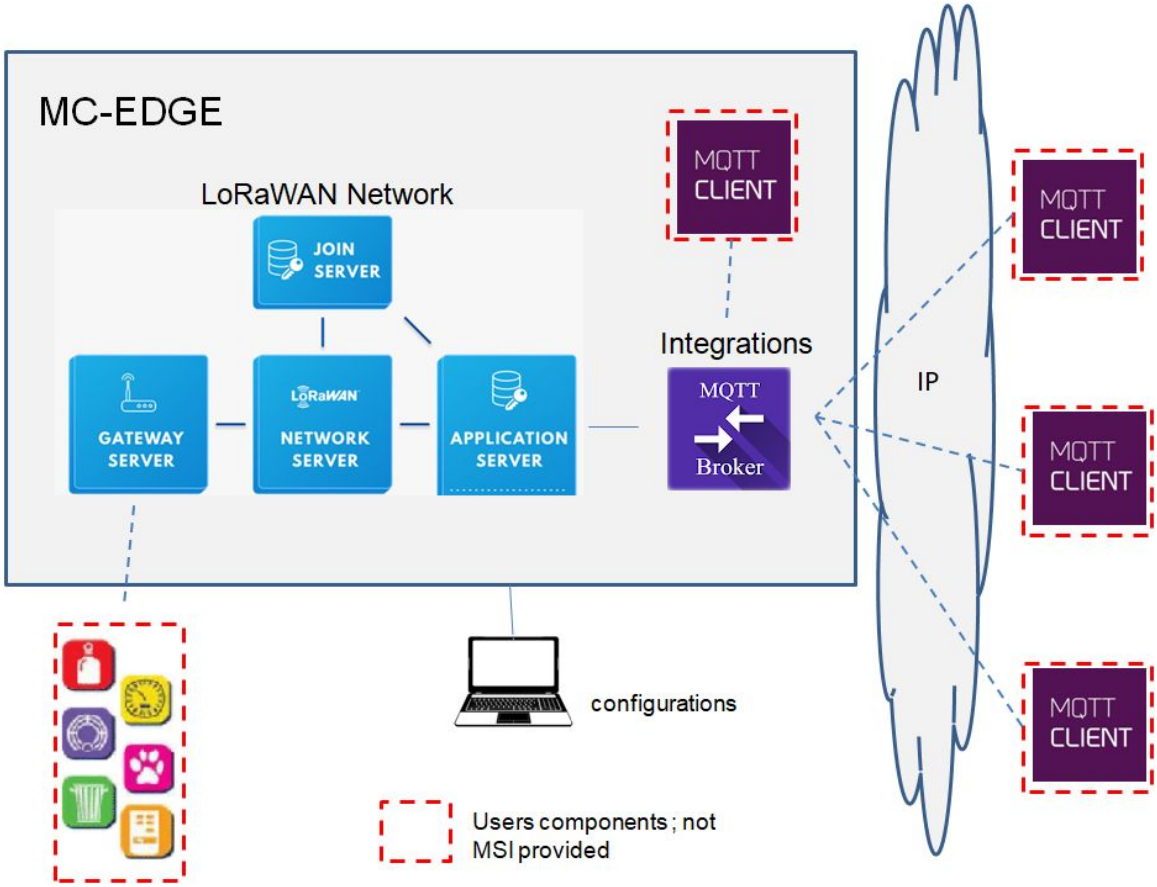

Figure 42- Single MC-EDGE including LoRaWAN to handle LoRa data using MQTT broker-client example

The MC-EDGE provides a built-in MQTT Broker "Integrations", This Integrations allows users to retrieve the LoRa end nodes information or send control to these nodes all from the LoRaWAN Application Server.
Users can develop their own internal application- MQTT client using the 'C' SDK environment to handle the LoRa end nodes via PUB/SUB against MQTT Broker "Integrations". The information can be saved on MC-EDGE users tables DB and transmitted out as MDLC over UDP/IP or it can be transmitted out in a user protocol over IP.
Users can also develop/provide external application- MQTT client and connect to MC-EDGE broker "Integrations" to subscribe and receive all LoRa information via TLS/IP.
The IP backbone may be ETH or LTE.

The MC-EDGE also supports a feature of MQTT Broker "Integrations" acting as a Bridge for external remote MQTT Broker. By this it allows users to connect the

MC-EDGE LoRaWAN with an external Data center/Cloud system which already arrives with its own built-in MQTT Broker.
The following figure depicts an example of the Bridge functionality:

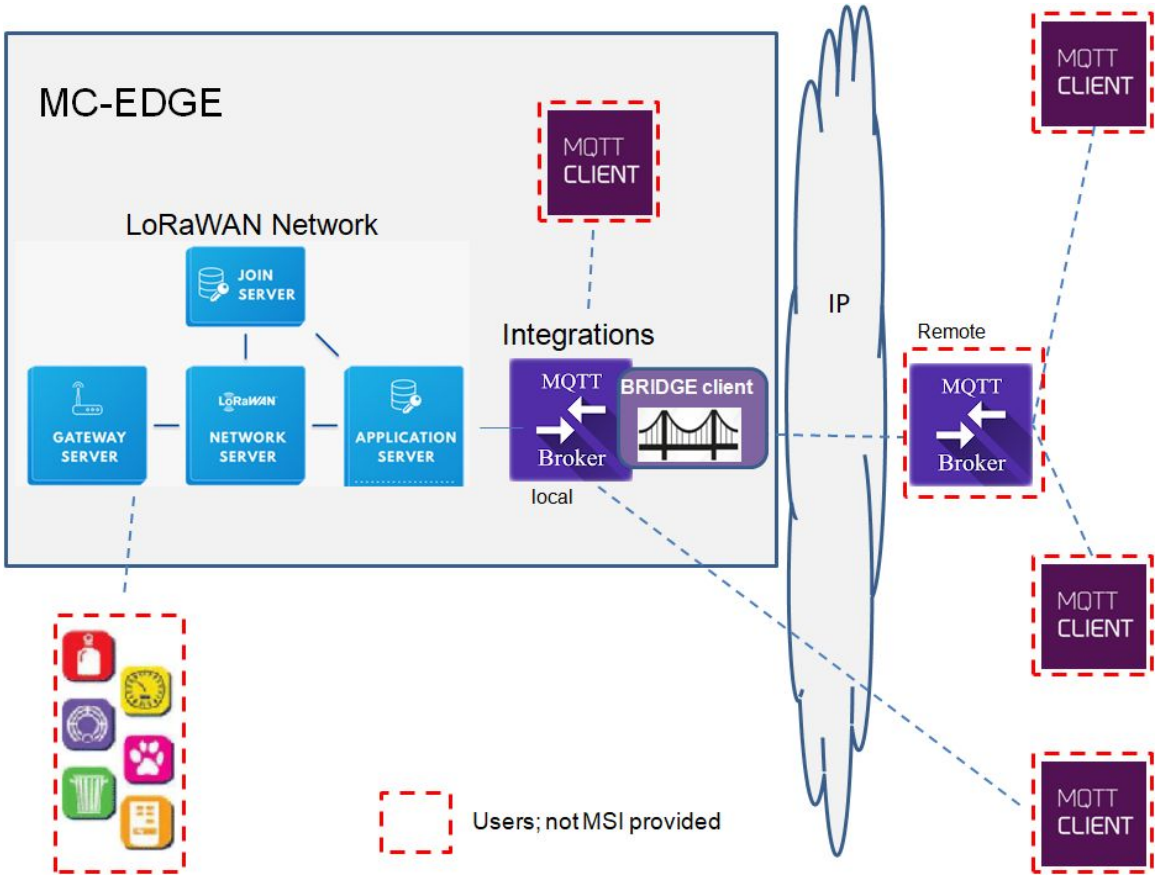

Figure 43- Single MC-EDGE including LoRaWAN to handle LoRa data using MQTT broker-client and broker-bridge example

The information received by the MC-EDGE LoRaWAN MQTT Broker can be "bridged" out as local broker to remote broker using MQTT PUB/SUB mechanism. The connectivity may be TCP/TLS and the IP infrastructure/backbone may be ETH or LTE.

IP Conversion Tables

The IP conversion table is created in the STS using the IP Conversion Table Manager. Note that unlike the network configuration, there is no default, and any IP conversion tables must be created manually. The IP conversion table maps sites in the system (site ID+link ID) to IP addresses or host names. Each site ID/link ID pair can have one unique entry in the table, though an IP address can appear in more than one row. A site ID of 0 is reserved for a group call.

In RS232/PPP and Ethernet DHCP, the IP address is read from the network once it is connected to the RTU. In Astro IV&D, this is not the real IP address set by the infrastructure; rather, it is a dummy address configured in the radio via the CPS Mobile Computer IP address which is by default 192.168.128.2. The IP conversion table does not specify this address, but the actual IP address assigned by the infrastructure operator.

The IP conversion table format includes a link ID column which allows more than one port in the same site to be connected to LAN or to PPP.

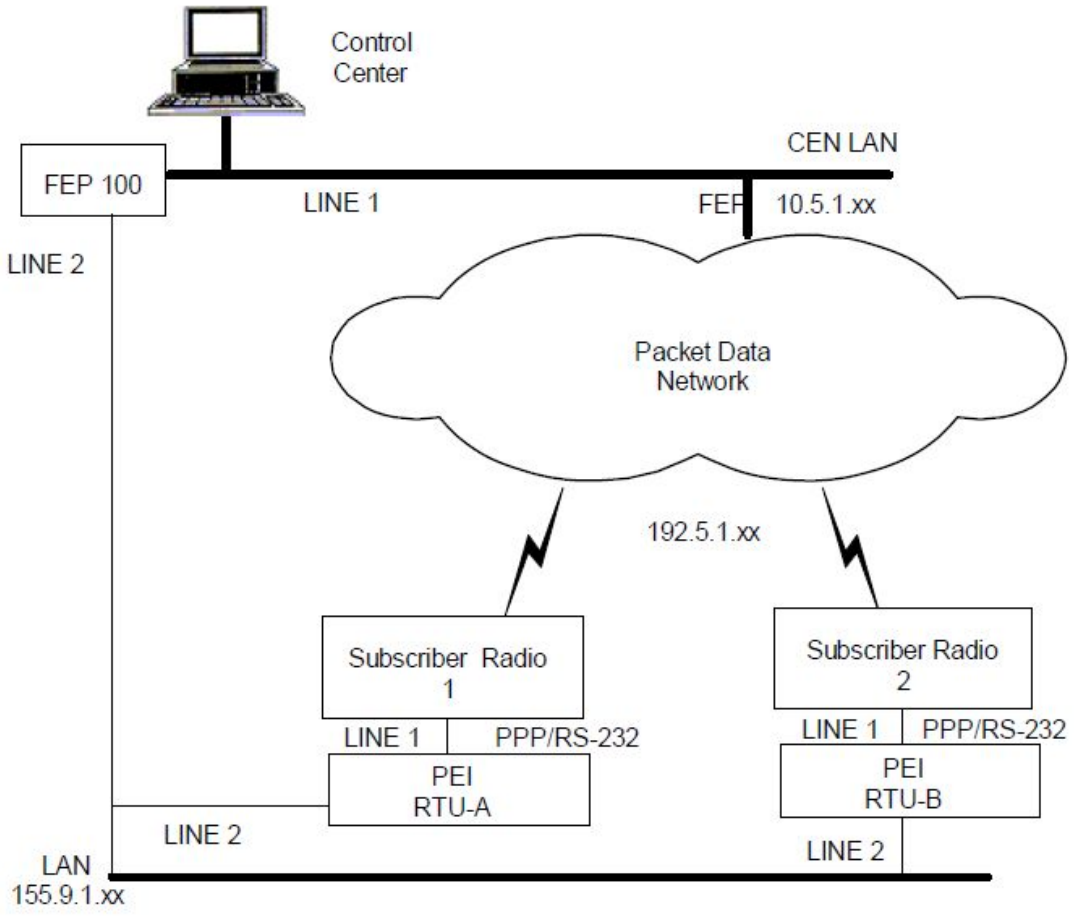

Figure 44 - IP-Sites example

In the example above, two sets of IP conversion tables should be created and the FEP's Table should be assigned to the RTUs:

The following IP Conversion Table should be loaded to the RTUs:

Site ID	Link ID	IP Address or Host name
100	LINE1	10.5.1.160
100	LINE2	155.9.1.17

The following IP Conversion Table should be loaded to the FEP:

Site ID	Link ID	IP Address or Host name
1	LINE1	192.5.1.161
1	LINE2	155.9.1.18
2	LINE1	192.5.1.162
2	LINE2	155.9.1.19

Network Configurations

The MC-EDGE system supports both simple and complex communication networks. The following sections describe different aspects of various configurations.

Single Link system

A single link system, consisting of a central computer and RTUs defined and connected over one communication link.

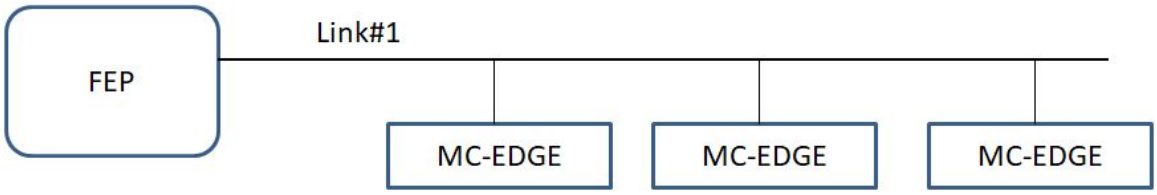

Figure 45- Single Link example

All the MC-EDGE MDLC communication deployments figure examples included in the MC-EDGE Deployments section (e.g MDLC over ASTRO) present a system with a single link.

Multiple Link Systems

A multiple-link system provides users with more than a single IP link backbone/infrastructure (e.g. ASTRO and LTE) an advantage of constant system availability. A multiple-link system can be configured to work in any of the following options:

- **Links defined with different coasting budget**
  In this option, each link is defined with different priority as primary, secondary, tertiary, quaternary and so on. In this option, the MDLC works only on a single link at a time starting with the primary. As long as the primary link has no communication issues, then the system continues to work with it. In the case that, for any reason, the primary link (temporary) fails, the MDLC mechanism automatically switches to work with the predefined secondary link, and so on. After each predefined period, the MDLC mechanism tries to return to work with the highest priority link. The advantage of this option is an automatic primary/redundancy capability, while the disadvantage is that the detection and switching links may take some time.

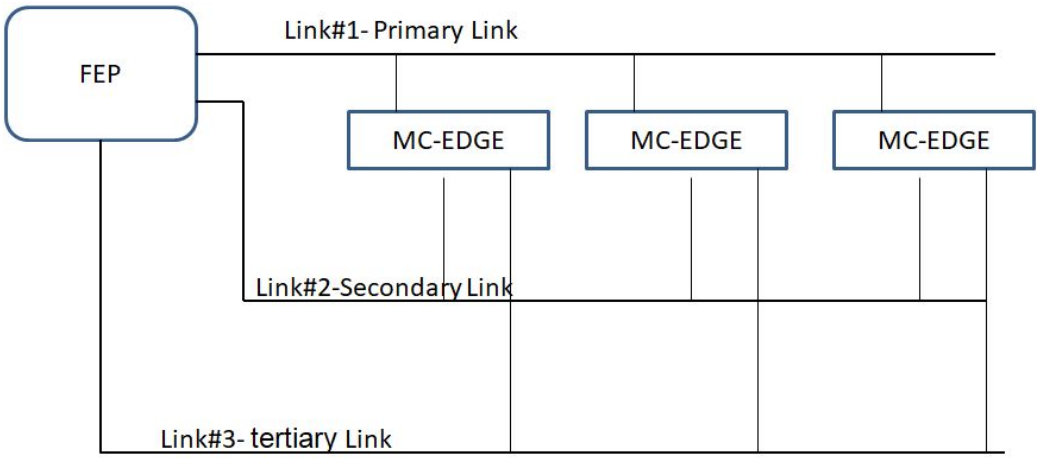

Figure 46- Multiple links with different coasting budget

- **All links defined with same coasting budget**
  A multiple link system can be defined with links of the same priority. In this system configuration, the user application will send the same message simultaneously on all links. The reception side will receive the same message from all/partial links. The advantage of this option is that the message will arrive at the fastest link for the current time and even if one of the links (temporarily) fails, the message will arrive at its destination from another link(s). The disadvantage of this option is that the receiving application needs to handle some logic as a frame index to know to handle only the first received message and through/ignore same message duplication received from other links,

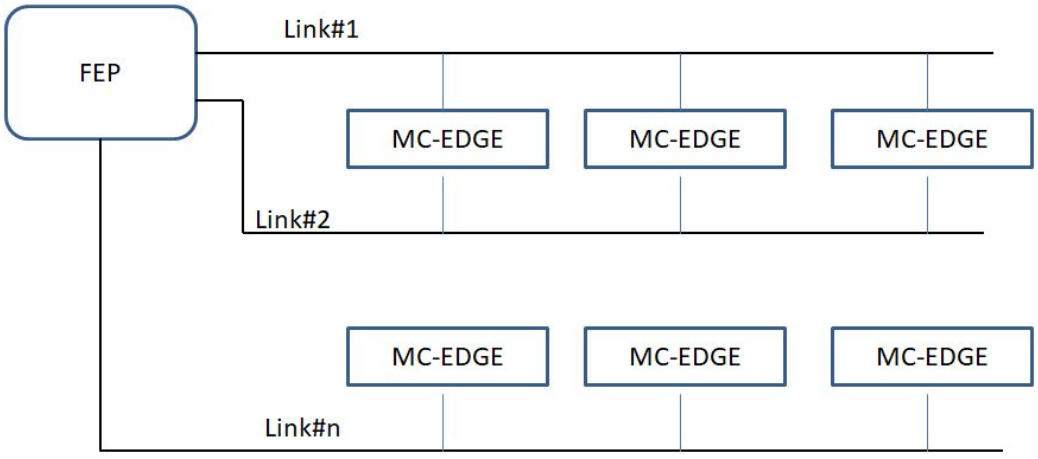

Figure 47- Multiple links with same coasting budget

MC-EDGE RTUs Multiple Links Deployment Example

The following figure depicts an example usage of MC-EDGE using multiple-links deployment:

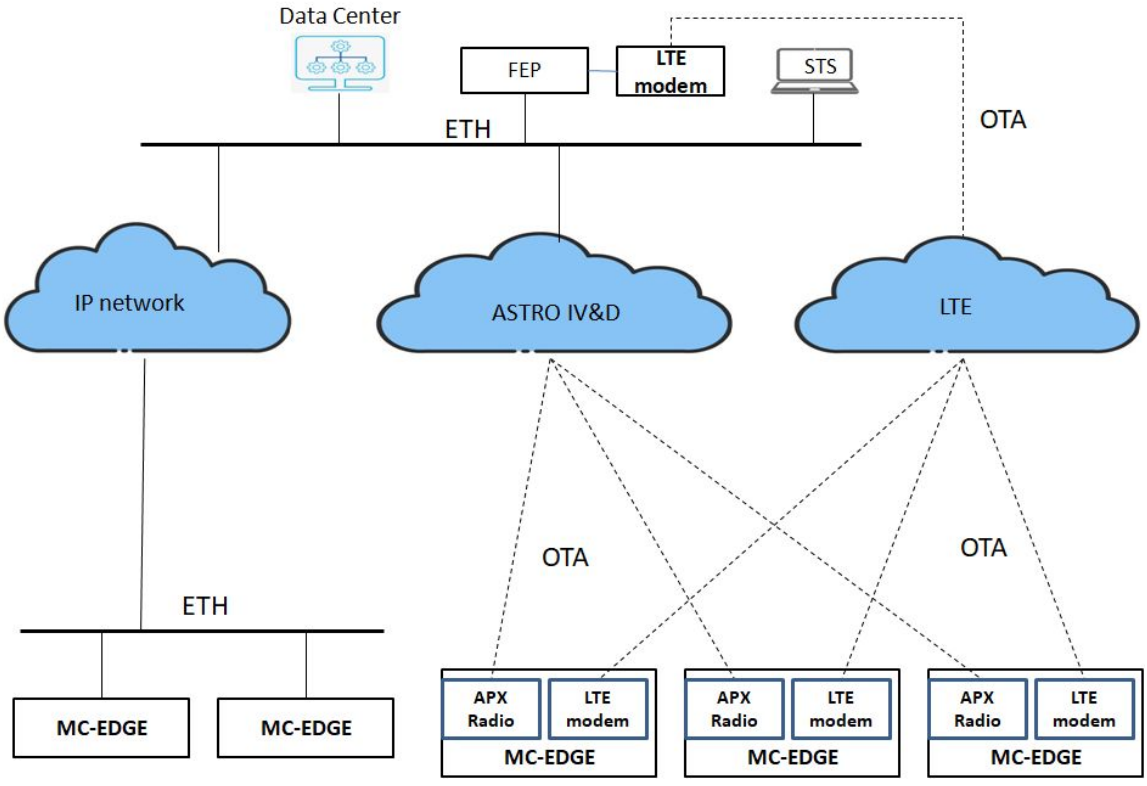

Figure 48- MC-EDGE with Multiple links Eth, ASTRO, LTE deployment example

Mixed System (MC-EDGE & ACE3600) RTUs Multiple Links Deployment Example

The following figure depicts an example of Mixed usage deployment involving MC-EDGE and Legacy ACE3600 RTUs using multiple-links deployment:

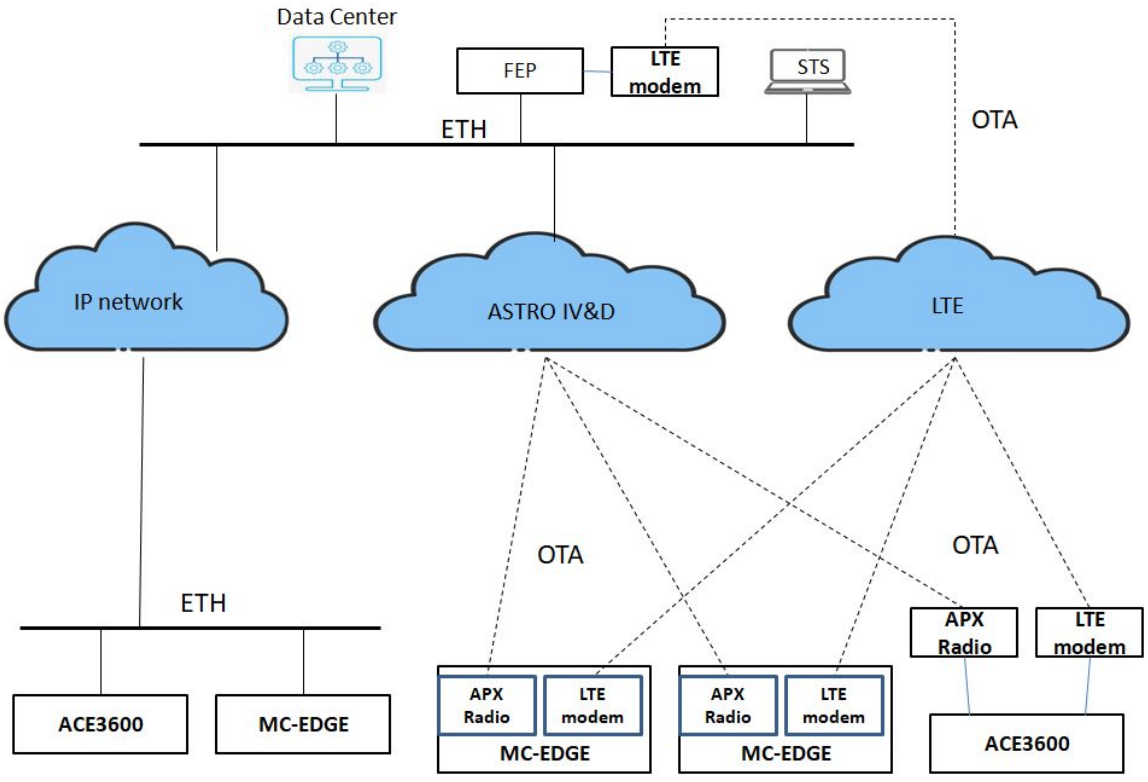

Figure 49- Mixed System RTUs with Multiple links Eth, ASTRO, LTE deployment example

MC-EDGE Non-MDLC IP protocol

The MDLC provides lots of benefits such as: same message transfer transparent to IP link type, automatic mechanism for primary/redundancy links, storing and forwarding messages, combination with legacy ACE systems, ability to communicate via NB private radio, lots of built-in utilities, automatic RTUs DB updates mechanism with FEP and more.

For users that, for any reason, would like to use a commercial standard protocol and not MDLC with a data center and have no (private radio) backbone/infrastructure limitation, MC-EDGE also supports that capability as an IoT concept unit. In such use cases, users can use the LTE or Eth ports for transferring messages with remote centers using any TCP/IP protocol handled by themselves.

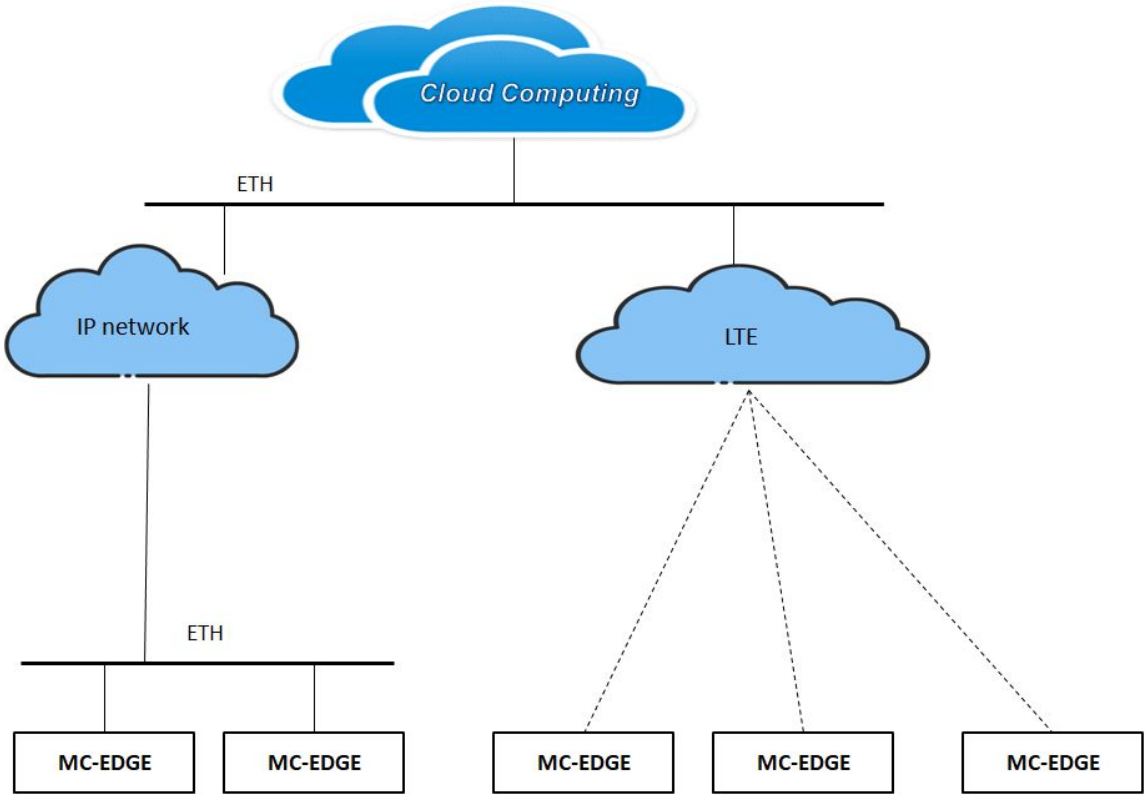

Figure 50- MC-EDGE with non-MDLC protocol usage example

As can be seen from the figure, when using non-MDLC protocol there is no need for FEP/IP-GW and the communication is handled directly with a server in the center. Such deployment can fit modern IoT ecosystems.

MC-EDGE Cyber Security Suite

The MC-EDGE supports a security suite to defend the system against security threats.

The security suite includes the following features:

- AES256 Encryption MDLC Traffic Messages
    - This feature encrypts the MDLC message contents so they can not be intercepted when they are transferred between RTU-RTU, RTU-FEP/GW.
- Users and M2M Provisioning
    - This feature provides provisioning management of system users. Only predefined users will be able to approach/configure/define the system and RTU parameters. Users can be defined with different priorities (Admin, tech…) and accordingly will have different system privilege capabilities on settings/readings/changing and other system operations.
- Users and M2M Authentication
    - This feature provides authentication of MDLC messages. It validates if the message has arrived from an authenticated source.
- MDLC messages Replay Attack prevention
    - This feature prevents the usage of recording messages attacks.
- Key Management Facility
    - This feature provides management of encryption keys, such as automatic keys change and keys creation.
- Security Logs recording and audit
    - This feature provides ability to record security events occuring in the system and to view the logs by provisioned users
- Encrypting Sensitive data on Rest
    - This feature saves sensitive information on MC-EDGE encrypted to prevent attempts to read it from RTU Flash.
- Security Files Digital signature verification
    - This feature handles signature verification on downloaded security files so MC-EDGE will verify the integrity before approving to apply them.
- IP firewall
    - This feature provides an IP firewall to allow only predefined specific TCP/UDP ports and block all other ports. In addition, users can define specific IP address range(s) that are allowed to be used in the system or allow any IP address.
- STS running capability over MSI Hardened Windows image with McAfee Anti Malware and McAfee Application Control
    - The Hardeneding protects the STS Windows OS, the application manager protects the STS sensitive directories.
- MSI Files signature verification

- This feature validates that only MSI provisioned files will be allowed to be installed on MC-EDGE.

For more details please refer to *MC-IOT Advanced System Security Guide*

Clock Functions and Synchronization

RTU Clock

The MC-EDGE includes an internal low drift Real Time Clock. The date and time are retained using an on-board rechargeable lithium battery. The rechargeable lithium battery provides backup power and data retention for the RTC. The MC-EDGE also supports daylight savings time as part of the time zone.

Time Adjustment and Synchronization

It is important for the system to be time-synchronized for several purposes such as security messages time stamp, recording log events with a proper time stamp, activating a predefined message on the same time/date and more. Each MC-EDGE is defined with the proper date/time upon staging procedure from STS. As the MC-EDGE RTC has some low drift it is required once in a while to sync all system components. There are several options to sync the MC-EDGE units time remotely when the system is active and running. All sync methods are handled via MDLC.

- STS Date & Time utility – From the STS, the user sets the RTU date/time to the PC's date/time (which is limited to second accuracy). For information on using the Date & Time utility, see the "Operation" chapter of the *STS User Guide*.
- STS Sync utility – From the STS, the user instructs the local RTU to synchronize (with milliseconds accuracy) the date/time of other RTUs attached to one or all links. It is recommended to synchronize all links, so that the entire system has the same date/time. For information on using the Sync utility, see the "Operation" chapter of the *STS User Guide*.
- FEP application – From the FEP application using MDLC message. In that case the FEP may be synced from an external lock source.

Appendix A: MC-EDGE Specifications

MC-EDGE General Specifications

The MC-EDGE general specifications are listed below.

Table A-1 MC-EDGE General Specifications

Attribute	Specifications
CPU MODULE	
Processor	TI Sitara Cortex A8 AM3356 microprocessor
Frequency	600 MHz (default)
MEMORY	
Flash	1 GByte, at least 32 MB available for user data
DDR	500 MByte LPDDR memory, at least 32 MB available for user data
SD Card Slot	Micro SD, up to 32 GB (card not supplied)
Optional user-supplied flash drive	Up to 32 GB on Sandisk Cruzer Blade (SDZ50-032G) or 4 GB on Sandisk Cruzer Blade (SDZ50-004G) (not supplied)
Operating System	Linux (Kernel version 4.59)
Real Time Clock	Hardware clock with year, month, date, day, hour, minute, and second supported.
Internal Backup Battery	The backup battery can maintain the RTC for at least 30 days@ +25ºC, when the main power is disconnected.
RTC crystal accuracy RTC crystal drift	±20ppm@25C or 2sec per day (24hours) @ 25C $\pm 0.04 ppm/(^0C)^2$
POWER IN	
Input Voltage	9-30 V DC
Power In Connector	5 mm pitch, Maximum 12 AWG
Power Consumption	CPU module: max 300 mA/typical 150 mA @12V (w/o SD card and USB) Input module: max 180 mA @12V/typical 100 mA@12V Output module: max 450 mA @12V/typical 250 mA @12V Sleep mode: typical 5.5 mA @12V
Auxiliary DC Power Out Connector	Optional auxiliary power output • Configurable to: 0 V (default), 5V/2A, 7.5V/2A, 9.5V/1.9A, 12V/1.5A, |Vout – Vin|> 2V Vout = Vin/2A @12V • Output voltage accuracy: ± 20%
ENVIRONMENTAL	

Physical Dimensions	7.6 cm (W) x 15.9 cm (H) x 11.8 cm (D) (3" x 6.3" x 4.7") (WxHxD) The depth of the unit including the front cover is 14.59 cm (5.74"). The depth to the tip of the grounding screw is 13.73 cm (5.41").
Weight	Approx. 0.5 kg
DIN Rail	Maximum thickness 1.0 mm Minimum length 26 cm
Operating Temperature	-40 ºC to +70 ºC (-40 ºF to 158 ºF) /-20 to+60 ºC for ATEX Model
Storage Temperature	-55 ºC to +85 ºC (-67 ºF to 185 ºF)
Operating Humidity	5% to 95% RH @ 50 ºC for 8 hours without condensation. For an uncontrolled humidity environment, it is recommended to use a NEMA enclosure.
Housing Sealing	IP30
Mechanical Vibrations	Per EIA / TIA 603 Base-station, Sinusoidal 0.07 mm @ 10 to 30 Hz, 0.0035 mm @ 30-60 Hz
Operating Altitude	-400 to +4000 meter (-1312 to + 13120 ft)

Communication Ports	Serial RS232/RS485 port (configurable) - RS-232 up to 115.2 Kb/s - RS485 up to 460.8 Kb/s USB ports: - USB 2.0 On-the-Go - USB 2.0 Host Ethernet port : -10/100 Mb/s Optional plug-in ports with two RS232 ports: - Up to 115.2 Kb/s 2 isolated (2500 V) Optional plug-in ports with two Eth ports

CPU ON-BOARD I/OS

Digital Inputs

Total Number of Inputs	3 DI Wet inputs
DI Fast Counter Input Mode	Max 2.0 kHz (minimum pulse width 250 µS)
Max. DC Input Voltage	30 V DC
“ON” DC Voltage Range	+6 to 30 V DC
“OFF” DC Voltage Range	0 to +3 V DC
Input Current	Max 8 mA@30V DC
DI Isolation to CPU	2500 V

Digital Output	
Total Number of Outputs	1 Magnetically Latched (ML)
DO Max. Contact Ratings	2A@30VDC or 0.6A@30VAC
DO Isolation	1500 V

Maximum Number of I/O Expansion Modules	5

PROTOCOL SUPPORT	
MDLC	Serial/Ethernet/USB/Internal RF modules
MODBUS Master	Serial/Ethernet

CONFIGURATION & PROGRAMMING TOOLS	
STS	Configuration tool
CodeSys Programmer	IEC61131-3 compliant application
'C' Programming SDK	'C' Language API

Time Synchronization	MDLC
Security	SSL, SSH

MC-EDGE Input Module Specifications

The MC-EDGE input module (mixed DI/AI) specifications are listed below.

Table A-2 MC-EDGE Input Module Specifications

Attribute	Specifications
Total Number of Inputs	12 DI wet inputs 8 AI: 0-20 mA (4-20 mA), 0-5 VDC differential inputs
Digital Inputs	
DI Fast Counter Input Mode Frequency	Max 2.0 kHz (minimum pulse width 250 μS)
Max. DC Input Voltage	30 V DC
"ON" DC Voltage Range	+6 to 30 V DC
"OFF" DC Voltage Range	0 to +3 V DC
Input Current	Max 8 mA@30V DC
DI De-bouncing Filter	10, 20, 30, 40, 50 msec
Diagnostic LEDs	Status LED per each input
User Connection	2 Terminal Blocks, with maximum 12 AWG
DI Isolation to CPU	2500 V
Analog Inputs	
A/D resolution	16 bit (including sign)
AI Accuracy	± 0.1% of full scale
AI Temperature Drift	±25 PPM/C
AI Smoothing	User configurable
AI Scaling	User configurable (positive range only)
AI Fast sampling	User configurable: No filtering – 10 samples /sec 60 Hz filtering – 7.5 samples /sec 50 Hz filtering –6.25 samples /sec
Impedance	Voltage channels - range 0 -5 V, 200 K input impedance or Current channels - range 0 -20 mA, 250 Ω input impedance
Physical Dimensions	7.6 cm (W) x 15.9 cm (H) x 11.8 cm (D) (3" x 6.3" x 4.7") (WxHxD) The depth of the unit including the front cover is 14.59 cm (5.74"). The depth to the tip of the grounding screw is 13.73 cm (5.41").
Weight	approx. 0.5 kg (1.64 Lb)

MC-EDGE Output Module Specifications

The MC-EDGE output (mixed DO/AO) module specifications are listed below.

Table A-3 MC-EDGE Output Module Specifications

Attribute	Specifications
Total Number of Outputs	8 DO: 4 ML/4 EE Form C (SPDT) 2 AO: current (0-20 mA) or voltage (0-10 V)
Digital Outputs	
DO Frequency	Max 10 Hz
DO Max. Contact Ratings	2A@30VDC or 0.6A@30VAC
DO Isolation	1500 V
Output Arrangement	0-20 mA or 0-10 V DC voltage; no isolation between channels
D to A Resolution	12 bit
AO Accuracy	±0.1% of full scale @ 25 ºC
AO Temperature Stability	±0.5% of full scale @ all range
AO Internal Settling Time	1mS
AO Load	Voltage: >1K Ω Current: <1K Ω
Output Protection	Voltage output: short circuit current, max. 35 mA Current output: No-load voltage max. 31V DC
User Connection	2 Terminal Blocks, with maximum 12 AWG
Isolation to CPU	1.5 kV between output and module logic
Physical Dimensions	7.6 cm (W) x 15.9 cm (H) x 11.8 cm (D) (3" x 6.3" x 4.7") (WxHxD) The depth of the unit including the front cover is 14.59 cm (5.74"). The depth to the tip of the grounding screw is 13.73 cm (5.41").
Weight	approx. 0.5 kg (1.64 Lb)

MC-EDGE Regulatory Specifications

The MC-EDGE regulatory specifications are listed below.

Table A-6 MC-EDGE Regulatory Specifications

Standard	Specification
Safety	UL 60950-1 (UL listed) EN62368-1:2018

	CSA 22.2-950-1 AS/NZS 62368-1:2018 NOTICE: ETH2, ETH3, FLN0050A, FLN0051A, FLN0052A are limited to indoor use only for the outdoor need to add external protection device.
Emission	CFR 47 FCC part 15, subpart B (class A)
Housing Sealing	IP30
	EN61000 EN61000-3-2 EN61000-3-3 EN61000-4-2, level 3 EN61000-4-3, 10V/m EN61000-4-4, level 3
	EN61000-4-5, level 3
	EN61000-4-6, level 3
	EN61000-4-8, level 1 EN61000-4-11

Appendix B: Cables and Adaptors

General

This appendix provides the following information:

- Connection to a computer via RS232
- Connection to a modem via RS232
- Connection to a PLC/RTU/FEP via RS232
- Connection to a PLC/RTU/FEP via RS485
- Connection to a computer via Ethernet
- Connection to a computer via USB
- MC-EDGE CPU to MC-EDGE I/O Expansion Module Connection

Note: Only original Motorola MC-EDGE cables should be used.

For information on connecting the MC-EDGE to a radio via USB or RS232, see "MC-EDGE Radio Types and Installation Kits" in *MC-EDGE RTU Owner's Manual*.

Connection to a Computer via RS232

Use this connection to configure an MC-EDGE mixed system using the STS.

To connect the unit's RS232 serial port to a computer, use the RS232 data cable (FKN0022), which includes an RJ45-to-RJ45 cable (3008439S01) and an adaptor (0189968V32) with a male 9-pin, D-type connector.Add a null modem cable (female-to-female) which is not provided.See the figure below.

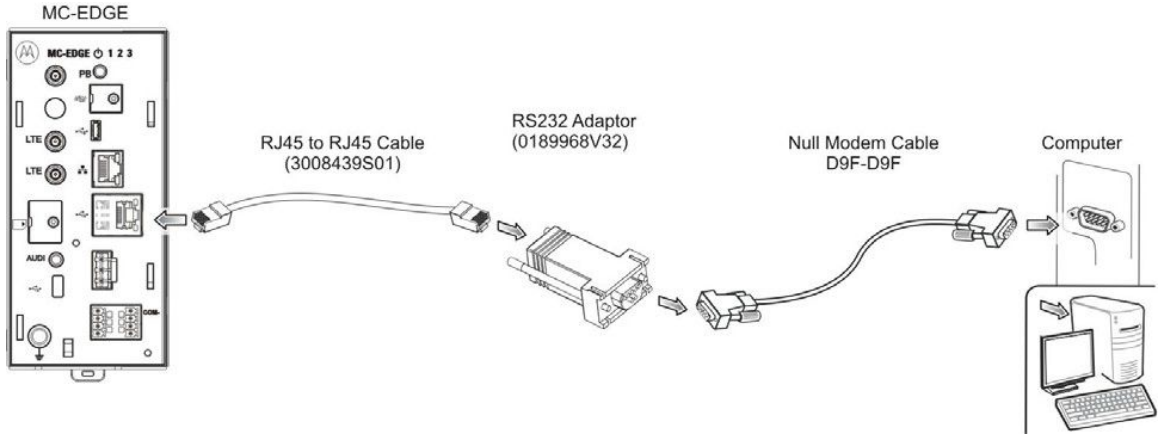

Figure B-01 Computer-RS232 Connectivity

The unit port is defined as an MDLC protocol port.The Flow Control parameter of the PC serial port should be set to None.
The signals that appear on the male 9-pin D-type connector are according to the RS232 standard. See the following table.

Table B-1 RS232-Computer Connection Pin Out

8-pin Connector (on RTU)	RS232 Adaptor (0189968V32) 9-pin D-type	Null Modem 9- pin Female (No flow control)	9-pin Male (on Computer/ Terminal)
7 (Rx) ←	2	3	3 (Tx)
8 (Tx) →	3	2	2 (Rx)
4 (DCD) ←	1	NC	7 (RTS)
1 (DTR) →	4	NC	8 (CTS)
2 (NC)	NC (not connected)	NC	6 (DSR)
5 (GND)	5	5	5 (GND)
6 (CTS) ←	8	NC	4 (DTR)
3 (RTS) →	7	NC	1 (DCD)
	NC	NC	9 (RI)

Connection to a Modem via RS232

Use this connection to communicate from an MC-EDGE unit over a modem.
To connect the unit's RS232 serial port to a modem, use the RS232 data cable (FKN0022), which includes an RJ45-to-RJ45 cable (3008439S01) and an adaptor (0189968V32) with a male 9-pin, D-type connector.See the figure below.

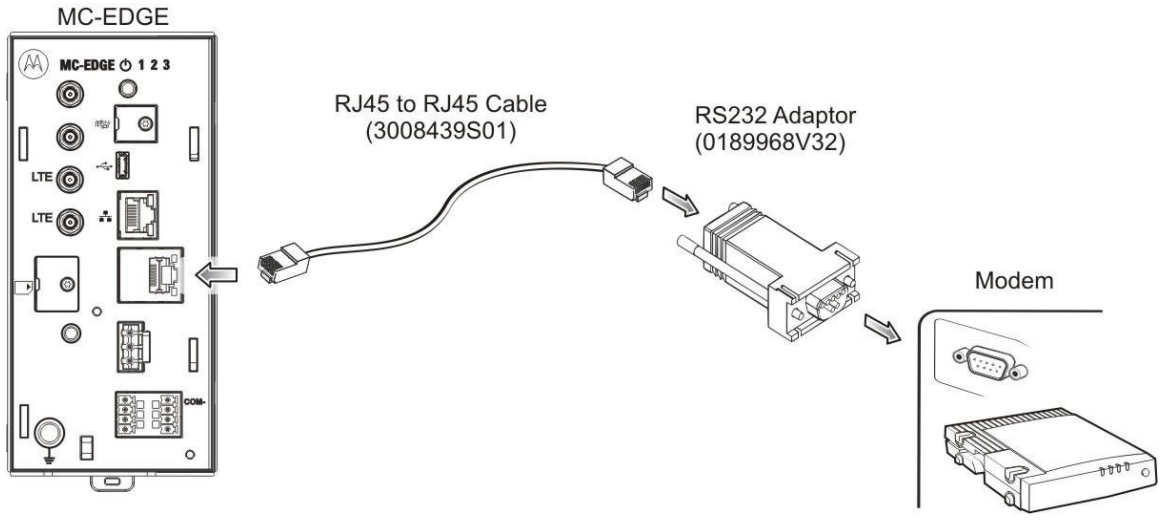

Figure B-02 RS232- Modem Connectivity

The unit port is defined as an MDLC protocol port.
The signals that appear on the male 9-pin D-type connector are according to the RS232 standard. See the following table.

Table B-2 RS232-Modem Connection Pin Out

8-pin Connector (on RTU)	RS232 Adaptor (0189968V32) 9-pin D-type	9-pin Female (on Modem)
7 (Rx) ←	2	2 (Rx)
8 (Tx) →	3	3 (Tx)
4 (DCD) ←	1	1 (DCD)
1 (DTR) →	4	4 (DTR)
2 (NC)	NC	6 (DSR)
5 (GND)	5	5 (GND)
6 (CTS) ←	8	8 (CTS)
3 (RTS) →	7	7 (RTS)
	NC	9 (RI)

Connection to a PLC/RTU/FEP via RS232

To connect the unit's RS232 serial port to a PLC/RTU/FEP, connect an RS232 data cable (FKN0022), which includes an RJ45-to-RJ45 cable (3008439S01) and an adaptor (0189968V32) with a male 9-pin, D-type connector, to each unit. Add a null modem cable (female-to-female), which is not provided, between the two data cables. See the figure below.

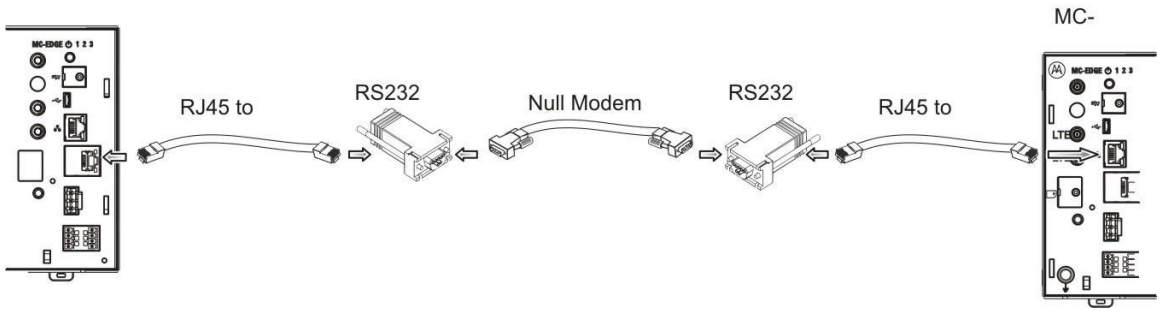

Figure B-03 RS232-RTU/FEP Connectivity

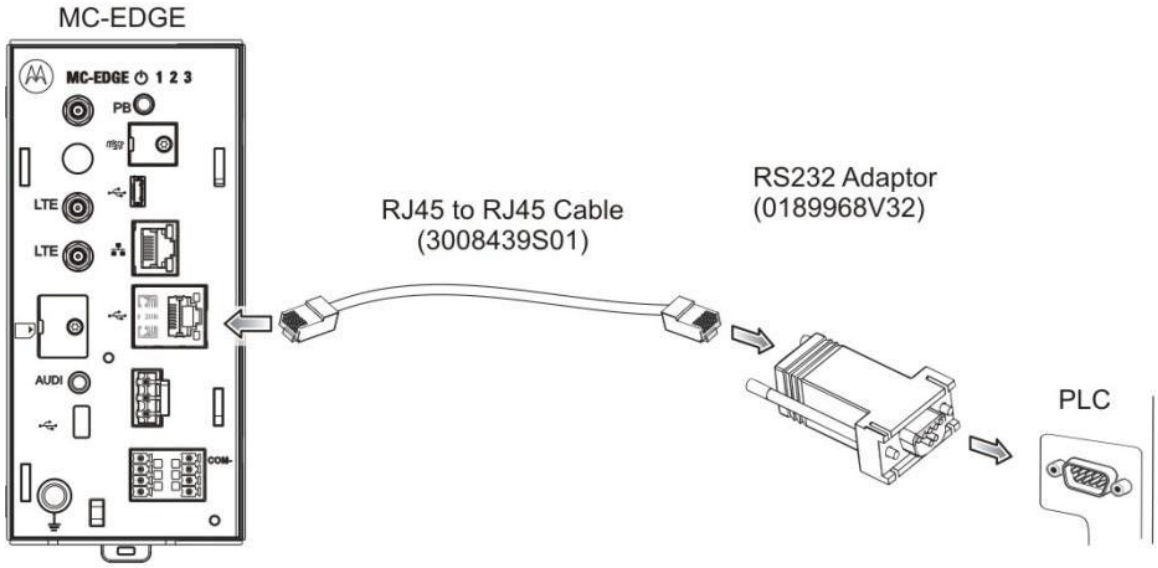

Figure B-04 RS232-PLC Connectivity

The unit port is defined as an MDLC protocol port.The connection between the RTUs/FEP can either be with partial flow control or with no flow control, based on the null modem setting.

The signals that appear on the male 9-pin D-type connector are according to the RS232 standard. See the following tables.

Table B-3 RS232-PLC/RTU/FEP Connection Pin Out without Flow Control

8- pin Connector (on RTU)	RS232 Adaptor (0189968V32) 9-pin D-type	Null Modem 9-pin Female (No Flow Control)	RS232 Adaptor (0189968V32) 9-pin D-type	8-pin Connector (on RTU/FEP)
7 (Rx) ←	2	3	3	8 (Tx)
8 (Tx) →	3	2	2	7 (Rx)
4 (DCD) ←	1	NC	1	4 (DCD)
1 (DTR) →	4	NC	4	1 (DTR)
2 (NC)	NC	NC	NC	2 (NC)
5 (GND)	5	5	5	5 (GND)

6 (CTS) ←	8	NC	8	6 (CTS)
3 (RTS) →	7	NC	7	3 (RTS)
	NC	NC	NC	

Table B-4 RS232-PLC/RTU/FEP Connection Pin Out with Partial Flow Control

8- pin Connector (on RTU)	RS232 Adaptor (0189968V32) 9-pin D-type	Null Modem 9-pin Female (with Partial Flow Control)	RS232 Adaptor (0189968V32) 9-pin D-type	8-pin Connector (on RTU/FEP)
7 (Rx) ←	2	3	3	8 (Tx)
8 (Tx) →	3	2	2	7 (Rx)
4 (DCD) ←	1	NC	1	4 (DCD)
1 (DTR) →	4	NC	4	1 (DTR)
2 (NC)	NC	NC	NC	2 (NC)
5 (GND)	5	5	5	5 (GND)
6 (CTS) ←	8	7	7	3 (RTS)
3 (RTS) →	7	8	8	6 (CTS)
	NC	NC	NC	

Connection to a PLC/RTU/FEP via RS485

To connect the unit's RS485 serial port to a PLC/RTU/FEP, use the RS485 adaptor cable (CB000207A01) which ends with a female 9-pin, D-type connector.

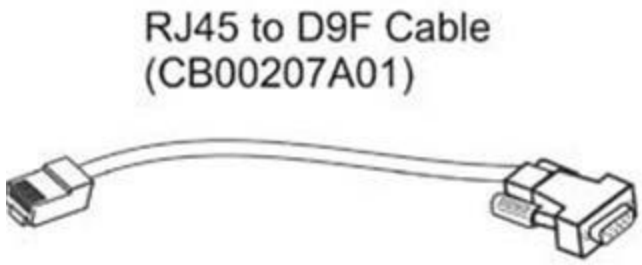

Figure B-05 RS485 - PLC/RTU/FEP Connectivity

The unit port is defined as an MDLC protocol port.
The signals that appear on the female 9-pin D-type connector are according to the RS485 standard with internal 120 Ω resistance. See the following table.

Table B-5 RS485-PLC/RTU/FEP Connection Pin Out

8-pin Connector (on RTU)	9-pin Female on Adaptor Cable (CB000207A01)
1 (Tx/RX+) ←	3 (Tx/RX+)
2 (NC)	1 (NC)

3 (NC)	2 (NC)
4 (NC)	4 (NC)
5 (GND)	5 (GND)
6 (NC)	6 (NC)
7 (NC)	8 (NC)
8 (Tx/RX-) ←	7 (Tx/RX-)

Connection to a Computer (Ethernet)

Use this connection to configure an MC-EDGE mixed system using the STS or to configure an MC-EDGE system using the MC-EDGE Easy Configurator.
To connect the RTU LAN port to a computer via Ethernet, use a standard Ethernet cable.

Connection to a Computer (USB OTG)

Use this connection to configure an MC-EDGE mixed system using the STS or to configure an MC-EDGE system using the MC-EDGE Easy Configurator.
To connect the RTU USB OTG (as device) port to a computer, use a USB 2.0 cable with a Micro-B connector.

MC-EDGE CPU to MC-EDGE I/O Expansion Module Connection

To connect the MC-EDGE CPU to an MC-EDGE I/O expansion module, or to connect one MC-EDGE I/O expansion module to another MC-EDGE I/O expansion module, use the 26 AWG RJ50 cable (#30013144001.)

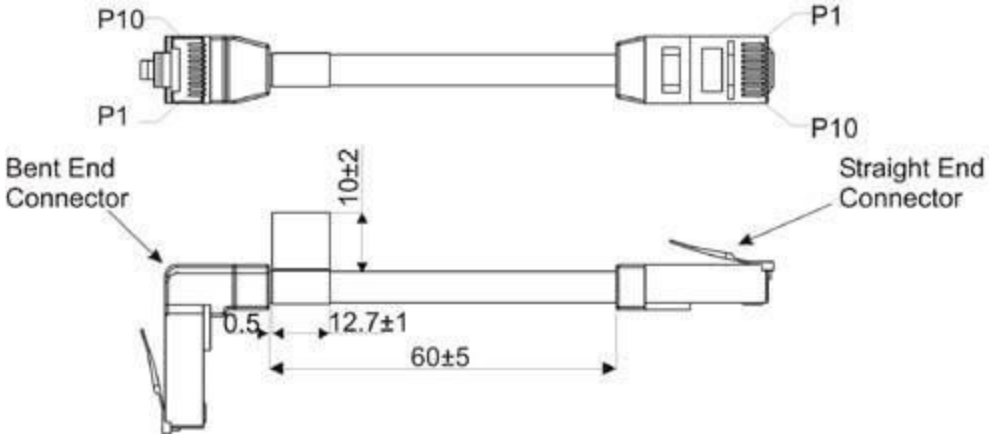

Figure B-06 MC-EDGE CPU to MC-EDGE I/O Expansion Module Connectivity

Table B-6 CPU-Expansion Module Connection Pin Out

Function	RJ50 Connector 1	RJ50 Connector 2
GND	1	1
GND	2	2

GND	3	3
CAN "-"	4	4
CAN "+"	5	5
CONFIG	6	6
RSV	7	7
PWR	8	8
PWR	9	9
PWR	10	10

Appendix C: MC-EDGE Security Recommendations

To protect MC-EDGE system against security threats, MSI recommends customer on the followings:

- Use MC-EDGE Cyber Security Suite (see details in “MC-EDGE Cyber Security Suite” section in this document)
- Deploy system components using private IP addresses and not public
- For LTE use private APN and static IP addresses (for details how to set the APN see *STS user guide* table 66- Advanced Physical Parameters. For private APN and static IP- customer needs to close agreement with his LTE operator)
- Protect CEN with firewalls and antivirus
- Protect PC (STS PC) with firewalls and antivirus
- Try to avoid system SCADA/FEP/IP-GW connectivity to the public internet
- Replace and maintain periodic replacement of MC-EDGE Linux passwords with customer own passwords (for details how to replace the default password see *MC-EDGE Owners Manual*)

- Use MC-EDGE and FEP/ACE IP GW IP Firewall (via STS) to restrict allowed IP address ranges (for details see *STS user guide*, “MC-EDGE firewall and hardening parameters” section)
- Close MC-EDGE and FEP/ACE IP GW “unused” ports (e.g LTE,APX,SI)- ports which are not required for deployment (for details see *STS user guide*, “Site configuration parameters” section)
- Close MC-EDGE TCP/UDP IP ports which are not required on field deployment (for details see *STS user guide*, “MC-EDGE firewall and hardening parameters” section)