



GO Bus Radio Communication Devices Installation Standard

MX-STC-STD-003

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Date: May 2023

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Preface

This is the first edition of the GO Bus Radio Communication Devices Installation Standard. Metrolinx owns a fleet of over 500 buses which demands safe and reliable radio communications with the Network Operation Center. The GO Bus Radio Communication Devices Installation Standard establishes a specified platform and installation procedure for radio equipment that are to be followed and applied in the installation of the UHF mobile radios by Metrolinx radio technicians, vendors, or contractors.

The technical content within the GO Bus Radio Communication Devices Installation Standard was developed by the Metrolinx Signals and Communication, Radio Systems office within Engineering and Asset Management Division. This Standard is available for external users to download via the Metrolinx public download site at http://www.gosite.ca/engineering_public/

Suggestions for revision or improvements can be sent to Metrolinx Signals and Communication, Radio Systems, Attention: Director, Signals and Communications who will introduce the proposed changes to Metrolinx Radio Systems. The Director, Signals and Communications ultimately authorizes the changes. A description of the proposed change shall be included along with information on the background of the application and any other useful rationale or justification. Proposals for revisions or improvements shall include your name, company affiliation (if applicable), e-mail address, and phone number.

May 2023

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1. Introduction

1.1 General

- 1.1.1 All GO Transit buses are provisioned with a mobile radio for the purpose of communication with Network Operations Center and other communication requirements in the Metrolinx Operating Area.
- 1.1.2 Mobile radios can be programmed with licensed or license-exempt frequencies. License-exempt frequencies are used by the general public, potentially interfering with other radio users on the same frequencies, limiting the use of license exempt frequencies to non-critical activities and non-professional or non-commercial radios. Besides, programming professional or commercial radios with license-exempt frequencies is considered a contravention to various federal acts. Innovation, Science and Economic Development Canada (ISED) considers this contravention as “operation of radio apparatus without a radio authorization”. Licensed frequencies are an asset and difficult to obtain, especially when such frequencies will be licensed to cover a large territory as the Metrolinx Operating area.
- 1.1.3 Metrolinx, as a provincial agency, will enforce all vendors, contractors and their employees to follow all federal regulations or acts, including the Radio Communications Act and operate only Commercial/Professional Radios with licensed frequencies for any work coordination within the operating area.
- 1.1.4 Metrolinx Radio Systems is licensed to use various Ultra High Frequencies (UHF) radio frequencies that are issued by ISED to be used throughout most of the Metrolinx Operating Area. As the licensed tenant, Metrolinx will supply radio equipment programmed with Metrolinx-licensed radio frequencies for work communications using Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA). Bus Operators shall follow the Metrolinx Radio Equipment and Communication protocols when operating bus-installed mobile radios.
- 1.1.5 This standard will be implemented across the entire GO Transit bus fleet to ensure installation consistency. The radio technicians will follow approved Metrolinx Radio Systems installation practices. Furthermore, the standardization of radio equipment installation and radio communication practices will create a baseline for installers to clearly define the requirement, and eliminate the possibility of radio interferences or mistakes that may occur when installing mobile radio equipment.

2. Definitions, interpretation, codes, and standards

2.1 Definitions

2.1.1 Capitalized terms used in this standard shall have the meanings prescribed in Table 1.

Table 1: List of definitions

Term	Definition
"Bus Operator"	Bus Operator is the person who drives and operated the bus.
"Channel"	In this document will be used as a short for Radio Channels
"Commercial/Professional Radios"	Higher tier radios with better performance and durability than general public radios.
"Digital Radio"	A Radio that includes digital audio processing circuits that enhances audio quality.
"GO"	GO Transit or GO is a network of train and bus lines that keep people moving around the Greater Toronto and Hamilton Area
"Good Industry Practice"	Means using standards, practices, methods and procedures to a good commercial and safety standard, conforming to applicable law and exercising that degree of skill and care, diligence, prudence and foresight which would reasonably and ordinarily be expected from a qualified, skilled and experienced person engaged in a similar type of undertaking under the same or similar circumstances.
"Interference"	electromagnetic interference is the influence of spurious unwanted signal energy into the radio system.
"Licenced Radio Channel (Radio Frequency)"	It is the legal authorization issued by ISED to allow someone to use a commercial/industrial/business or amateur frequency in the radio spectrum
"Metrolinx"	This Means Metrolinx, a non-share capital corporation, continued under the Metrolinx Act, S.O. 2006, c.16 and a Crown Agency in accordance with the Crown Agency Act, R.S.O. 1990, c.48 and includes all operating divisions.

Term	Definition
"Metrolinx Operating Area"	Metrolinx Operating Area is in the Greater Toronto and Hamilton Area.
"Mobile Radio"	Two-Way Radio that is installed in vehicles.
"Network Operations Center"	NOC is an integrated control center with a holistic view of operations to ensure the highest standards of safety, customer service, reliability and crisis management.
"Electromagnetic Noise"	Electromagnetic noise is a time-varying electromagnetic phenomenon apparently not conveying information and which may be superimposed on or combined with a wanted signal.
"Radio Channel"	Individual Radio Frequency designated by a proper authority (ISED in Canada) for specific radio communications use.
"Radio Frequency"	It is the number of radio waves per second.
"Radio Spectrum"	All the range of radio frequencies available for radio communications.
"Service Loop"	Service loop is the added length of cable or wire in the installation for accessibility, service maintenance and freedom of equipment movement.
"Two-way Radio"	Radio communications devices used to transmit and receive radio signals

2.2 Abbreviations

2.2.1 The abbreviations used in this standard shall have the meaning prescribed in Table 2.

Table 2: List of abbreviations

Abbreviation	Definition
A	SI unit of electric current, equal to the electric current corresponding to the flow of elementary electric charges per second
AWG	American Wire Gauge (AWG) is a standard method of measuring and identifying cable thickness developed in the United States for electrically conductive wire.
dB	Decibel is a unit used to measure sound or electrical signal levels.

Abbreviation	Definition
EIA/TIA	EIA: Electronic Industries Alliance TIA: Telecommunications Industry Association EIA/TIA is the consortium formed by these two Standards Agencies
EMI	electromagnetic interference (EMI) is degradation in the performance of equipment or transmission channel, or a system caused by an electromagnetic disturbance
IEC	International Electrotechnical Commission. It creates Standards for electrical and electronic technologies
ISED	Innovation, Science and Economic Development Canada, (formerly IC - Industry Canada). It is the government agency that among other things is in charge of licensing the radio spectrum and resolve interference disputes of licensed frequencies.
FDMA	Frequency Division Multiple Access is a multiple access technique in which the various terminals having access to a link are allotted separate frequency channels for transmission
kHz	1000 hertz or cycles/second. A unit used to measure the frequency of an audio or electrical signal.
P25	P25 is a suite of standards and specifications which enable interoperability among digital two-way. land mobile radio (LMR) communications products provided by multiple manufacturers to support. the mission critical public safety requirements.
RF	Radio frequency is a measurement of the oscillation rate of electromagnetic field, in the frequencies ranging from few kilohertz (kHz) to as high as 300 gigahertz (GHz).
TDMA	Time Division Multiple Access. A technology that permits a more efficient use of a radio channel by splitting it in two fully functional digital channels.
UHF	UHF, which means Ultra High Frequency, is the designation for radio frequencies in the range between 300 megahertz (MHz) and 3 gigahertz (GHz).
Unwanted Signal	Unwanted signal is a signal that may impair the reception of a wanted signal.
V	Volt, electric potential, potential difference, electromotive force.

Abbreviation	Definition
VSWR	Voltage Standing Wave Ratio is a measure of how efficiently radio-frequency power is transmitted from a power source, through a transmission line, into a load

2.3 Codes, standards, and reference documents

2.3.1 All systems, equipment and materials required for work relating to this standard, shall be provided by Metrolinx in accordance with the most current edition of applicable federal, provincial, Municipal, and industry codes, standards, and guidelines (collectively, "Standards and Guidelines") including the following:

- a) Radio Communications Act;
- b) Environmental Engineering Considerations and Laboratory Tests; Portable Military Standards MIL-STD 810 C, D, E, F and G;
- c) TIA-102, EIA/TIA 603;
- d) Canadian Centre for Occupational Health and Safety;
- e) P25 Standard;
- f) Canadian Standards Association (CSA);
- g) French Language Services Act; and
- h) Motorola APX Mobiles Installation Manual

3. Bus mobile radio installation

3.1 Radio equipment wiring requirements

- 3.1.1 To minimize risk of electromagnetic interference (EMI) and noise induction, route all radio wiring, including the antenna cable, as far away as possible from the electronic control units and associated harnesses.
- 3.1.2 Radio cables/wires shall be installed in split loom, labeled, and hidden inside bus walls along existing bus wires protected from water and dust and physical damage.
- 3.1.3 Wires shall be properly tightened and secured to minimize chafing, pinching, crushing, and overheating.
- 3.1.4 Cables and wires shall have the minimum 30 cm of service loop at the rear of equipment for accessibility, maintenance, and freedom of equipment movement. Service loop for battery and antenna cables must not be coiled.
- 3.1.5 Any hole drilled to run cables, shall be protected by a grommet. (See Figure 1)
- 3.1.6 Cable splices should be avoided. If, for any reason, an extension is required, the wire extension should be of the same gauge and the same colour as the existing wire.
- 3.1.7 Use only Metrolinx-approved radio kit (antenna, cables, wires, mounting bracket). Unauthorized parts, modifications or extensions could damage the radio and may result in non-compliance with RF Safety Standards.
- 3.1.8 Use shielded twisted pair cable to protect the Emergency alarm circuit (wiring for Panic switch) from unwanted signals and EMI; the cable shall be properly grounded. (Refer to 3.2.1.h)
- 3.1.9 All radio A+ wires (12V DC, Red) shall be fused with a 20A fuse as per manufacturer installation instructions and be rated at 10AWG. (Refer to 3.2.1.c)
- 3.1.10 Place the fuse holder as close as possible to the battery or the main power source. Ensure that it is not near any hot engine component. Mount the fuse holder using its mounting hole and dress the wires as required.

Insert the stripped end of the red lead of the fuse holder into the ring lug hole and crimp it. Connect the fuse holder red adapter lead plug to the mating receptacle on the red lead of the power cable. (see Figure 2)
- 3.1.11 Connect the power cable black lead directly to the vehicle chassis ground using the shortest possible cable length.
- 3.1.12 Connect the red lead ring lug from the fuse holder to the positive (+) battery terminal. Make sure the adapter cable is connected to the main power cable red lead. (see Figure 2)
- 3.1.13 Dedicated independent power source shall be provisioned for all other radio-related power requirements (see Figure 4). Resettable fuses should be used to power up the

Radio and Control Head, located as close as possible to the equipment and in an easily accessible area for maintenance purposes.

3.1.14 Antenna shall be mounted on a square or circle grounded metal plate (35 cm in length) on the bus roof, as close to the radio as possible to assure compliance with RF Energy Safety standards and have VSWR smaller than 1.6 (see Figure 5)

Antenna cable shall be easily accessible within the bus for service and maintenance.



3.1.15 Trunnion Kit Mounting Bracket for the Radio Transceiver shall be installed following good industry practices in a location that can be easily accessed for testing the radio and maintenance. It shall not be installed in a congested, hard-to-reach location for safety reasons. Figure 3 demonstrates the application of a sliding rack tray.

3.1.16 External Radio Speaker shall be installed right beside the driver seat (see Figure 6).

3.1.17 Radio Control Head shall be installed in the dashboard at an easily accessible location for the bus driver to safely operate the radio (see Figures 6 and 7).

3.2 Radio accessories' part number

3.2.1 Metrolinx shall provide the radio kit comprised of the following items:

a.	AP 4020	Antenna Plus - Low Profile Antenna with 6 Meter coaxial cable	
b.	SPKR-01	Speaker extension cable 3 Meter	

c.	HKN4192B	Power Cable Assembly 6 Meter, 10 AWG, 20A	
d.	HKN6188A	Control Head Power Cable with External Speaker Connector	
e.	HKN6168	Remote Mount Cable, 9 Meter	
f.	HLN7002	Trunion Kit Mounting Bracket	

g.	PLN5005 (GO-01)	Faceplate - (Control Head Bracket)	
h.	HKN6161	Option Plug Emergency Alarm cable	

Figure 1: Power cable routing through the access hole

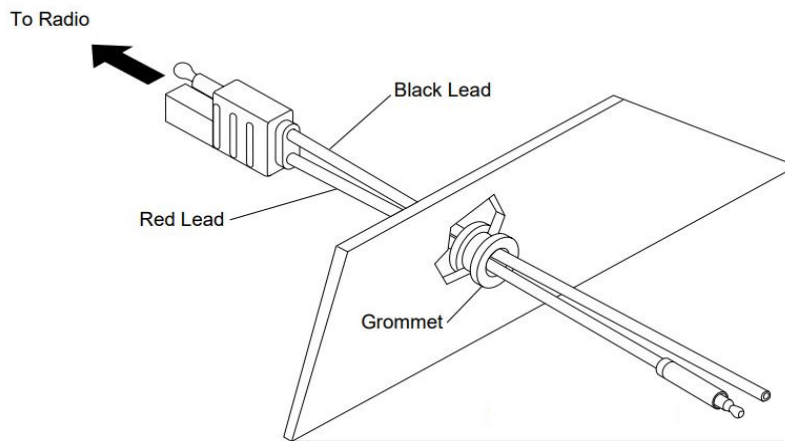


Figure 2: Power cable assembly

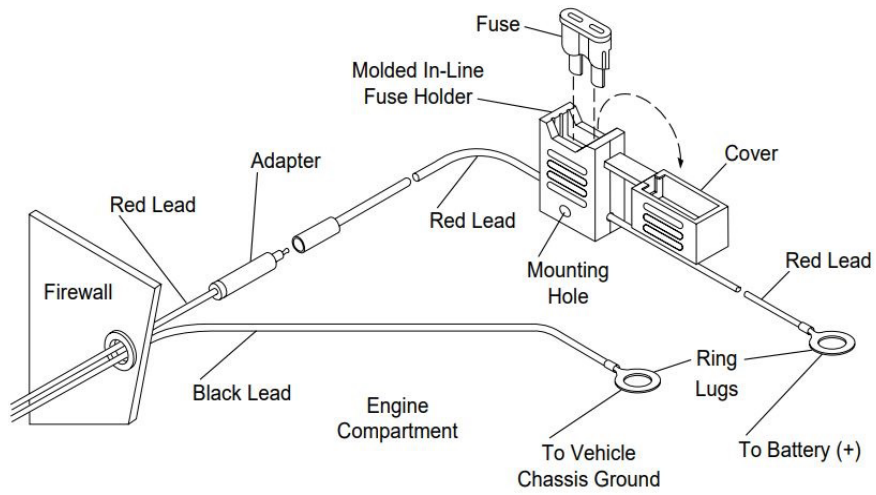


Figure 3: Radio transceiver installed on sliding rack tray

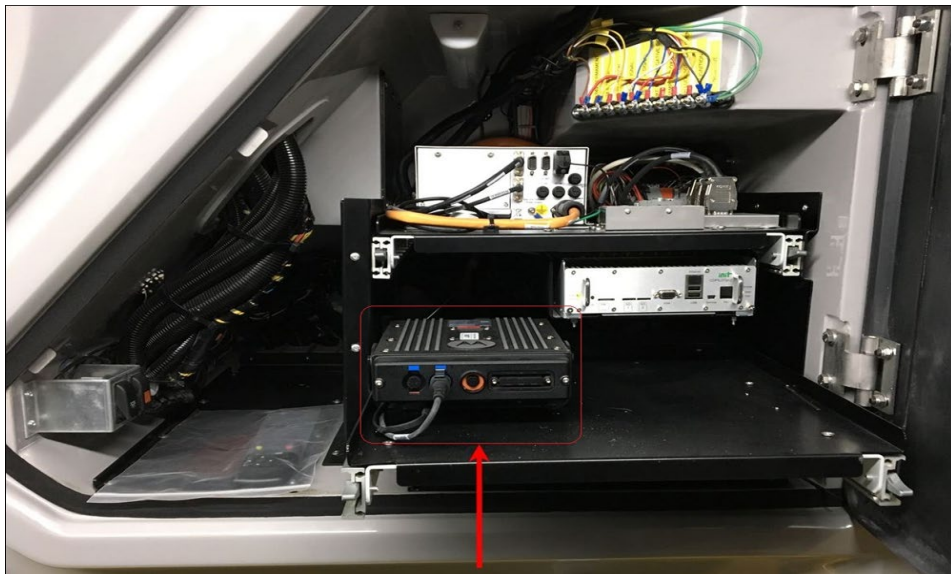


Figure 4: Power source for radio equipment

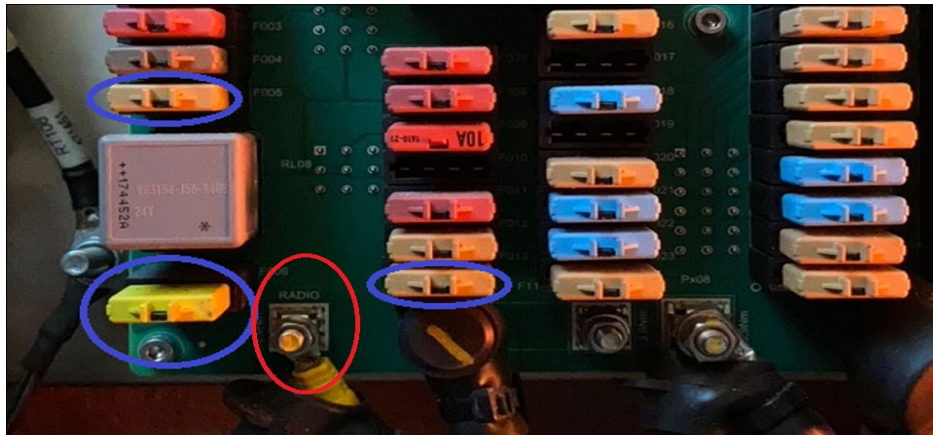


Figure 5: Radio antenna location



Figure 6: External speaker and radio control head location



Figure 7: Radio control head location

