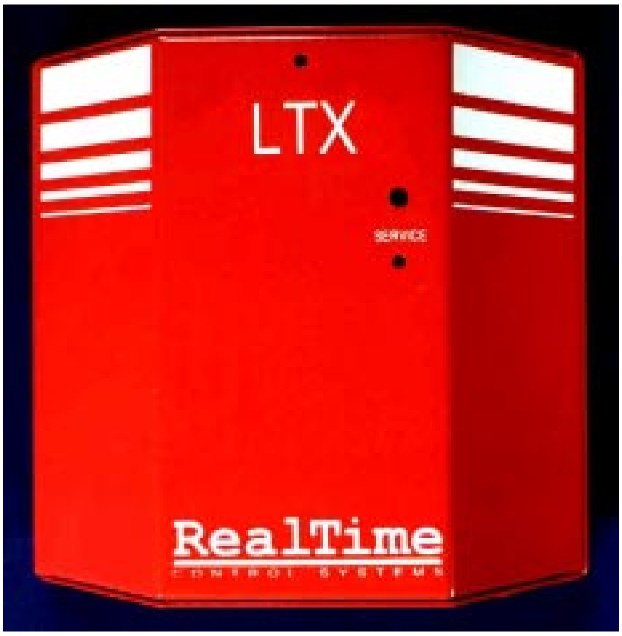
RealTime
CONTROL SYSTEMS

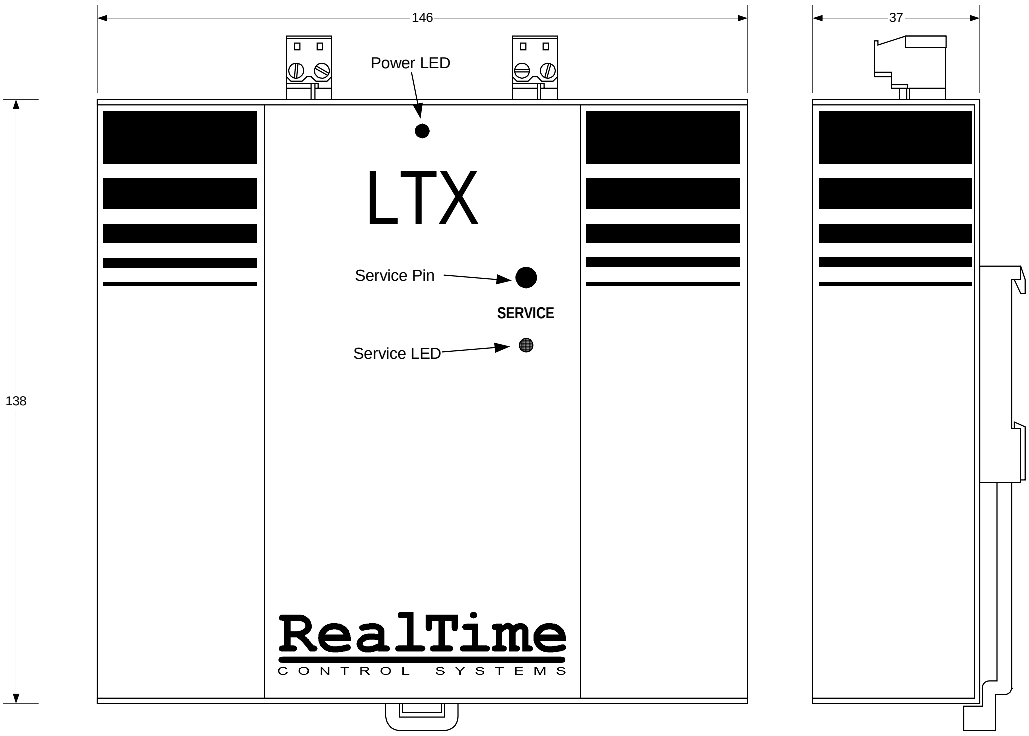
LTX-21 Datasheet

LTX-21 BMS Gateway for Toshiba air-conditioning units



Description

The LTX-21 provides the necessary functionality for integrating R22 and R407C Toshiba RAV range air-conditioning units with the UK's leading BMS manufacturers products. The gateway removes the need for hardwired connections to BMS input and outputs and replaces them with a networked connection. All functionality available using hardwired inputs is available, in addition specific fault-codes from the Toshiba system are reported as BMS alarms and can be received by any connected BMS supervisor either on site or remotely. Furthermore the return-air temperature from each unit is also fed back for control and monitoring purposes. The gateway can handle up to 16 independent zones, removing the need for up to 80 hardwired i/o points on the BMS, and can report fault codes from each of the indoor units connected.



Dimensions (mm)

LTX-21 Iss2.00

New features - LTX-21 Issue 2.00

- **Software controlled Master/Slave Grouping under both BMS and Keypad control**
- **Remote reset of units locked out by critical stopping faults.**
- **Selective reporting and time filtering of Critical and Non-Critical Faults**
- **Options for Common alarm or individual unit fault reporting**
- **Heartbeat and Common fault feedback to BMS**
- **Compatibility with PIN protected Outstations**
- **Compatible with Cooling-only and R22 RAV systems using the RealTime LRC-LG**

LTX-21 Features

- Direct integration with existing control strategy
- Independent control of up to 16 air-conditioning units
- No hardwiring required
- BMS alarm reporting of fault codes for each of the 16 indoor units and attached outdoor units.
- Programmable default operating conditions
- Feedback of measured temperatures from each indoor unit – no need for separate space temperature sensors
- Co-ordinated BMS and local user control with keypad lockout facilities
- Compatible with UK leading BMS control system

System Description

The LTX-21 integrates Toshiba R407C RAV Heat-pumps into conventional BMS controls without the need for hardwired points. As illustrated in Figure 1 this integration is achieved by a combination of a RealTime LTX-21 and a Toshiba LG1. Connection to the host BMS is via the RJ-11 Supervisor port found on most controllers. For correct functionality the controller must have a ‘network aware’ supervisor port – consult the manufacturers literature to ensure that the selected controller has this capability.

The control of the air-conditioning equipment is achieved via the Toshiba LG1 interface, one of which is required for every 16 indoor units. Both the LTX-21 and Toshiba LG1 are based on

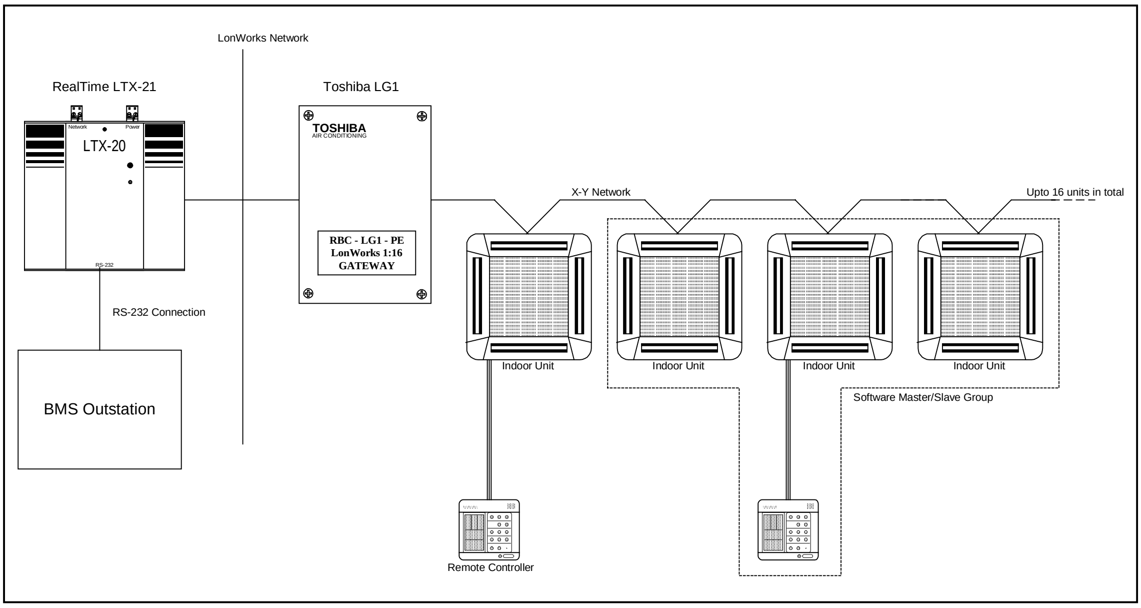


Figure 1. LTX-21 Topology

LTX-21 Iss2.00

LonWorks® technology which allows the devices to be directly connected via a single free-topology network. In order to enable communications between the LTX-21 and the LG1 interfaces it is necessary to 'bind' the devices together using a suitable LonWorks Network Management tool. The LonWorks design and commissioning should be performed by a competent LonWorks engineer. An LTX-21 is required for each LG1 in the system. Once the initial network engineering has been performed the system can be configured and tested from either the LonWorks or the BMS side of the gateway.

Interfaces required for connecting to the LTX-21 are shown in the following table of Toshiba products.

	RAS - xxx	RAV - Heatpump	RAV – Cooling only
R22 – Series 0 to 3	✗	*LRC-LG*	*LRC-LG*
R407C – Series 4	✗	*Toshiba LG1*	*LG1/LRC-LG**

*NOTE: Series 4 Cooling-Only *split* units do not have X-Y connections and are therefore not compatible with the LG1. However 'Cooling-only' units in VRF applications are actually 'heat-pump' indoor boards (with the –H) in the unit code, these *are* compatible with the LG1 as they have X-Y terminals.

The LTX-21 datasheet focuses on integration of the LTX-21 with the Toshiba LG1. For information about using the LRC-LG consult the datasheet available at *www.realtime-controls.co.uk*. **Note that temperature feedback is not available from the LRC-LG**.

Functionality

Each indoor unit requires the following information to be set to determine its operation.

- Setpoint
- Fan speed
- Run Mode
- Louver Control
- On/Off state

Values for these states are usually determined in the BMS control strategy according to time-of-day, external conditions etc.

The LTX-21 works by extracting these values from the analogue array of an outstation and converting them into *network variables* compatible with the LG1 LonWorks interface. The LG1 feeds back the return-air temperature, heat exchanger temperature and fault code from each unit. The measured temperatures can be sent to the outstation for monitoring and control purposes. Each zone can be independently mapped into a different part of the analogue array, allowing multiple 'soft' zones and the ability to rezone through software. The control can be split over two outstations if more complex control strategy is required.

The LTX-21 monitors the faults codes of each of the indoor units and if a unit enters a particular fault state a standard BMS alarm is generated which reports which unit is in alarm and the particular fault code. These codes are briefly summarised at the end of this datasheet. The fault-codes can be written into fields in the BMS outstation to allow the hexadecimal fault codes to be displayed on BMS supervisors. Decimal equivalents of the fault codes can also be written to the BMS to allow the control system to account for faulty units.

The LTX-21 also provides a 'fail-safe' mode of operation that places all of the air-conditioners in a user defined default mode should communications with the BMS fail for any reason.

Standard Applications

This section will cover the initial configuration of the system and LTX-21 configuration for these standard applications:

- Systems Installation
- BMS Control of A/C Units
- Temperature Feedback from indoor units
- Fault Code Feedback
- Alarm generation from unit fault codes
- Unit Defaults and Communications Faults

A standard installation requires the following steps:

1) Installation and commissioning of the air-conditioning units
2) LonWorks engineering of the LTX-21 and LG1 interfaces
3) Engineering of the BMS to LTX-21 interfaces

Toshiba Installation and Commissioning

Details and requirements for setting up the Toshiba air-conditioning units are provided in the pull-out on page 27. This information should be provided to the air-conditioning installer to ensure that the units are configured correctly for operation with an LG1.

Note: The installation and configuration required for LTX-21/LG1 control of Toshiba A/C units is different from the standard method of installation. All units should be installed as 'masters', any master/slave groupings are created by engineering the LTX-21. If units are hardwired as slaves then fault and temperature information will not be available. In addition software grouping provides the greatest flexibility because any future re-zoning can be achieved purely through software.

Once the air-conditioning units are installed and operational the LG1/LTX-21 interface must be engineered using a LonWorks engineering tool to create the linkage between the two devices. This engineering is described in detail in the LonWorks Engineering section on page 23.

BMS Configuration

The LTX-21 is configured using text communications. There are two possible ways of ways of communicating with the gateway using text communications, either using standard BMS engineering software or using a LonWorks SNVT to enter commands. The LonWorks side engineering feature is useful in situations where only a single supervisor port is available and so both the BMS engineering software and the LTX-21 cannot be plugged into the system at the same time, see the section on LonWorks Engineering (page 23) for further details. A blank commissioning sheet is supplied on page 30 for recording the LTX configuration.

On the BMS side the LTX-21 can be engineered by most available tools. When engineered in VDU mode the LTX-21 will not return the usual menu commands, but can still be engineered using text commands. When entering VDU mode the LTX-21 will return the header of the form

```
LTX-21 Iss2.00 Config Mode
OS1:OK  OS2:OK  LG1:OK
```

The first line gives the device type and the firmware issue. The second line shows the current communications status. If communications with the primary remote outstation is ok then OS1:OK will be displayed, if a communications failure has occurred then OS1:FAIL will be displayed. If a secondary outstation is allocated and there are active zones allocated to the secondary then OS2 will be displayed along with OK/FAIL according to the communications status. If there is at least one active zone then LG1 communications status will display FAIL if all of the actives zones are not returning data from the LG1.

Activating the BMS-LTX Link

1) Activate the BMS Outstation supervisor port
To active the BMS-LTX connection the outstation that the LTX is physically connected to must have its supervisor port made active on the network by allocating a network address to it in the outstation. This network address then becomes the address of the LTX, and any remote engineering of the LTX is performed by using an engineering tool configured for this address.

> *To confirm that the LTX connection is active, in LTX engineering mode R(L) will return the local address of the LTX when it detects that the supervisor port is active.*

2) Set-up the LTX remote outstation address
The LTX must be then configured with the address of the remote outstation where the control data is located, and where feedback temperatures and fault codes are written to. This remote outstation also acts a time master for the LTX.

> *Configure the LTX remote address using R(M=x) where x is the address of the remote outstation, this must be on the same LAN as the LTX. If possible the remote outstation should be the outstation that the LTX is physically connected to. To confirm that the LTX is communicating, the command T(L) will return the first time value received from the remote outstation.*

3) Set-up the alarm reporting address
If alarm are to be transmitted to an alarm supervisor either on the local network or via a remote dial-up the LTX must be configured with the alarm address and LAN.

> *LTX alarm addressing is configured R(A=x,R=y) where is the alarm address and y is the alarm LAN.*

4) Set-up the LTX PIN access
If the remote outstation has PIN protection it is necessary to configure the LTX with the PIN code if any data such as temperatures or fault codes are written back to the outstation.

> *Configure the LTX PIN access using R(P=x) where x is the 4 digit PIN number. The PIN provided must be at least level 95 to allow data to be written into the outstation.*

Configuring Unit Control

The next step is to configure the LTX-21 gateway to transfer data to and from the BMS and to report alarms to the correct destination. The strategy running in the BMS will determine the required operating conditions for each zone. The following summarises the required outputs for a single zone and the values that should be set for different operating requirements.

Output	Values
1. Setpoint	18 to 29°C
2. Fanspeed	0 AUTO 1 LOW 2 MEDIUM 3 HIGH
3. Run Mode	0 AUTO 1 HEAT 2 FAN ONLY* 3 COOL
4. Louver Control	0 OFF 1 ON
5. On/Off	0 BMS control - OFF 1 BMS control – ON 10 Local Control – OFF 11 Local Control – ON

*NOTE: Previous versions have used 'Fan Only'=9, this has been changed to simplify the use of range limited knobs, so that the range 0-3 covers all valid modes.

For each zone five adjacent nodes in the analogue array of the controlling outstation must be reserved. So for example if analogue nodes A121 to A125 are reserved for Zone 1, then A121 will contain the Setpoint, A122 will contain the Fanspeed and so on up to A125 which contains the On/Off mode. This is illustrated in Figure 2.

For each unit number ‘x’ the command Zx(R) is used to define the remote offset into the outstation analogue array where the five values are located. In the above example the command Z1(R=121) is used to set Zone 1 to point to analogue nodes 121 to 125.

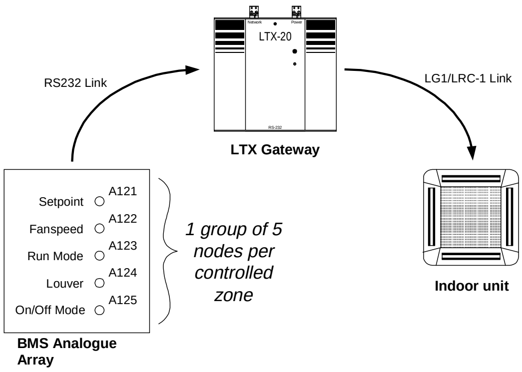


Figure 2. Unit Control

The default Remote Offset value for each zone is zero, this means that the zone is inactive. Setting the Remote Offset value for particular zone to a non-zero value sets the zone as *active*, meaning that the corresponding indoor unit is polled, temperature measurements and any fault are fedback and the indoor unit is controlled from the remote outstation analogue array.

For each active unit, setting Zx(R=y) (with y>0) will activate the control and monitoring of unit x, where x is the same is the unit address of the indoor unit on the X-Y network. For y>16 the zone is set up as a Master, and y represents the Remote offset into the analogue array in the remote outstation. Values in the analogue array Ay to Ay+4 will be used to control Zone x.

Master/Slave Grouping

In most applications units are grouped so that several units receive a common set of operating conditions. This also allows multiple units to be controlled from a single remote controller keypad if local control is being used. With the LTX-21 grouping is performed in software, rather than by hardwiring. One unit within a group is assigned as the *group master*, the rest of the units are designated as *group slaves*. If remote controllers are in use then the group master will be the unit with the remote controller.

The group master is assigned a remote offset into the remote BMS analogue array, e.g. Z1(R=161). Group slaves then have their ‘remote’ source assigned as Zx(R=1), meaning that they are slaves to Z1. Setting Z*x*(R=*y*) will assign Z*x* as a slave to unit *y*, where *y* is in the range 1 to 16. Slave units will then operate using the settings from the master, the master settings may be sourced from the BMS or the masters’ remote controller depending on the current operating mode – see the *Advanced Applications* section for further details on combined BMS and local operation.

Configuring the groups within the LTX-21 means that no hardwiring is required to create group control and allows rezoning to performed simply by altering the configuration of each zones Remote offset.

Slave zones are configured using Zx(R=y) where y is between 1 and 16. The slave zone then operates using the same settings as Zy.

Indoor Unit Temperature Feedback

The LTX-21 can be used to feedback the return air temperature and heat-exchanger temperature from each indoor unit. This is achieved by allocating an array of up to 16 adjacent analogue nodes within the remote outstation for each set of temperatures. The commands F(R) and F(E) respectively define offsets into the analogue array for the return air and heat-exchanger temperatures. Temperatures are only fedback for active zones, hence if only Zones 1 and 2 are active then only two consecutive analogue nodes need to be reserved for each temperature measurement. For example if there are 10 active zones 1 to 10, if F(R=201) and F(E=211) then the return air temperatures from zones 1 to 10 will be written to analogue nodes 201 to 210, and the heat-exchanger temperatures will be written to analogue nodes 211 to 220. Note that the offset is based on the zone number, so if only Zones 1 and 16 are active and F(R=201), then only analogue nodes 201 and 216 will be written to. Hence logically addressing the indoor units from 1 upwards ensures that the values are written back in a single group of nodes.

Unit temperature feedback is activated using F(R=x) for unit return air temperature and F(E=y) for heat exchanger temperature, where x and y are offsets into the remote outstations analogue array. These values can then be attached to internal sensors, alarms and plots.

Fault Code Feedback

The fault codes for each air-conditioning unit can be written into the remote outstation in a similar fashion to the temperature feedback. The standard method for reporting and displaying faults from Toshiba air-conditioners is based on *hexadecimal* numbers, with codes such as ‘0C’ and ‘B7’.To retain consistency with service manuals this method is used in the LTX-21 to report fault codes. However the standard method for displaying values within the remote outstation uses decimal values. In order to allow fault codes to be displayed in hexadecimal the codes are treated as text and written into an internal sensor ‘Units’ fields, for example S17(%=”0C”) and S18(%=”—“), where two dashes “—“ indicates no fault.

By allocating a set of internal sensors for this purpose and leaving their values as zero, it is possible to display the sensor label and units to give a summary of all units codes on a single page. With some supervisors it is necessary to reload the page to refresh the values as they are only read from the outstation once. The command F(H) defines an offset into the sensor array as with the temperature offsets. So for example with zones 1 to 8 active, setting F(S=11) will write the fault codes for each zone into sensors S11(%) to S18(%). At present no alarm bits are set within the sensor. A convenient method of displaying unit information is to write the return air temperatures into the same sensor values, this allows the temperatures and fault codes to be displayed on local display panels as well as user pages.

Fault Code feedback in hexadecimal is activated using F(H=x), where x is the offset into the remote outstations sensor array. Fault codes for each unit are then written into the S(%) units field for each active LTX zone.

Alarm Reporting

The LTX-21 has several different alarm reporting modes, these are discussed in detail in the *Advanced Applications* section. Here we will discuss the default alarm reporting mode.

In the default alarm reporting mode, the occurrence of a unit fault code causes a text alarm to be generated containing the LTX identifier defined by R(D), a zone number 1 to 16 corresponding to the indoor unit address, the fault code in hex format and the time and date that the alarm occurred. Each alarm will be added to the LTX alarm review buffer accessible by the commands V1 to V20. If an alarm reporting address has been set-up by configuring R(A) then the text alarm will be transmitted to this address. When the fault clears then an ‘ERROR CLEARED’ alarm message is transmitted for that zone number.

More sophisticated reporting allows alarms to be classified as critical or non-critical, time filtering to be applied to filter transient alarms, common fault alarms generation and the selective reporting of faults. These topics are covered in the *Advanced Applications* section.

Alarm reporting is activated by setting the alarm address using R(A,R). The controller label text in the alarm can be configured using R(D) – default label is "LTX-21". Default alarm reporting reports fault codes for each unit. The alarm review buffer allows a review of the last 20 alarms that occurred.

Unit Defaults and Communications Faults

The communications link between the LTX and the BMS is a critical link because the desired operating conditions of the units are sourced from the BMS. If the link is disconnected or the BMS cannot communicate for any reason then the air-conditioning units may remain off or may remain in an undesirable state such as pre-heat. To prevent this causing significant problems the LTX monitors the communications and if they fail will place the units into default override conditions defined within the LTX. When the communications link is restored the LTX will revert to the BMS operating conditions.

A special defaults zone is defined, this zone is accessed via Z17 and contains the desired default conditions such as OnOff state, setpoint etc. It is also possible to activate the unit keypads so that under default conditions the units are placed under local user control with the initial conditions defined by the default conditions.

When using primary and secondary outstations the communications with each is monitored separately, should communications fail with only one of the outstations then only those zones controlled by that outstation will be placed in default override.

Communications failure between the LTX and the BMS causes all affected units to be place in default override. Default override conditions are set via the unit operating conditions in the default zone Z17 using Z17(S, F, M, L, E, K). Local keypad control under default override can be enabled by setting Z17(K=1).

Advanced Applications

The Advanced Applications section covers:

- Combined BMS and Remote Keypad control of units
- Multiple outstation addressing.
- Feedback of decimal fault codes for use in control strategy
- Alarm reporting: common, critical and non-critical alarms
- Time-based filtering of alarms
- Feedback of heartbeats and alarm bits

Combined BMS and Local Control

The LTX-21 can be used to operate the air-conditioning units in conjunction with local user interfaces (generally called 'remote' controllers). This type of control is more complex as it requires co-ordination to ensure that the BMS does not override user demands.

Combined BMS/local control generally involves allocating times during which the user has control of the system, and times during which the BMS has control of the system. This is achieved by using several different On/Off modes. The fifth control parameter written in the BMS is the On/Off value, this has a number of different modes

OnOff Value	On/Off Mode
0	BMS control – OFF
1	BMS control – ON
10	Local Control – OFF
11	Local Control – ON

The basic control mode is BMS control, in which case the local user control is locked out. OnOff=0 switches the unit off, the local user control displays the word 'Central' flashing, and the keypad is completely attached. Setting OnOff=1 switches the system on, the word 'Central' is displayed constantly and all keys except for the on/off key are locked out. If the user turns the unit off the LTX-21 will detect this and switch the unit back on within 60 seconds.

In local control mode, the transition of the OnOff state is used to set the mode. For example the transition OnOff=0 to OnOff=10 causes the unit to remain off, but enables the local controller and locks out the BMS control. If a user switches the unit on, and alters the operating mode, the unit will remain under user control until the OnOff state changes.

***Example**: a meeting room is held off during unoccupied hours (OnOff=0) and during occupied hours local control is enabled but the system is kept off (OnOff=10). If the meeting room becomes occupied during defined occupancy hours the occupants can turn the system on until the occupancy time defined in the BMS is ended, at which time OnOff changes to 0, the system is turned off and local control is locked out.*

The mode OnOff=11 allows the unit to be turned on, so that the indoor unit controls to whatever the current BMS operating conditions are. After the unit has been turned on the BMS control is locked out and the user is free to make any desired alterations to the units operation.

When under local control, any units that are defined as slaves using Z(R=1..16) respond to the keypad settings of the master zone. If a keypad is attached to a slave it will always remain locked out as the slave unit takes it settings from the master unit. Hence it is important that units with keypads attached are defined as masters in the LTX.

Transition between BMS and local control is achieved by changing the OnOff value in the BMS from {0,1} (BMS control) to {10,11} (local control). OnOff=10 causes the unit to be set OFF under switched to local control, OnOff=11 causes the unit to be set ON and switched to local control. Units configured as slaves in the LTX are controlled by the keypad of the master in local control.

Multiple Outstation Addressing

With heavy strategy usage it is possible that not all zones can be controlled from a single outstation. In this case the use of a secondary outstation is possible. By defining secondary remote outstation R(S) and the switchover zone F(S), the control becomes split between the primary remote R(M) and the secondary remote R(S). The switchover zone defines the zone at which the switch between the two outstation occurs. For example if F(S=10), then zones 1 to 9 are controlled from the primary remote, and zones 10 to 16 are controlled from the secondary. If the secondary outstation is activated then the LTX status line showed when logging on will display the communications status for both the primary and the secondary outstations.

If switchover is used then the indoor unit temperature and fault code feedback is also switched between primary and secondary. The remote offsets F(H), F(D), F(R) and F(E) define the base offsets into analogue and sensor arrays for both outstations; for example, if F(R=201) and F(S=10) then A201 to A209 in the primary outstation contain the return air temperatures from zones 1 to 9, and A210 to A216 in the secondary outstation contain data from the zones 10 to 16.

The secondary remote outstation is activated by assigning R(S) a valid outstation address on the local LAN. The switchover zone is defined by setting F(S=x) where x is 1 to 16.

Decimal Fault Code Feedback

It is possible that there is a need to use the fault status of each indoor unit to generate additional alarms or to operate some form of e.g. for duty/standby changeover. In this case there is a need to send a decimal value to the outstation so that the value can be used within strategy calculations. The command F(D) defines an offset into the analogue array that allows each active zones fault code to be written as a *decimal* value, using the same offset method used for temperature feedback.

The fault code is written as its decimal equivalent e.g. '0C' is written as 12 and 'B7' is written as 183. The standard method for displaying the 'no fault' condition is to display two dashes in the form '—', when writing back decimal fault codes this value is written back as 255 in decimal. Therefore the value 255 indicates a normally operating unit, and a strategy that tests if value NOT EQUAL to 255 can be used to perform changeover if a fault occurs. Similarly specific strategy can be written to respond to particular fault conditions. Mappings between decimal and hex fault codes are provided on page 28 of this datasheet.

It is strongly recommended that the decimal values are not displayed to the user as the use of hexadecimal values is well established and displaying the decimal values is likely to lead to confusion between values displayed by the BMS and values given in service manuals.

Decimal fault code feedback is activated by setting F(D) to a non-zero value corresponding to an offset into the BMS analogue array. This offset defines an array of up to 16 values corresponding to the active zones within the LTX. Decimal value 255 corresponds to a fault free condition.

Alarm reporting: common, critical and non-critical alarms

The LTX contains a number of configuration options which allow different types of fault reporting. When a fault occurs the fault is classified as either critical or non-critical. For each type it is possible to report individual unit fault codes or to report common fault alarms indicating that at least one unit is in critical or non-critical fault. This allows the user to control the amount of information that needs to be dealt with at the alarm supervisor. In addition separate time filtering is available for critical and non-critical faults so that e.g. critical faults are reported immediately whereas non-critical faults must exist for several hours before an alarm is generated.

Alarm reporting is determined by the *alarm reporting mask* defined by R(G), this is a single decimal number that contains the various reporting options. The table below summarises these options and shows how the value of R(G) is calculated.

		R(G)	B7 as Non-Critical	Reset Alarm	Critical Common Alarm	Critical Unit Alarm	Non-Critical Common Alarm	Non-Critical Unit Alarm
#	**Description**	**Value**	**32**	**16**	**8**	**4**	**2**	**1**
1.	All unit faults	5				✓		✓
2.	Common Critical and common non-critical	10			✓		✓	
3.	Critical Unit Faults, Common Non-Critical	6				✓	✓	
4.	As (1) with Reset Alarms	21		✓		✓		✓
5.	As (2) with Reset alarms	26		✓	✓		✓	
6.	As (1), B7 faults as non-critical	37	✓			✓		✓
7.	As (2), B7 faults as non-critical	42	✓		✓		✓	

Each option is represented in binary as a single bit of R(G). The value of R(G) indicates which bits are on or off and therefore what options are selected. Below each alarm options is a number 1,2,4,8 etc. R(G) is calculated by adding these values for each option selected. So for example in row 1 of the table non-critical unit alarms (value=1) and critical unit alarms (value=4) are selected so R(G) is equal to 1+4=5. Similarly in row two only critical and non-critical common alarms are selected so R(G) is equal to 2+8=10. It is therefore possible to report both common and unit alarms for critical and non-critical states by setting R(G) to 1+2+4+8=15. All alarm reporting is held off by setting R(G) to zero.

An alarm can be generated when ever the LTX-21 resets or powers-up. In row 4 of the table we add reset alarm reporting by adding 16 to the value so that R(G) is equal to 1+4+16=21.

A further option available is the classification of B7 faults. These are generated by master units with slaves connected on the A-B-C connections. If any of the slave units has any type of fault code the master will generate a B7 fault. The B7 fault is assumed to be critical, however it may be that slaves generate significant numbers of non-critical faults that appear as critical B7 faults. In this case the option is available to reclassify the B7 fault as non-critical by adding 32 to the value of R(G).

Alarm reporting options are set using R(G). The value of R(G) represents a set of option bits that determine if critical and non-critical faults are reported, and whether they are reported as common alarms or as individual unit alarms containing the fault code that occurred.

Alarm Filtering: common, critical and non-critical alarms

Two alarm filter timers are available for filtering the reporting of alarms. These are particularly important for non-critical faults which can occur transiently and clear without necessarily meaning that a fault has occurred. Alarm filtering allows a time hysteresis to applied so that there is a minimum time required between a fault occurring or clearing before an alarm is reported. A fault that occurs and then clears in less than the time defined by the alarm filter will not be reported.

The configuration values R(F) and R(T) define the filter times in minutes for non-critical and critical faults respectively. The timers are applied individually to each unit alarm as well as the common alarms.

It is recommended that critical faults are not filtered or only given a filter time of a few minutes. Non-critical faults should have filtering between 60 and 180 minutes to eliminate transient alarms.

Note that alarm filtering only applies to the generation of alarms transmitted to the alarm supervisor. The alarm filtering is not applied to any of the feedback values written to the BMS nor to the values available within the LTX.

Feedback of Heartbeat and Alarm Bits

The LTX can write a status byte back to the BMS containing alarm status information as well as a heartbeat. The feedback byte in the primary remote outstation is defined by F(A=x) where x is the byte number. If F(A) is non-zero then this byte will be written into the remote outstation R(M) once every minute. The following bits are currently set:

x,2 Common Non-critical fault status
x,1 Common Critical fault status
x,0 Heartbeat bit

where x is the byte number defined in F(A).

The fault status bits are set if any of the units are in critical or non-critical fault condition. These statuses are *not* filtered by the alarm filters.

The heartbeat bit alternates between 0 and 1 every minute. This can be used on the BMS side to generate an alarm if communications with the LTX is lost. This alarm is implemented as follows:

1. *Create a gate switched by the heartbeat bit so that alternating values of 0.0 and 100.0 are written into an analogue node.*

2. *Create a filter sourced from the above analogue node with a unit scaling F=1 and a filtering parameter E of 0.99 to 0.997.*

3. *Create an internal sensor attached to the destination of the filter and set the low alarm limit to 10 and the high alarm limit to 90. Activate high and low alarm reporting on the sensor.*

Under normal conditions the input to the filter will alternate every minute. The filter averages this out and its output will oscillate around 50%. If the heartbeat stops then the input to the filter will stop changing and remain at 0 or 100%. The output of the filter will converge towards this value at a rate determined by the filter parameter. With alarm limits of 10% and 90% a filter parameter of 0.99 will lead to an alarm after about 3 minutes of lost heartbeat, a filter parameter of 0.997 will lead to an alarm after about 10 minutes.

> *The alarm byte is written back to the primary remote outstation by setting F(A=x) to a non-zero value where x is the byte number in the remote outstation. The alarm byte contains critical and non-critical bits as well as a heartbeat bit.*

Commissioning Methods

Having configured the LTX, LG1 and connected the Toshiba X-Y network, the following procedures can be used to check the system functionality. The Troubleshooting Guide on page 31 provides solutions for some of the common problems found.

1) Data Readback from LG1

The command Z(A) will return the statuses of all 16 units, showing which ones have been activated using Z(R). For the active units the readback fault codes, return air temperature (RA) and heat-exchanger temperature (HE) will be displayed. If the RA and HE values are zero and the zone is showing E:COMMS then the unit is not replying. If there is no reply from the unit after 8 queries the zone will indicate a 99 fault code. If the zone status is showing E:UPDATE then the unit is responding but not updating with the required conditions. See the trouble shooting guide for more details.

2) BMS to LTX Communications

If the LTX is communicating with the remote outstation then the command T(L) will return the first time/data that communications was established after a reset. The command #(R=1) allows a software reset to be applied to test this (allow at least a minute after a reset). The command T(H,N,D,M,Y) will return the current outstation time/date in the LTX if communications are functioning. **Note that the LTX will not be able to communicate with the remote outstation if it is currently in engineering config mode**.

To check that unit settings are being passed to the LTX from the BMS, change the setpoint or other parameter in the remote BMS for a particular zone. The command Z(S) will show the changed setpoint value, this may take up to a minute to update. The analogue array within the

LTX can also be used to check the raw values transferred from the BMS, see the *Engineering Command Summary* for details.

3) LTX to BMS Communications

If the LTX has been configured to write back values to the BMS then various different values can be checked. The array of values for return-air temperature or heat-exchanger temperature will contain the same values as observed using Z(A). The array of internal sensors used for fault feedback should contain the fault codes in the units field, with '—' for units with no fault. If the alarm byte feedback is enabled then the target byte will contain common alarms statuses as well as an alternating heartbeat bit. The heartbeat bit can be seen alternating (once a minute) by querying the outstation in text mode rather than entering config mode which blocks LTX communications.

4) Manual Unit Operation

To manually control units from the LTX interface it is necessary to disable the BMS link to prevent BMS control values overwriting manually set values. This can be achieved by temporarily disabling the remote outstation link by setting R(M=0). Zone masters can then be set using the Z(S,M,F,L,E,K) values. Individual units can be controlled using e.g. Z1(S=19,E=1), or all units can be set in one step using a global Z(S=19,E=1) command. Slave units will still operate from their current zone masters settings. Individual units can also be temporarily placed in stand-alone operation by setting Zx(R=x) e.g. Z13(R=13), allowing the unit to be manually controlled without disabling the BMS link.

Using Z(K=1) places the unit under local keypad control, in addition Z(S,F,M,L,E) then contains the readback values from the unit. This is useful if the zone is showing E:UPDATE problems and shows what the unit is actually doing. Setting Z(K=0) and re-viewing the unit settings then displays what settings the LTX is calling for.

5) Fault and Alarm Generation

To view or demonstrate fault codes occurring and alarms being generated several different methods can be used. The command #(A) will send a test alarm to the current alarm target, and will send a 'TEST ALARM CLEARED' alarm when the first test alarm is logged by the supervisor. This is especially useful for proving dial-up reporting is active. Viewing the LTX alarm buffer will show these two alarms, if they haven't been successfully transmitted then a '*' symbol will be shown by the alarm.

The simplest fault code to generate is the 99 code, this can be generated by activating a zone using Zx(R) for a non-existent unit, or by powering down one of the A/C units. The LTX will timeout trying to communicate with the unit and generate a 99 fault - this will be written into the outstation, transmitted as an alarm, generate a common critical fault etc. depending on what options have been configured.

If the A/C installer is available then it is also possible to generate 'real' fault codes. The easiest to generate are 0C and 0d faults which can be created by temporarily disconnecting the TA and TC sensors on the indoor unit PCB.

Remote Maintenance Procedures

The LTX-21 allows the A/C units to be managed remotely and allows initial response and investigation of faults to performed remotely. This removes the need for site attendance simply to reset units and ensures that site maintenance only occurs for urgent faults that have already been investigate. The following sections outline what tools are available for observing, diagnosing and clearing faults remotely.

1) Identifying Units with Faults

Use the command Z(A) to show a list of current unit fault codes and temperatures. The command Z(C) will show the last recorded fault for any unit that is currently clear. If unit fault reporting is enabled (setting the correct masks in R(G)) then even if there is no alarm target the alarm review buffer will contain the last 20 alarms that have occurred. This is useful for sites with no alarm supervisor, the history will identify units that are repeatedly reporting fault codes and provides time/data information that can be used to identify patterns in fault conditions.

2) Fault Diagnosis

The fault codes provide an indicator to the type of problem that is occurring (refer to the Toshiba Service manual for details). However often there may be several possible causes for a particular problem. For example an 09 fault may be caused by low refrigerant charge or incorrect sensor positioning. The severity of a fault can be determined by the length of time a fault occurs and the frequency of the alarms and this information can also by used to distinguish different reasons for a particular fault code to occur.

The return air temperature and heat-exchanger temperature can also be used as diagnostic aids. The heat-exchanger temperature will show the temperature of the coil and whether the unit is actually actively cooling or heating. Units can be temporarily overridden and the setpoints modified so that the unit can be forced into heating or cooling to determine if the unit is working correctly. The heat-exchanger and return air temperatures can be written back into the BMS so that plots can be set up if there is a need to observe a units behaviour over a period of hours or days.

3) Fault Clearing

The fault clearance command #(C) can be used to reset all indoor units and clear any unit faults (except 99 faults). Note it may be necessary to send the #(C) command several times before all units reset. Clearing faults allows false alarms and occasional stopping faults to be distinguished from permanent faults. E.g. high temperature or pressure lockouts on outdoor units may simply be due operation on exceptionally hot day or high load. Resetting the unit will allow the unit to restart and reduces the urgency of the problem unless there is a fundamental problem in which case the unit will stop again.

Engineering Command Summary

Addressing

Remote Outstation Address

Command :	R(M)	addRess(reMote address)

Defines the outstation address of the remote BMS outstation where the control values for each of the control zones are located. This outstation must be on the same LAN as the LTX-21. This address is also used to set the time in the LTX-21. The default value for R(M) is zero, which prevents the LTX-21 from updating any of the zones control values or time values.

Secondary Outstation Address

Command :	R(S)	addRess(Secondary remote)

Defines the outstation address of the optional secondary remote BMS outstation where the control values for each of the control zones can be located by defining a switchover zone F(S). This outstation must be on the same LAN as the LTX-21. The default value for R(S) is zero, which prevents the LTX-21 from updating any zones that are allocated to the secondary outstation.

Outstation PIN Number

Command :	R(P)	addRess(Pin number)

If the remote outstation has PIN protection it is necessary to configure the LTX with the PIN code if any data such as temperatures or fault codes are written back to the outstation. Configure the LTX PIN access using R(P=x) where x is the 4 digit PIN number. The PIN provided must be at least level 95 to allow data to be written into the outstation. The same PIN is used for both primary and secondary outstations. The default value is R(P=10000), meaning PIN access is disabled.

Alarm Address and LAN

Command :	R(A,R)	addRess(Alarm address, alaRm lan)

Defines the address and remote Lan of the target for BMS alarms. The default value for R(R) is zero, the local LAN. The default value for R(A) is also zero, this value defines no alarm target so no alarms are transmitted.

Local Address and Lan

Command :	R(L,N)	addRess(Local address, local laN)

The local address is defined by the controller that to which the LTX-21 is attached and is automatically detected.

Device Identifier

Command :	R(D)	addRess(iDentifier)

The identifier is a 15 character text identifier that can consist of upper and lower case characters, numbers, spaces and punctuation excluding inverted commas. The identifier is used in alarm transmissions should be set to identify the device and its function. The identifier is written by placing inverted commas around the string e.g. R(D="abcd").

Alarm Configuration

Command :	R(G)	addRess(alarm confiGuration)

Alarm configuration options are set by the value of R(G). Each bit controls the reporting of particular types of alarms such as critical, non-critical and common. See the *Advanced Applications* section for details on calculating the required value of R(G). The default value is R(G=5), meaning that unit alarm reporting is enabled for critical and non-critical faults.

Non-Critical Alarm Filter Time

Command :	R(F)	addRess(non-critical Filter time)

The alarm filter is used only for Non-critical alarms and can be used to prevent short 'glitch' alarms from being reported. Filter time defines the minimum time in minutes that an alarm must exist before it is reported. Similarly an alarm must be cleared for the same amount of time before the alarm is reported. If R(F=0) then all alarms are reported no matter how short the duration before the alarm clears or changes. The default value is zero, no alarm filtering.

Critical Alarm Filter Time

Command :	R(T)	addRess(critical filter Time)

The alarm filter is used only for Critical alarms and can be used to prevent short 'glitch' alarms from being reported. Filter time defines the minimum time in minutes that an alarm must exist before it is reported. Similarly an alarm must be cleared for the same amount of time before the alarm is reported. If R(T=0) then all alarms are reported no matter how short the duration before the alarm clears or changes. The default value is zero, no alarm filtering.

Feedback Offset Indexes

Switchover Zone

Command :	F(S)	oFfset(Switchover zone)

Defines the zone at which control switches from primary to secondary outstation. Valid when a secondary address R(S) is set. The default value is zero, meaning all zones are located on the primary remote outstation. If F(S=1) then all zones are located on the secondary outstation.

Hexadecimal Fault Code Offset

Command :	F(H)	oFfset(Hexadecimal fault code offset)

Defines the offset into the Sensor array in the remote outstation (and the secondary if used) where fault codes can be reported. The codes are reported in hexadecimal and written into the

Units field S(%). The default value is zero, no feedback of hex fault codes. Values are only reported for active zones, if H=1 then S1(%) contains the hex fault code for Zone 1, and S16(%) contains the fault code for Zone 16.

Decimal Fault Code Offset

Command :	F(D)	oFfset(Decimal fault code offset)

Defines the offset into the analog array in the remote outstation (and the secondary if used) where fault codes can be reported. The codes are reported in decimal and written into the analog node value The default value is zero, no feedback of decimal fault codes. Values are only reported for active zones, if D=101 then A101(V) contains the decimal fault code for Zone 1, and A116(V) contains the fault code for Zone 16.

Return Air Temperature Offset

Command :	F(R)	oFfset(Return air temperature offset)

Defines the offset into the analog array in the remote outstation (and the secondary if used) where return air temperatures can be reported. The default value is zero, no feedback of return air temperatures. Values are only reported for active zones, if D=101 then A101(V) contains the return air temperature for Zone 1, and A116(V) contains the return air temperature for Zone 16. The temperatures are reported to a resolution of 0.5^{o}C, the resolution available from the indoor units.

Heat Exchanger Temperature Offset

Command :	F(E)	oFfset(heat Exchanger temperature offset)

Defines the offset into the analog array in the remote outstation (and the secondary if used) where heat exchanger temperatures can be reported. The default value is zero, no feedback of heat exchanger temperatures. Values are only reported for active zones, if D=101 then A101(V) contains the heat exchanger temperature for Zone 1, and A116(V) contains the heat exchanger temperature for Zone 16. The temperatures are reported to a resolution of 1.0^{o}C, the resolution available from the indoor units.

Alarm Byte Offset

Command :	F(A)	oFfset(Alarm byte offset)

Defines the offset into the digital byte array in the primary remote outstation where the alarm byte is written to. The defautl value is F(A=0), feature disabled.

Zone Control

Zone Remote Analogue Array Offset

Command :	Zx(R)	Zone x(Remote offset) where x=1 to 16

The remote offset defines the location of the control values for Zone x. If R is greater than 17 then the zone is a *BMS Master* and the value defines an offset into the remote outstation analogue array. Each zone corresponds to five consecutive values in the analog array beginning at the location defined by Zx(R). If R is between 1 and 16 then the zone is a slave zone controlled from the LTX. The special case Zx(R=x) makes the zone *stand-alone*, this is for commissioning purposes and allows the units operating conditions to be manually controlled by the commissioning engineer.

In the case of a BMS Master, for example Z2(R=161) specifies that Zone 2 corresponds to analogue nodes 161 to 165 in the remote outstation. In this case the values are is follows

A161(V) is the setpoint temperature
A162(V) is the fanspeed
A163(V) is the run mode
A164(V) is the louver control
A165(V) is the on/off state

The default value for Zx(R) is zero, this indicates that the remote link feature for zone x is not activated and the network outputs for this zone are only controlled by the local analog array values.

Zone Alarm Summary

Command :	Zx(A)	Zone x(Alarms) where x=1 to 16

The alarm summary is a read-only command that returns the hexadecimal alarm code for the corresponding indoor unit. In addition the command also returns the return-air temperature and heat-exchanger temperatures for the unit. The zone number is equal to the address of the indoor unit on the X-Y network attached to the LG1.

For example the command Z1(A)Z2(A)Z3(A) will produce the response of the form:

```
Z1   CODE:99  RA:0.0   HE:0.0   LOCAL KEYPAD E:COMMS
Z2   CODE:--  RA:19.5  HE:7.0   BMS CONTROL
Z3   CODE:O9  RA:23.5  HE:18.0  Z2 GROUP SLAVE
```

The hex fault code is reported together with the return air temperature (RA) and the heat exchanger temperature (HE) of the unit. If no fault exists then two dashes '—' are displayed instead of a code. Note that the fault code is not filtered, but shows the current code readback from the unit.

The status of the zone is also returned in the data. The following statuses can occur

Text	**Status**
NOT ACTIVE	Zx(R) is zero - zone is not polled and no data is displayed
STAND ALONE	Zx(R=x) - zone is controlled from its settings within the LTX – commissioning mode
Zy GROUP SLAVE	Zx(R=y) , y is 1 to 16. The zone is a slave to zone y in the LTX
BMS CONTROL	A BMS Master with OnOff set to BMS control {0,1}
LOCAL KEYPAD	A BMS Master with OnOff set to local keypad control {10,11}

Additional information is also provided if there are communications problems with the indoor unit.

Text	**Status**
E:COMMS	The zone is polled, but the LG1 is not responding with data for this zone. If E:COMMS occurs for all zones then the LTX-21 is probably not communicating with the LG1. If there is no reply from only some of the units, check that the addresses of the units correspond to the allocated zone numbers, also check that the number of units defined in LG1 covers all allocated addresses. The LTX-21 will generate a '99' fault code for the zone if there is no reply from the unit after 8 attempts
E:UPDATE	Data is being returned from the zone but is inconsistent with the required operating condition. Common reasons for this to occur are - if louver activation is called for on a unit without louvers – or the louver jumper CN21 has been removed - heating is called on a cooling only unit. - The unit has a local hold-off device such as a Toshiba T2 - The rotary switch SW01 on the unit is not set to 1, SW02 not set correctly or the unit has not been repowered after addressing.

The command Z(A) returns the data for all 16 LTX-21 zones.

Last Fault Code

Command :	Zx(C)	Zone x(last fault Code) where x=1 to 16

The last recorded fault condition for the specified unit. This is not filtered and is therefore useful in systems where short term faults such as 09 and 0B may be missed. In addition if only common alarms are being reported then Zx(C) provides a record of the last fault for each unit. The command Z(C) will return the last fault code for all 16 units.

Zone Setpoint

Command :	Zx(S)	Zone x(Setpoint) where x=1 to 16

The current setpoint of the unit. If the unit is under BMS control then this value is the setpoint sent from the BMS. The value is limited to the range 18 to 29, values from the BMS outside of this range will be hard limited. If the zone is under local keypad control then the value reflects the current setpoint readback from the keypad. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, e.g. Z1(S=25) sets the setpoint of zone 1 to 25^{o}C.

Zone Fanspeed

Command :	Zx(F)	Zone x(Fanspeed) where x=1 to 16

The current fanspeed of the unit. If the unit is under BMS control then this value is the fanspeed sent from the BMS. The value is limited to the range 0 to 3 {0=AUTO, 1=LOW, 2=MEDIUM, 3=HIGH}, values from the BMS outside of this range will be hard limited. If the zone is under local keypad control then the value reflects the current fanspeed readback from the keypad. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, e.g. Z1(F=2) sets the fanspeed of zone 1 to MEDIUM.

Zone Mode

Command :	Zx(M)	Zone x(Mode) where x=1 to 16

The current mode of the unit. If the unit is under BMS control then this value is the mode sent from the BMS. The value is limited to the range 0 to 3 {0=AUTO, 1=HEAT, 2=FAN ONLY, 3=COOL}, values from the BMS outside of this range will be hard limited. If the zone is under local keypad control then the value reflects the current mode readback from the keypad. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, e.g. Z1(F=3) sets the mode of zone 1 to COOL.

Zone Louver

Command :	Zx(L)	Zone x(Louver) where x=1 to 16

The current louver state of the unit. If the unit is under BMS control then this value is the louver state sent from the BMS. The value is limited to the range 0 to 1 {0=OFF, 1=ON}, values from the BMS outside of this range will be hard limited. If the zone is under local keypad control then the value reflects the current louver state readback from the keypad. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, e.g. Z1(L=1) switches on the louver in zone 1.

Zone Unit Enable

Command :	Zx(E)	Zone x(unit Enable) where x=1 to 16

The on/off state of the unit. If the unit is under BMS control then this value is the on/off state sent from the BMS (0 or 10 = off, 1 or 11=on). The value is limited to the range 0 to 1 {0=OFF, 1=ON}, values from the BMS outside of this range will be hard limited. If the zone is under local keypad control then the value reflects the current on/off state readback from the keypad. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, e.g. Z1(L=1) switches on the unit in zone 1.

Zone Keypad Enable

Command :	Zx(K)	Zone x(Keypad) where x=1 to 16

The lockout state of the units local keypad. Under BMS contol this value determined by the state of the OnOff variable, values {0,1} operate the unit under central control and K=0. values {10,11} operate the unit under local control and K=1. This value always zero for slave zones because they are always under central control of the master zone. Under stand-alone control the value is editable so that the unit can be manually controlled from the LTX, the value is limited to values {0,1}. e.g. Z1(K=1) switches the unit in zone 1 to local keypad control.

When viewing unit settings using Z(S,F,M,L,E), the source of the values is determined by the value of K for each zone. If K=0 then the values reflect settings sent from the LTX, sourced either from the BMS, a Master Zone or simply from these values if the zone is under stand-alone control. If K=1 then the values reflect those readback from the unit itself.

Zone Defaults

Command :	Z17(S,F,M,L,E,K)	where x=1 to 16

Zone 17 is a special zone used to contain the default values for the units. Z17(A,R,C) do not work as the zone simply holds the default operating values for the units. These default values are used when the LTX is powered up or reset, and if a communications failure occurs between the LTX and the BMS. The operating conditions of all units are set by defining values for Z17(S,F,M,L,E,K). If Z17(K=1) then when default conditions are in use the local keypads are unlocked, allowing users local control over the units until BMS communications are restored. The factory default settings are Z17(S=21,F=0,M=0,L=0,E=1,K=0).

Analogue Array

Analogue Value

Command :	Ax(V)	Analogue(Value) where x=1 to 80

The LTX-21 contains a simple analogue array containing the data read from the BMS. Data is only written in BMS Master zones that read data from the BMS. The zones relate to the local analogue array as follows

	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Z10	Z11	Z12	Z13	Z14	Z15	Z16
Setpoint	1	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76
Fan Speed	2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77
Mode	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78
Louvre	4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79
On/Off	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80

The values contained within the analogue array are exactly the values read from the BMS and are not range limited. The analogue array does not usually need to be accessed by is sometimes useful as a diagnostic tool as it allows the raw data from the BMS to be viewed.

Time

Current Time

Command :	T(H,N,D,M,Y)	Time(Hour, miNute, Day, Month, Year)

Returns the current time as set by the remote outstation defined by R(M). Default values are all zero before communications are established.

Last Reset Time

Command :	T(L)	Time(Last reset)

Returns the time of the last LTX power-up or reset providing communication was established with the primary remote outstation. Default values are all zero before communications are established.

Alarm Review

Alarm Review

Command :	Vx	reView x (x=1..20)

Allows the last 20 alarms to be reviewed. The command Vx displays the 10 alarms from x to x+9 in the alarm buffer. If x>11 then returns alarms x to 20. The alarm at index 1 is the earliest alarm and index 20 contains the latest alarm (if at least 20 alarms have been generated). So V1 displays alarms 1 to 10 and V11 displays alarms 11 to 20 in the buffer.

If an alarm has not been acknowledged by the alarm supervisor then an asterisk '*' will be displayed after the index number and the alarm is still queued for transmission.

The alarm review buffer retains alarm information across node resets but does not retain alarms across power-ups.

LTX Commands

A number of commands are available for performing various diagnostic operations via text commands. The basic format of the commands is "#(command)".

Reset Command

Command :	#(R=1)	#(Reset)

Causes the LTX-21 to perform a software reset as if the device were re-powered. The command requires that #(R=1) is entered rather than simply #(R) to reduce the chance of a reset occurring due to mistyping.

Wink Command

Command :	#(W)	#(Wink)

Causes the yellow service LED on the front of the LTX-21 to blink several times. Useful for identifying a specific device if several are in use.

Test Alarm Command

Command :	#(A)	#(test Alarm)

If a valid alarm address is set, #(A) causes the LTX-21 to send a test alarm to the alarm supervisor, and causes another alarm to be sent when it receives an acknowledgement from the supervisor. A useful commissioning tool for proving the alarm reporting route in both directions. The LTX-21 locally reponds to the #(A) command by responding with “>TEST ALARM OCCURRED”, and when the supervisor acknowledgement is received with “>TEST ALARM CLEARED”.

Send Service Pin Message Command

Command :	#(S)	#(Service pin)

The same as pressing the Service Pin on the front of the LTX when installing the device in a LonWorks engineering tool. Useful if the LTX is physically inaccessible.

Clear Faults Command

Command :	#(C)	#(Clear faults)

Resets all indoor units causing any faults to clear and any stopped units to restart. This requires the nvoClearance Network Variable to be bound. This is equivalent to causing a physical reset from a remote controller keypad. This command is very useful as it allows units to be restarted that have locked out due to stopping faults(e.g. through high temperature/high pressure faults).

Note that 99 faults will not be cleared as they are generated by the LTX and will only be cleared when communications with a unit are re-established.

LTX-21 LonWorks Engineering

The first step in configuring an LTX-21 and the LG1 interfaces is to perform the necessary LonWorks engineering to bind the devices together. Any suitable LonWorks network management tool can be used. Details of the LTX-21 functional profile are provided at the back of this datasheet.

Firstly, install the LTX-21 in the engineering tool either by pressing the service pin on the front or using the LTX command #(S). If no copy of the external interface file is available then upload this from the device. Add the LTX-21 function block to the project.

Next install the LG1 into the tool and import the interface. Not all network inputs and outputs are necessary for configuration. For clarity it is recommended that only those necessary for configuration are added to the function block.

The following network variables should be bound

LTX-21	Direction	LG1
nvoUnitSettings	⇨	nviUnitSettings2
nvoQuery	⇨	nviQuery
nvoClearance	⇨	nviClearance
nviIndoorData	⇦	nvoIndoorData

Note that the LG1 contains two Unit Settings network variables, only nviUnitSettings2 should be bound to.

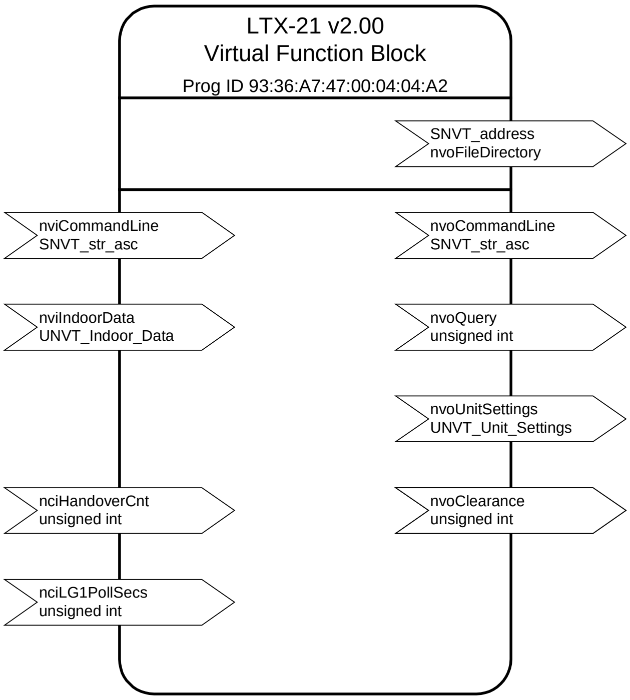
The LTX-21 uses an addressing method to send and receive data with the air-conditioning interface. The units that are controlled by the LTX-21 are determined by which zones are configured as active within the LTX-21. Note that it is important to set the LG1 configuration parameter nciNumUnits equal to the maximum indoor unit address. If the value is less then certain units will not be controlled and it may lead to unpredictable behaviour. If in doubt set nciNumUnits to 16.

Once the binding for each zone is complete the LonWorks engineering of the system is complete, however it is recommended the engineering tool is left attached to the network, or is reattached after commissioning is complete as this will allow LTX-21 configuration parameters to be saved in the project database for backup purposes.

Text Comm Engineering via LonWorks

Engineering the LTX from the LonWorks side is achieved by setting up a network variable browser with monitoring enabled and browsing the LTX-21 Node Object. Within the node object are two SNVTs called nviCommandLine and nvoCommandLine. The nviCommandLine can hold text commands of up to 30 characters, and the nvoCommandLine will report any responses to these commands, although responses of greater than 30 characters will be truncated. Using the LonWorks nviCommandLine method allows most engineering and commissioning steps to be performed without disconnecting the LTX-21 from the BMS.

LTX-21 Functional Profile



The LTX-21 functional profile is shown above. The following table gives a summary for each network variable.

NV Index	Name	In/Out	Type	Description
0	nvoFileDirectory	Out	SNVT_address	File pointer to configuration data
1	nviCommandLine	In	SNVT_str_asc	Command Line input string
2	nvoCommandLine	Out	SNVT_str_asc	Command Line response string
3	nvoUnitSettings	Out	UNVT_Unit_Settings	Unit settings data
4	nvoQuery	Out	unsigned int	Indoor data query index
5	nvoClearance	Out	unsigned int	Fault clearance command
6	nviIndoorData	In	UNVT_Indoor_Data	Indoor unit data
7	nciHandoverCnt	In	unsigned int	Repeat count on handover to local
6	nciLG1PollSecs	In	unsigned int	LG1 poll rate

The LTX-21 is a gateway used for transferring significant amounts of data between the BMS and the air-conditioning system. As such the functionality of the gateway is very different from a standard LonWorks device. The gateway uses several user defined network variables to allow compatibility with target devices such as the Toshiba LG1. Data is transferred to the air-conditioning interface using the nvoUnitSettings data structure. One field in this data structure is the address of the target indoor unit, the rest of the data fields contain all of the necessary variables required to completely define the operation of the unit. To read-back data from the units, the nvoQuery network variable is set to a particular unit address, the air-conditioning interface responds by writing its current state to the nviIndoorData. Again this contains an address field to identify the source address of the data.

LTX-21 Network Variables

network output UNVT_Unit_Settings ***nvoUnitSettings***

User defined data structure with the following fields

```
typedef struct {
        unsigned int   unit_number;
        SNVT_hvac_mode hvac_mode;
        SNVT_temp_p    setpoint;
        unsigned int   on_off;
        unsigned int   fan_speed;
        unsigned int   louver;
        unsigned int   filter_reset;
        unsigned int   priority_c_o;
        unsigned int   operation_ban;
} UNVT_Unit_Settings;
```

Valid values for these fields are as follows

Field	Valid Values
unit_number	1..16
hvac_mode	{AUTO=0, HEAT=1, COOL=3, FAN ONLY=9}
setpoint	18.00-29.00 Degrees Centigrade
on_off	{OFF=0, ON=1}
fan_speed	{AUTO=0, LOW=1, MEDIUM=2, HIGH=3}
louver	{OFF=0, ON=1}
filter_reset	{NORMAL=0, RESET=1}
priority_c_o	{REMOTE=0, CENTRE=1}
operation_ban	{NONE=0, PRESENT=1}

This data structure contains the complete operation commands for a single air-conditioning unit, addressed by the field `.unit_number`.

---

network output unsigned int ***nvoQuery***

Output range is between 1 and 16 and corresponds to the current unit address being queried

---

network output unsigned int ***nvoClearance***

Propagates the value 1 on the LTX command #(C)

---

network input unsigned int ***nviIndoorData***

User defined data structure with the following fields

```
typedef struct {
        unsigned int   unit_number;
        SNVT_hvac_mode hvac_mode;
        SNVT_temp_p    setpoint;
        unsigned int   on_off;
        unsigned int   fan_speed;
        unsigned int   louver;
        unsigned int   filter_state;
        SNVT_temp_p    indoor_temp;
        SNVT_temp_p    heat_exch_temp;
        unsigned int   unit_fault;
} UNVT_Indoor_Data;
```

Valid values for these fields are as follows

Field	Valid Values
unit_number	1..16
hvac_mode	{AUTO=0, HEAT=1, COOL=3, FAN ONLY=9}
setpoint	18.00-29.00 Degrees Centigrade
on_off	{OFF=0, ON=1}
fan_speed	{AUTO=0, LOW=1, MEDIUM=2, HIGH=3}
louver	{OFF=0, ON=1}
filter_state	{OK=0,DIRTY=1}
indoor_temp	-255.00..255.00
heat_exch_temp	-255.00..255.00
unit_fault	1..255, 0 indicates no unit

The data is returned from the indoor unit and indicates its current operating state.

---

*network input SNVT_str_asc **nviCommandLine***

This NV is primarily used for commissioning and engineering purposes. A string of up to 30 ASCII characters plus a terminator can be entered. All of the standard LTX-21 text based engineering commands can be entered. Any responses to the commands are returned in nvoCommandLine. The commands can entered from any engineering tool that allows the SNVT value to be manually entered.

---

*network output SNVT_str_asc **nvoCommandLine***

Returns responses to commands entered in nviCommandLine. The response is limited to 30 characters so responses of length greater than 30 characters are truncated. For commands that produce multi-line responses each response is sent to the NV, but it is likely that only the last line of the response will be observed.

---

*network input config unsigned int **nciHandoverCnt**=1*

Config network variable. The handover count defines the number of repeat transmissions the LTX sends to place a unit into local control. Default is 1 repeat.

---

*network input config unsigned int **nciLG1PollSecs**=5*

Config network variable. The rate that the LTX polls the LG1 for data. Default is 5 seconds.

Configuration Parameters

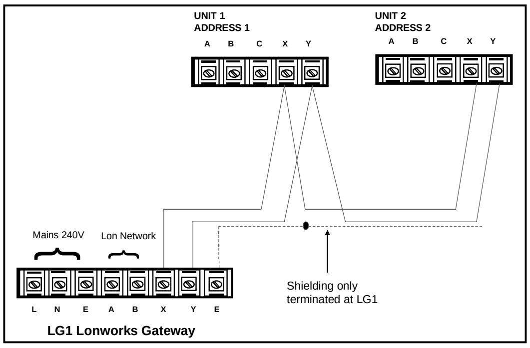
The LTX-21 has a series of internal configuration parameters stored in EEPROM that retain all of the addressing settings of the device. These are not designed to be directly edited via LonWorks. Instead they are accessed through commands such as “R(M=38,A=91)”. This is a safe access method that ensures that only valid values are set. The values can be set on the LonWorks side using nviCommandLine.

The LonWorks engineering tool used should have the capability for uploading and downloading configuration parameters. After the device has been engineered the configuration parameters should be uploaded from the device (e.g using the command “Resync CPs” in LonMaker and selecting *Upload from device*). If the device needs to be replaced in the future or the database is duplicated for another site, these values will be installed in the new device.

Toshiba Installation and Commissioning

1) All units (if possible) should be placed on the X-Y network. B-C Slave wiring should NOT be used

2) The X-Y network should be wired as a daisy chain from the panel where the LG1 is located to each unit. Multiple cables should not be run out from the panel, refer to Toshiba instructions for more details.



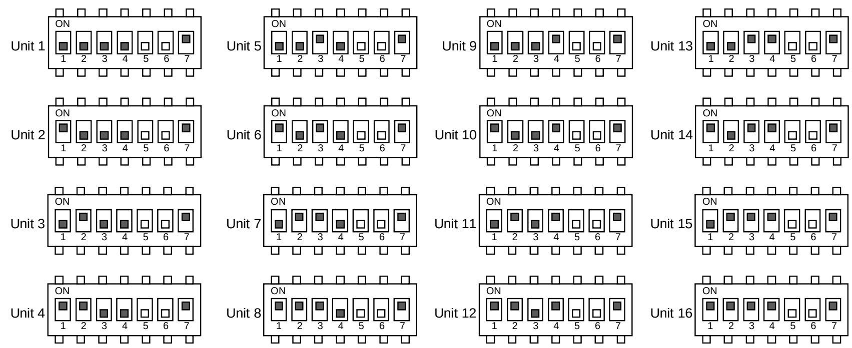
3) If more than 16 units are installed, then the units should be divided into groups of 16 or less and each group wired and addressed seperately. An LG1 interface (and LTX) is required for every 16 units

4) If remote controllers are used, they should only by wired to the MASTER via ABC, The slave BC connection should NOT be installed if the slaves are on the X-Y network. Slave control is performed by the BMS.

5) All units on X-Y network should be setup with SW01 rotary switch set to 1. All units are ‘masters’ on the X-Y. Slave groups are created in software. SW02 should be set to the unit number using the following dip switch settings. **Note that the indoor board must be re-powered for this addressing to take effect.**

1) Set Rotary switch SW01 to 1

2) Set SW02 according to the following settings.



6) To commission the system, instead of using a remote controller the network should be commissioned using a Central Controller available from Toshiba. This works on the X-Y network and will confirm that the unit addresses are set up correctly. It allows units to be individually run and shows the fault code status for each unit**.**

7) **Once the system is commissioned , the X-Y network cable can be simply transferred from the central controller to the Toshiba LG1.** Refer to the Toshiba LG1 installation instructions for further details of X-Y network wiring and DIP switch settings for address allocation.

Summary of Toshiba Fault Codes

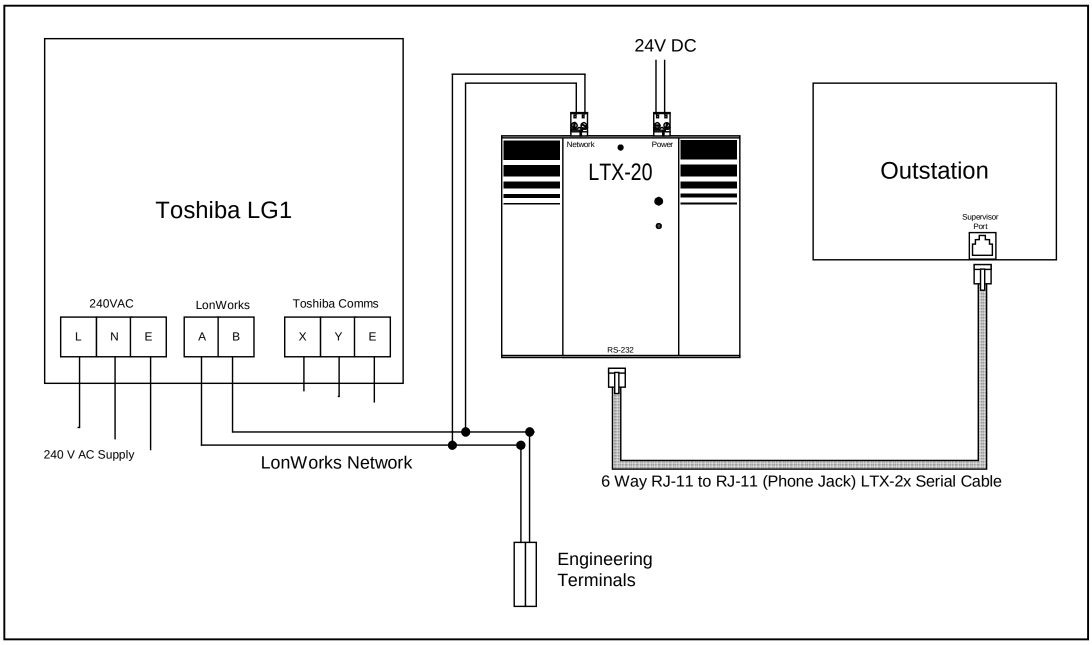
Below is a brief summary of the Alarm codes that can be generate by the Toshiba units. Refer to the Toshiba Service manual for more detailed explanations of the codes.

Hex Code	Fault	Critical	Decimal Code
00	No indoor unit connected	✘	0
04	No communication on 1-2-3 terminals	✓	4
08	Reverse temperature change	✘	8
09	Frost or no-temp change	✘	9
0B	Indoor unit float switch	✘	11
0C	Indoor temperature sensor TA	✘	12
0D	Indoor heat-exchanger sensor TC	✘	13
12	Indoor microprocessor fault	✓	18
14	Refer to outdoor unit (Super Multi)	✓	20
15	Refer to Multi Controller	✓	21
18	Refer to outdoor unit (TE Sensor Fault)	✓	24
19	Refer to outdoor unit (TL/TD Sensor Fault)	✓	25
1C	Refer to outdoor unit (Super Multi)	✓	28
1D	Refer to outdoor unit (Super Multi)	✓	29
1E	Refer to outdoor unit (High discharge temp)	✓	30
1F	Refer to outdoor unit (Super Multi)	✓	31
21	Refer to outdoor unit (High pressure switch)	✓	33
99	Lost communications with indoor unit	✓	153
B7	Group Fault Code	✓*	183
FF	No Fault	-	255

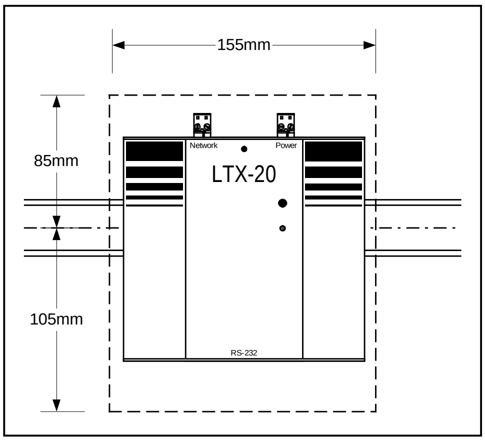
* B7 Fault code indicates a fault in one or more slaves attached on the A-B-C network of a master. By default it is assumed that B7 *could* be critical. LTX alarm options defined by R(G) allow B7 faults to be classified as non-critical if so desired.

NOTE: There only difference between decimal and hexadecimal is the way the number is displayed. When viewing fault codes from the LG1 the data may be formatted in either hexadecimal or decimal format, depending on what viewing method is used. To maintain compatibility with established fault code methods these codes are reported by the LTX-21 in *hexadecimal*.

Installation Instructions



The LTX-21 is connected as shown in the above diagram.



1) Mount the LTX-21 on a standard symmetric DIN rail. A clearance of 85mm above and 105mm below the DIN rail centreline should be allowed and 155mm horizontal clearance. See the figure to the right.

2) Connect the LTX-21 Power connector (black) to a 1.5VA 24Vdc supply. The connection is polarity independent. **Note that the power supply should not be isolated, 0V should be connected to ground**. Do not power the device up.

3) Install the LonWorks network between the LTX-21 connector labelled ‘Network’ (orange or green) and the LG1 terminals labelled ‘A-B LonWorks’ using unshielded twisted pair; the connection is polarity independent. Multiple devices can be daisy-chained.

4) Daisy-chain the LonWorks connection from the LTX-21 to a pair of screw-terminals mounted on the DIN rail adjacent to the LTX-21. This is for engineering purposes and allows easy access to the network.

5) Daisy chain a network terminator to the LonWorks network if specified.

6) Connect the supplied grey RJ-11 to RJ-11 cable between the LTX-21 port labelled ‘RS-232’ and the outstation supervisor port.

LTX-21 Commissioning Sheet

Site Name	
Controller Location	

Addressing

Identifier	**R(D)**	

Local Address	R(L)	
Remote Address	R(M)	
Secondary Address	R(S)	

Alarm Address	R(A)	
Alarm Lan	R(R)	

Non-Critical Alarm Fitler	R(F)	
Critical Alarm Fitler	R(T)	

Alarm Configuration	**R(G)**	

Outstation PIN	R(P)	

Offsets

Switchover Zone	F(S)	
Hex Fault code offset	F(H)	
Decimal Fault Code offset	F(D)	

Return Air Temp offset	F(R)	
Heat Exch Temp offset	F(E)	
Alarm Byte Offset	F(A)	

Zone Remote Offsets

Z1(R)	
Z2(R)	
Z3(R)	
Z4(R)	
Z5(R)	
Z6(R)	
Z7(R)	
Z8(R)	

Z9(R)	
Z10(R)	
Z11(R)	
Z12(R)	
Z13(R)	
Z14(R)	
Z15(R)	
Z16(R)	

Defaults Settings

Setpoint	Z17(S)		18oC to 29oC
Fanspeed	Z17(F)		{0=AUTO, 1=LOW, 2=MEDIUM, 3=HIGH}
Run Mode	Z17(M)		{0=AUTO, 1=HEAT, 2=FAN ONLY, 3=COOL}
Louver	Z17(L)		{0=OFF, 1=ON}
Run Enable	Z17(E)		{0=OFF, 1=ON}
Keypad Enable	Z17(K)		{0=CENTRAL, 1=LOCAL}

Troubleshooting Guide

Problem	Cause	Actions/Checks
LTX not communicating with the Remote Outstation	LTX operating on isolated power supply	Connect the 0V of the supply down to earth
	Incorrect Remote OS address	Set R(M) to the correct address
	BMS Supervisor port not allocated a network address	Allocate a valid address to the outstation supervisor port
Zone in 99 Fault or showing E:COMMS	Unit not responding to queries	Check X-Y network Installed correctly
		Check indoor boards addressed correctly
		Check Rotary switch SW01 set to 1.
		Check for duplicated unit addresses on SW02
		Check units re-powered after re addressing
Zone not Operating	Run settings not compatible with unit	Check cooling-only units are being sent COOL command rather than AUTO
		Unit addressing problem
		Unit Has local hold-off device
Zone showing E:UPDATE	Unit readback settings are different from settings sent by LTX	Check if louver activation is called for on a unit without louvers – or the louver jumper CN21 has been removed
		Heating is being called on a cooling only unit.
		The unit has a local hold-off device such as a Toshiba T2
		Check Rotary switch SW01 set to 1.

Technical Specification

Electrical

Supply	24V DC unisolated
Power	1.5VA
Processor	Echelon 3150
Clock Speed	10 MHz
External Memory	32kb PROM, 24kb SRAM
LON Network	FTT-10A Transceiver, Free topology network
RS-232	9k6 baud, max cable length 3 metres Use cable LT-CC-1 supplied

Mechanical

Dimensions	H138 x W146 x D38 without DIN clip H144 x W146 x D48 with DIN clip
Mounting	Quick release standard DIN rail
Clearance around DIN rail	Minimum 85mm above and 105mm below DIN rail centreline
Casing Material	Casing – Powder coated 18 gauge steel to RAL 3020
Weight	250g
Power and LON **Connectors**	Two part rising clamp 0.5mm" to 2.5mm" cross sectional area cable
RS-232 Connector	RJ-11 Socket

Environmental

Temperature	
Storage	-10oC to 50oC
Operation	0oC to 50oC
Humidity	0-90% RH non-condensing
Protection	IP30
EMC Emissions	EN50081-1
EMC Immunity	EN50082-1

Note on Serial Communications

Serial communications with the BMS involves RS-232 communications using the Tx and Rx channels but no hardware handshaking. This makes the operation of the LTX-21 and the connected outstation completely asynchronous and independent and avoids any possibility that hardware handshaking could influence the operation of the outstation communications port.

Future updates of this datasheet available from http://www.realtime-controls.co.uk