

High Accuracy Digital Temperature Sensor and Thermal Watchdog with Two-Wire Interface

Features

- SMBus interface
- Hardware Power-on Setting & Programmable over temperature limit
- Separate open-drain output pin operates as interrupt or comparator at output
- Register readback capability
- Power up defaults permit stand-alone operation as thermostat
- Shutdown mode to minimize power consumption

Key Specifications

- Supply Voltage 3.0V to 3.6V
- Supply Current

operating	110 μ A (typ)
	130 μ A (max)
shutdown	1 μ A (max)
- Temperature Accuracy

-10°C to 80°C	$\pm 1^\circ\text{C}$ (max)
-55°C to 125°C	$\pm 3^\circ\text{C}$ (max)

General Description

The G753H is a temperature sensor, analog-to-digital converter, and digital over-temperature detector with SMBus interface. The host can query the G753H at any time to read temperature. The open-drain ALERT# output becomes active when the temperature exceeds a programmable limit which initiated by hardware power-on setting. This pin can operate in either "Comparator" or "Interrupt" mode.

Applications

- System Thermal Management
- Personal Computers
- Office Electronics
- Electronic Test Equipment

Ordering Information

ORDER NUMBER	MARKING	PACKAGE (Green)
G753HT11U	753hx	SOT-23-5

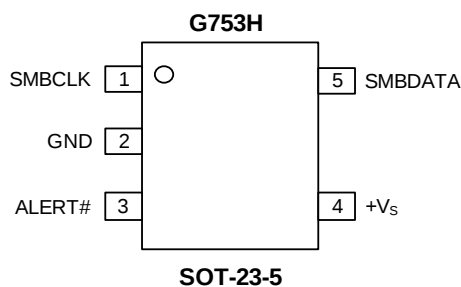
Note: T1: SOT-23-5

1 : Bonding Code

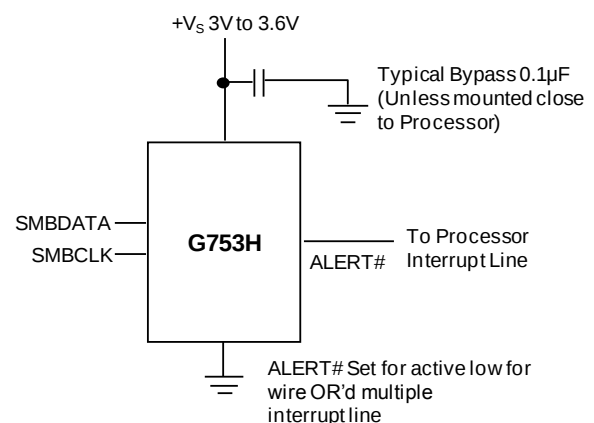
U: Tape & Reel

Green : Lead Free / Halogen Free

Pin Configuration



Typical Application Circuit



Absolute Maximum Ratings

+Vs to GND.. -0.3V to +3.6V
 SMBCLK, SMBDAT, ALERT#, to GND -0.3V to +3.6V
 SMBDATA, ALERT#. Current. -1mA to +50mA
 ESD Protection (human body model)..2000V
 Thermal Resistance Junction to Ambient, (θ_{JA})
 SOT-23-5. 240°C/W
 Continuous Power Dissipation ($T_A = +25^\circ\text{C}$)
 SOT-23-5 0.5W

Thermal Resistance Junction to Case, (θ_{JC})
 SOT-23-5. 60°C/W
 Operating Temperature Range -55°C to +125°C
 Junction Temperature. +150°C
 Storage temperature Range. -65°C to +165°C
 Reflow Temperature (soldering, 10sec) +260°C

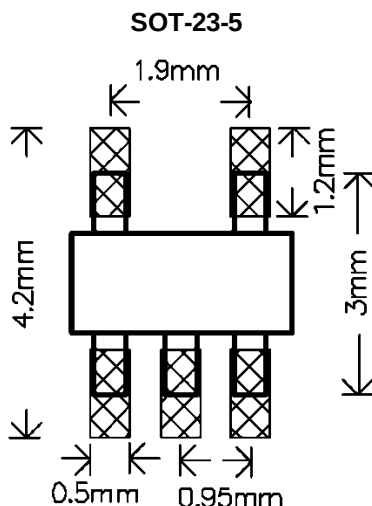
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Temperature-to-Digital Converter Characteristics

Unless otherwise noted, these specifications apply for +Vs=+3.3V Vdc. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}** ; all other limits $T_A = T_J = +25^\circ\text{C}$, unless otherwise noted.

PARAMETER	CONDITIONS	TYPICAL	LIMITS	UNITS
Accuracy	$T_A = -10^\circ\text{C}$ to $+80^\circ\text{C}$	---	± 1.0	°C
	$T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$	---	± 3.0	
Resolution		8	---	Bits
Temperature Conversion Time		100	---	ms
Quiescent Current	conversion rate=16Hz	110	130	μA
	Shutdown Mode	9	20	μA
ALERT#. Output Saturation Voltage	$I_{OUT} = 4.0\text{mA}$	---	0.8	V (max)
ALERT#. Delay		---	1	Conversions (min)
		---	6	Conversions (max)

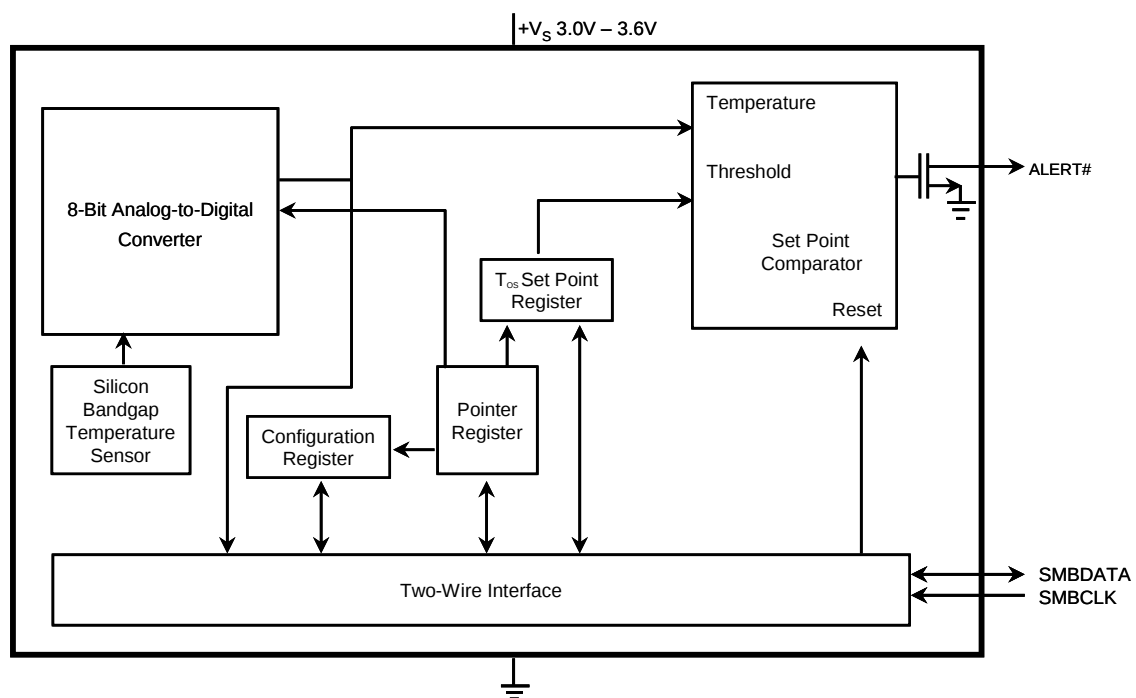
Minimum Footprint PCB Layout Section



Pin Description

PIN	LABEL	FUNCTION	TYPICAL CONNECTION
1	SMBCLK		
2	GND	Power Supply Ground	Ground
3	ALERT#.	Overtemperature Shutdown Open Drain Output	Pull Up Resistor, Controller Interrupt Line
4	+Vs	Positive Supply Voltage Input	DC Voltage from 3V to 3.6V
5	SMBDATA	SMBus Serial Bi-Directional Data Line	From Controller
---	NC	No Connect	

Block Diagram



Logic Electrical Characteristics

Digital DC Characteristics

Unless otherwise noted, these specifications apply for $+V_s = +3.3$ Vdc. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}** ; all other limits $T_A = T_J = +25^\circ\text{C}$, unless otherwise noted.

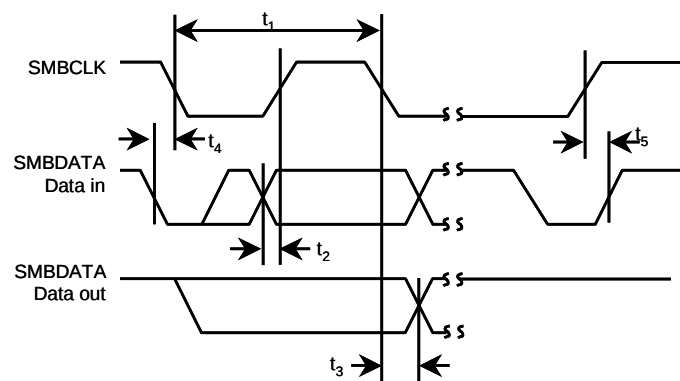
SYMBOL	PARAMETER	CONDITIONS	TYPICAL	LIMITS	UNITS
$V_{IN(1)}$	Logical "1" Input Voltage		---	$+V_s \times 0.7$	V (min)
			---	$+V_s + 0.5$	V (max)
$V_{IN(0)}$	Logical "0" Input Voltage		---	-0.3	V (min)
			---	$+V_s \times 0.3$	V (max)
$I_{IN(1)}$	Logical "1" Input Current	$V_{IN} = 3.3\text{V}$	0.005	1.0	μA
$I_{IN(0)}$	Logical "0" Input Current	$V_{IN} = 0\text{V}$	-0.005	-1.0	μA
C_{IN}	All Digital Inputs		20	---	pF
I_{OH}	High Level Output Current	$V_{OH} = 3.3\text{V}$	---	100	μA (max)
V_{OL}	Low Level Output Voltage	$I_{OL} = 3\text{mA}$	---	0.4	V (max)
t_{OF}	Output Fall Time	$C_L = 400\text{pF}, I_O = 3\text{mA}$	---	250	ns (max)

SMBus Digital Switching Characteristics

Unless otherwise noted, these specifications apply for $+V_s = +3.3$ Vdc and C_L (load capacitance) on output lines = 80pF unless otherwise specified. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}** ; all other limits $T_A = T_J = +25^\circ\text{C}$, unless otherwise noted.

The switching characteristics of the G753H fully meet or exceed the published specifications of the SMBus. The following parameters are the timing relationships between SMBCLK and SMBDATA signals related to the G753H. They are not the SMBus specifications.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	LIMITS	UNITS
t_1	SMBCLK (Clock) Period		---	2.5	μs (min)
t_2	Data in Set-Up Time to SMBCLK High		---	100	ns (min)
t_3	Data Out Stable after SMBCLK Low		---	0	ns (min)
t_4	SMBDATA Low Set-Up Time to SMBCLK Low (Start Condition)		---	100	ns (min)
t_5	SMBDATA High Hold Time after SMBCLK High (Stop Condition)		---	100	ns (min)



Functional Description

The G753H temperature sensor incorporates a band-gap type temperature sensor and 8-bit ADC (Analog-to-Digital Converter). The temperature data output of the G753H is available at all times via the SMBus. If a conversion is in progress, it will be stopped and restarted after the read. A digital comparator is also incorporated that compares a series of readings, the number of which is user-selectable, to user-programmable setpoint and hysteresis values. The comparator trips the ALERT#. output line, which is programmable for mode and polarity.

SMBus Digital Interface

From a software perspective, the G753H appears as a set of byte-wide registers that contain temperature data, alarm threshold values, or control bits. A stand-

ard SMBus 2-wire serial interface is used to read temperature data and write control bits and alarm threshold data.

Each A/D channel within the device responds to the same SMBus slave address for normal reads and writes.

The G753H employs four standard SMBus protocols: Write Byte, Read Byte, Send Byte, and Receive Byte (Figure 1). The shorter Receive Byte protocol allows quicker transfers, provided that the correct data register was previously selected by a Read Byte instruction. Use caution with the shorter protocols in multi-master systems, since a second master could overwrite the command byte without informing the first master

Write Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	DATA	ACK	P
	7 bits			8 bits		8 bits		1

Slave Address: equivalent to chip- select line of a 3-wire interface

Command Byte: selects which register you are writing to

Data byte: data goes into the register set by the command byte (to set thresholds, configuration masks, and sampling rate)

Read Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	S	ADDRESS	RD	ACK	DATA	///	P
	7 bits			8bits			7bits			8 bits		

Slave Address: equivalent to chip- select line

Command Byte: selects which register you are reading from

Slave Address: repeated due to change in data-flow direction

Data byte: reads from the register set by the command byte

Send Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	P
	7 bits			8 bits		

Command Byte: sends command with no data, usually used for one-shot command

Receive Byte Format

S	ADDRESS	RD	ACK	DATA	///	P
	7 bits			8 bits		

Data Byte: reads data from the register commanded by the last Read Byte or Write Byte transmission; also used for SMBus Alert Response return address

S = Start condition Shaded = Slave transmission P = Stop condition /// = Not acknowledged

Figure 1. SMBus Protocols

**Table 1. Temperature Data Format
(Two's-Complement)**

TEMP (°C)	SIGN	MSB	LSB
+127	0	111	1111
+25	0	001	1001
+1	0	000	0001
-1	1	111	1111
-25	1	110	0111
-65	1	011	1111

The temperature data format is 8bits plus sign in two's-complement form, transmitted MSB first.

Slave Address

The G753H appears to the SMBus as one device having a common address for both ADC channels. The G753H has the following SMBus slave address:

	A6	A5	A4	A3	A2	A1	A0
G753H	1	0	0	1	0	0	0

The G753H also responds to the SMBus Alert Response slave address (see the Alert Response Address section).

ALERT# Output

The G753H ALERT# pin is an active-low open-drain output pin which is triggered when measured temperature exceeds the limitation defined in the limit registers. There are three types of ALERT# output mode: the ALERT# output comparator mode, the ALERT# output interrupt mode, and the ALERT# output SMBus ALERT# mode.

ALERT# Output Comparator Mode

Figure 2 shows the mechanism of the ALERT# output comparator mode. In this mode, the ALERT# pin will be alerted if the monitored temperature is out-of-limit and the ALERT# pin keeps low until the temperature goes back to the target range.

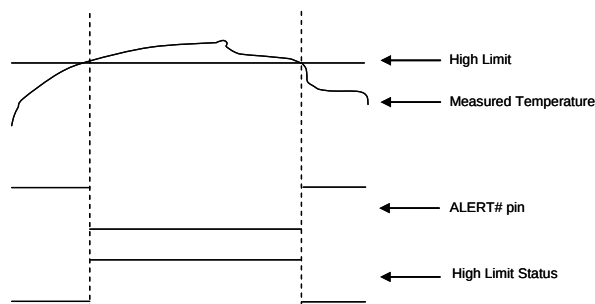


Figure 2

ALERT# Output Interrupt Mode

Figure 3 shows the mechanism of the ALERT# output interrupt mode. In this mode, the G753H will set the ALERT mask bit of Configuration Register during a read of the Status Register if any flag in Status Register, except the ADC_Busy flag is set. This prevents further ALERT# triggering until the master has reset the ALERT mask bit (write 0 to Alert_MSK), at the end of the interrupt service routine. The Status Register flags are cleared only upon a read Status Register command from the master and will be re-alerted at the end of the next temperature conversion if the measured temperature still falls outside of the allowed range.

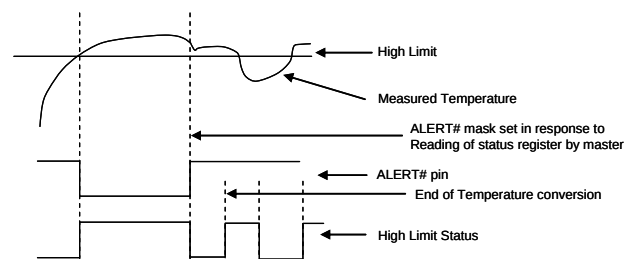


Figure 3

ALERT# Output SMB_{US} alert Mode

Figure 4 shows the mechanism of the ALERT# output SMBus alert mode. In this mode, the ALERT# output of the G753H is connected to the SMBus alert line which has more than one device connected to it. Through such an implementation, SMBus alert mode can assist the master in resolving which slave generates an interrupt. When the measured temperature falls outside of the allowed range, the ALERT# pin will be pulled low and the corresponding alert flags in Status Register will be set to 1. The ALERT mask bit will just be set if there is a read command for Status Register or when SMBus ALERT Response Address (ARA) occurs from master (Alert Response Address is 0001100x). Meanwhile, the G753H will generate and return its own address to the master. If the temperature never falls outside of the allowed range, the latched ALERT# pin can release by the reset ALERT mask bit and the latched corresponding alert flags in Status Register can release by reading command for Status Register.

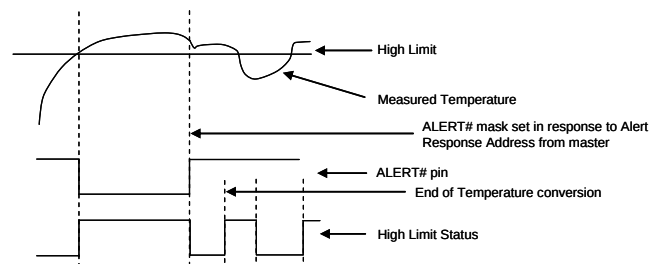


Figure 4

ALERT# point hardware power-on setting

The default value could be set after power up 100ms by different pull-up resistor of ALERT# pin:

PULL-UP RESISTOR		TEMPERATURE (°C)
ALERT	2kΩ	75
	7.5kΩ	90
	10.5kΩ	100
	14kΩ	105
	18.7kΩ	110

Table 2. Command-Byte Bit Assignments

REGISTER	COMMAND	POR STATE	FUNCTION
LT	00h	0000 0000*	Read local temperature. It returns latest temperature
STATUS	02h	N/A	Read status byte (flags, busy signal)
CONFIG(R)	03h	0000 0001	Configuration byte
CRATE(R)	04h	0000 1000	Conversion rate byte
THIL(R)	05h	0100 1011(75)	Local T _{HIGH} limit
CONFIG(W)	09h	1100 0001	Configuration byte
CRATE(W)	0Ah	0000 1000	Conversion-Rate
THIL(W)	0Bh	0100 1011(75)	Local T _{HIGH} limit
ONESHOT	0Fh	N/A	One-shot command (use send-byte format)
Customer Data Log Register 1	2Dh	0000 0000	Customer data log Reg1[7:0]
Customer Data Log Register 2	2Eh	0000 0000	Customer data log Reg2[7:0]
Customer Data Log Register 3	2Fh	0000 0000	Customer data log Reg3[7:0]
Alert mode	BFh	0000 0001	Alert MD
CID (Chip ID)	FDh	0101 0000	Chip ID of G753H is 50h
VID (Vendor ID)	FEh	0100 0111	Vendor ID of G753H is 47h
DID (Device ID)	FFh	0101 0000	Device ID of G753H is 9xh

Command 02h. Status-Byte Bit Assignments

BIT	NAME	FUNCTION
7 (MSB)	BUSY	A high indicates that the ADC is busy converting.
6	LHIGH*	A high indicates that the local high-temperature alarm has activated.

*These flags stay high until cleared by POR, or until the status byte register is read.

Command 03h/09h. Configuration-Byte Bit Assignments

BIT	NAME	POR STATE	FUNCTION
7 (MSB)	MASK	0	Masks all $\overline{\text{ALERT}}$ interrupts when high.
6	$\overline{\text{RUN/STOP}}$	0	Standby mode control bit. If high, the device immediately stops converting and enters standby mode. If low, the device converts in either one-shot or timer mode.
0	EN_FaultQueue	1	EN_FaultQueue —Enable Fault Queue function. ALERT# will be generated if monitor result of any channel is three successive times above or below high/low set point.

Command 04h/0Ah. Conversion Rate

BIT	NAME	POR STATE	FUNCTION
3-0	CRATE	1000	The conversion rate programs the time interval between conversions in free-running auto-convert mode.

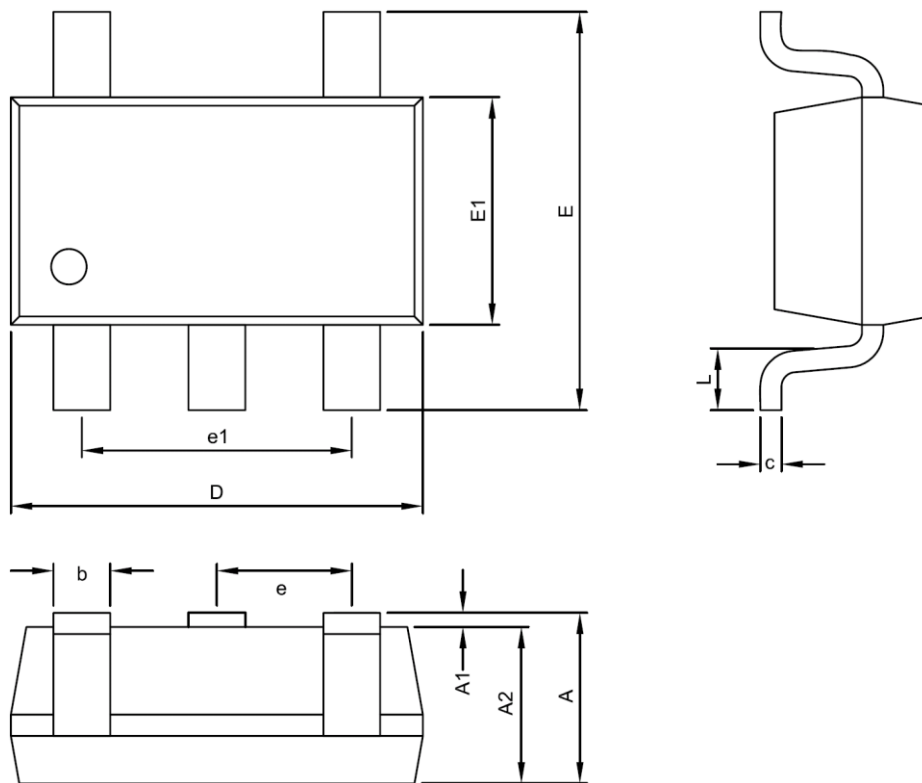
Table 3. Conversion-Rate Control Byte

DATA	CONVERSION RATE (Hz)
00h	0.0625
01h	0.125
02h	0.25
03h	0.5
04h	1
05h	2
06h	4
07h	8
08h	16
09h to FFh	RFU

Command BFh. Alert mode

BIT	NAME	POR STATE	FUNCTION
0	Alert mode	1	ALERT_MD – ALERT mode configuration 0 = Interrupt or SMBus alert mode , 1 = Comparator mode

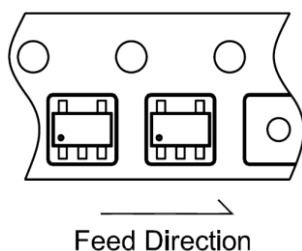
Package Information



SOT-23-5 Package

Symbol	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.95	1.10	1.45	0.037	0.043	0.057
A1	0.00	---	0.15	0.000	---	0.006
A2	0.90	1.10	1.30	0.035	0.043	0.051
D	2.70	2.90	3.10	0.106	0.114	0.122
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.08	0.15	0.25	0.003	0.006	0.010
b	0.30	0.40	0.50	0.012	0.016	0.020
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
L	0.30	0.45	0.60	0.012	0.018	0.024

Taping Specification



PACKAGE	Q'TY/REEL
SOT-23-5	3,000 ea